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Presentation Abstracts
Noisy Harmonic Grammar (NHG; Boersma and Pater 2016) is a framework for stochastic grammars that uses the GEN-cum-EVAL system originated in Optimality Theory (Prince and Smolensky 1993). As a form of Harmonic Grammar, NHG outputs as winner the candidate with the smallest harmonic penalty (weighted sum of constraint violations). It is a stochastic framework because at each “evaluation time,” constraint weights are nudged upward or downward by a random amount; with multiple iterations this creates a probability distribution over candidates.

Standard NHG can be “tweaked” in various ways creating alternative theories. It’s worth exploring these varieties because the differences in their behavior correspond to broad claims about gradient phenomena in language. For instance, noise can be added per tableau cell rather than per constraint; it can be added before or after the multiplication of weights by violation counts; and it can let weights go negative. To these “tweaks” correspond empirical differences: (a) whether harmonically-bounded candidates can receive non-zero probabilities; (b) whether a phonological process applicable in multiple loci will apply in “lockstep” or independently in each locus; (c) whether the sigmoid frequency curves generated by isofunctional constraint families (Zuraw and Hayes, in press) must be symmetrical. I briefly survey the empirical picture regarding these questions, comparing also the predictions of Stochastic OT (Boersma 1997) and of maxent (Goldwater and Johnson 2003). I conclude with some tentative suggestions about what stochastic constraint-based theories currently look most viable.
Looking into segments

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The last two decades of research in phonological theory have focused almost exclusively on grammar (e.g., Optimality Theory, Harmonic Grammar). In the previous decades, however, the focus was almost exclusively on representations (e.g., autosegmental theory, feature geometry), exploding the traditional segment both vertically (into features and feature hierarchies), and horizontally, through many-to-one and one-to-many mappings between features and segments. Throughout all these changes, the notion of segment has remained largely intact, captured in the notation of an IPA symbol, or (in autosegmental terms) the concept of a autosegmental timing unit.

In this talk, based in part on work with Stephanie Shih, I explore the possibility of exploding the segment into a series of three temporally ordered subsegments, corresponding very roughly to the informal concepts of onset, target, and offset of a vowel or consonant. This quantalization of the internal temporal structure of a segment is called Q-theory; it builds very directly on insights from Articulatory Phonology and from Aperture Theory, among other.

This talk will focus on three consequences of Q theory. One is the ability of the theory to model complex segments, including segments (‘Q’) that contrast in the timing of their internal ‘q’ components. A second is that the components of the traditional unit of segment can be referenced independently of one another by the grammar, permitting more insightful descriptions of local and long-distance ‘segmental’ interactions. A third is that the notion ‘segment’ becomes emergent rather than preconceived. While Q Theory allows references to Q, or ‘segment’, as a unit of representation, it also permits the analyst to challenge the utility of this concept. If the notion of ‘segment’ can be reconceptualized as a string of q’s which are more similar to one another, more tightly interrelated with one another, than to other adjoining q’s, we gain the possibility of q-strings both larger and smaller than the traditional segment.
Human perception and memory is susceptible to *illusory conjunctions*: errors that recombine features or parts of different objects (e.g., Treisman & Schmidt, 1982). Previous research has used illusory conjunctions to shed light on the syllabification and syllable-internal structure of spoken words (e.g., Brady et al., 1983; Treiman & Danis, 1988; Treiman et al., 1994; Kolinsky et al. 1995; Mattys & Melhorn, 2005) as well as on the feature structure of sounds and syllables (e.g., Cutting, 1976; Tartter, 1988; Zeng & Mattys, 2011). In this talk, I present evidence from illusory conjunctions for separate consonant and vowel tiers in the mental representation of English disyllables. A computational model of several memory experiments suggests that elements on the same tier may have a cohesiveness similar to that of tautosyllabic segments. The pattern of memory errors observed here is related to results from previous artificial grammar studies of non-local dependency learning. More generally, because illusory conjunctions and other memory errors are frequent and highly structured, they provide many opportunities for studying phonological representation and should be factored into the analysis of experiments on phonological learning and generalization.
I. Introduction. Recent proposals suggest that CLASH, LAPSE, and other constraints that directly refer to stress successfully derive stress patterns without the foot (Steriade 2008, Stanton 2015). While such constraints may supplant simple disyllabic feet, I show that the maira trochee (Hayes 1995) is uniquely necessary to account for stress shift, lengthening, sonority-driven stress, and subminimal word augmentation in Mohawk (Michelson 1988). The Mohawk stress-epenthesis interactions (MSEI) can only be derived if (‘H) and (‘LL) both satisfy FtBin(-µ).

II. Core Analysis. In Mohawk, stress is typically penultimate. Either a coda (1a) or vowel lengthening (1b) supplies the second mora. Stress can ‘shift’ though, when an epenthetic vowel ([e]) occupies the penult. If [e] occupies a closed penult, it receives stress, as we expect (1c). However, when [e] occupies an open penult, stress ‘shifts’ to the antepenult instead (1d).

(1) a. /k-atirut-haʔ/ [.ka.ti(‘.rut.)haʔ.] ‘I pull’  
    b. /k-mortat-s/ [.kha(‘.ra.)tats.] ‘I am lifting it up a little (with a lever)’  
    c. /wak-nyak-s/ [.wa(‘.ken.)yaks.] ‘I get married’  
    d. /w-a kra-s/ [(.‘.wa.ke)ras.] ‘It smells’

We can understand these patterns as means of satisfying an unviolated FtBin(-µ) with either an (‘H) or (‘LL) foot (Ikawa 1995, Rawlins 2006). FtBin, M(ONO)S(VLLABIC)F(OOT) >> DEPM expresses a general preference to lengthen a vowel to build an (H) foot, over an (LL) foot (2a,b). The ranking of a constraint against long epenthetic vowels though, DEPV; , over MSF, prefers (‘LL), if lengthening would produce a long epenthetic vowel (2d).

(2) Input Winner Loser FtBin DEPV; MSF DEPM
   a. k-mortat-s .kha(‘.ra.)tats .kha(‘.ra.)tats W e e L
   b. k-mortat-s .kha(‘.ra.)tats (.‘.kha.ra.)tats e e W L
   c. w-a kra-s (.‘.wa.ke)ras .wa(‘.ke)ras W e L e
   d. w-a kra-s (.‘.wa.ke)ras .wa(‘.ke)ras e W L L W

The choice of (‘H) or (‘LL) to satisfy FtBin derives the data in (1). Other analyses of these data (Alderete 1995, Elfner 2016) do not use the maira trochee. To derive the entire set of MSEI though, reference to the two foot types (‘H) and (‘LL) is essential.

III. Supporting data. Mohawk also has a process of [a] epenthesis in noun incorporation. The behavior of [a] is almost exactly like that of [e]: in closed penults, [a] receives stress (3a). But, in open penults, [a] does not; stress falls on the antepenult. Unlike [e] forms though, if the antepenult is open, the tonic vowel lengthens (3b).

(3) a. /te-wak-iʔtsyuk-nyu-s/ [.te.wa.keʔtsyuu(‘.kan.)yus.] ‘I’m sneezing’  
    b. /te-ka-naket-ke-O/ [.te.kan(‘.ke.)ta_ke] ‘Two containers’

We can understand lengthening in (3b) as the emergence of an (‘H) foot on the antepenult, when an (‘LL) foot would place a sonorous vowels in the weak position of a foot (de Lacy 2002). AL(IGN)R >> MSF prefers an (‘LL) foot over an (‘H) foot on the antepenult (4a) The constraint *(‘.a) however, ranked above AlR, prefers a monosyllabic foot on the antepenult (4b). Thus, the option between (‘LL) and (‘H) allows us to understand the difference between [e] and [a] forms: when an epenthetic vowel occupies the penult, (‘LL) is generally, preferred, but where it would place a sonorous vowel in a weak position, (‘H) is optimal.

(4) Input Winner Loser FtB * (‘.a) AlR DEPV; MSF DEPM
   a. w-a kra-s (.‘.wa.ke)ras .wa(‘.ke)ras e e W e L e
   b. ...ket-ke(...‘.ke.)ta.ke ...(.‘.ke.ta.)ke... e W L e W e

The choice between (‘H) and (‘LL) also derives forms with epenthetic vowels occupying both the antepenult and penult syllables. In forms where [a] occupies the antepenult, and [e] the
penult, the antepenult receives stress, and no lengthening occurs (6a). But, when [e] occupies the antepenult, the penult receives stress, and [a] gets lengthened (6b).

(6) a. /yo-hnek-kri-Ø/ [.oh.ne(.ka. ke).ri.] ‘broth’
   b. /te-ka?-mnukr-ke-Ø/ [.te.ka?.nuk.se(.ra. ke).ke.] ‘two onions’

The same constraints in (4) derive these data. $\text{DEPV:} \gg \text{MSF}$ prefers a disyllabic foot to a long epenthetic vowel (7a). But, *(.a) $\gg \text{DEPV:}$ will select a candidate with a long epenthetic vowel, if it avoids a sonorous vowel in the weak position of a foot (7b).

(7) Input | Winner | Loser | FtB | *(.a) | ALR | DEPV: | MSF | DEPM
--- | --- | --- | --- | --- | --- | --- | --- | ---
a. ..k-kri-Ø | ..(.’ke. ke).ri. | ..ka(‘.ke.:.)ri. | e | e | e | W | L | e
b. ..sr-ke-Ø | ..se(‘.ra:)ke. | ..(.’se.ra:)ke. | e | W | e | L | W | e

A process of subminimal word augmentation provides further evidence for the moraic trochee. [i] is inserted to satisfy the minimum word requirement (= foot + extrametrical syllable) (8a). [e] is inserted though, if it satisfies both the minimal word requirement and a constraint on bad syllable contact (8b). However, [i] is inserted, in addition to [e], in just those cases that would require [e] to lengthen to satisfy FtBin (8c). We can understand [i] insertion in (8c) in terms of building an (‘LL) foot, where an (‘H) foot would violate DEPM:

(8) a. [.i]: /k-ya-s/ [(.i.k.yas.)] ‘I put it’
   b. [e]: /k-rho-s/ [(.ser.)hos] ‘you coat it with something’
   c. [.i] + [e]: /s-riht-Ø/ [(.i.sg.)riht.] ‘Cook!’

$\text{DEPV:} \gg \text{DEPV}$ prefers insertion of a separate vowel, over lengthening an epenthetic vowel (9a).

(9) Input | Winner | Loser | FtB | *(.a) | ALR | DEPV: | DEPV | MSF | DEPM
--- | --- | --- | --- | --- | --- | --- | --- | --- | ---
a. s-riht-Ø | (.i.sg.)riht. | (.sg:)riht. | e | e | e | W | L | W | e

IV. Alternative Analyses. The choice of (‘H) vs. (‘LL) as alternative means of satisfying FtBin and other constraints on foot form provides a unified analysis of a wide array of data in Mohawk. A number of facts are difficult to understand without reference to the two-syllable window the (‘LL) foot provides, and the (‘H) as an alternative option.

Abandoning feet,, assume some constraint accounts for the fact that [e] receives stress in closed syllables, and does not in open syllables (ex. Alderete’s (1999) HEAD-DEP). The lengthening facts would still remain mysterious. $\text{STRESS}(\text{O})\text{W(EIGHT)} \gg \text{DEPM}$ can account for vowel lengthening in open penults (10a; foot structure omitted). But, this ranking incorrectly predicts that lengthening should always occur, including when stress shifts to the antepenult (10b). Without the notion of bimoraic foot that can be satisfied by (‘H) or (‘LL), it is difficult to understand why lengthening does not always apply to vowels in open, stressed syllables.

(10) Input | Winner | Loser | STW | DEPM
--- | --- | --- | --- | ---
a. k-haratat-s | .kha.’ra:.tats. | .kha.’ra.tats. | W | L
b. w-akra-s | . ’wa:.ke:.ras. | .’wa(‘.ke.)ras. | W | L

Similarly, it is difficult to understand the lengthening asymmetries between forms with [e] and [a]. Recall that, when [e] occupies an open penult, the tonic vowel does not lengthen, but when [a] occupies an open penult, the tonic vowel does (ex. [.wa.ke:.ras.] vs. [.te.ka.na.’ke.:ta. ke:]; and similar facts from (6), above). We can appeal to a dispreference for a sonorous vowel in the weak position of a foot to understand these facts. Without the two-syllable window however, it is difficult to capture sonority-driven stress, where the relevant position is not the stress position.

MSEI provides evidence for the necessity of the moraic foot. The distribution of lengthening is easily understood if, because of an unviolated FtBin, (‘H) and (‘LL) are the only two footing options. Additional data, and an alternative analysis of Mohawk in Harmonic Serialism (McCarthy 2000, a.o.) from Elfner (2016) are discussed as well.
1. Introduction. Regarding HS (Harmonic Serialism; McCarthy 2000, a.o.), McCarthy (2013) asks: for two particular operations \( op_1 \) and \( op_2 \) and input \( x \), need \( \text{GEN} \) generate candidate \( op_2(op_1(x)) \) in a single step? This would constitute irreducible parallelism in the sense that \( op_1 \) and \( op_2 \) must apply to the input in parallel. Four cases have been argued to necessitate \( op_2(op_1(x)) \) and require parallel OT (Optimality Theory; Prince & Smolensky 1993/2004): assimilation-epenthesis in Lithuanian (Baković 2005, Albright & Flemming 2013), reduplication-glide formation in Maragoli (Zymet 2015), footing-lengthening in Mohawk (Adler 2016), and harmony-deletion in Gurindji (Stanton 2016). Little, however, has been said about what formal properties these systems share (cf. McCarthy 2010). In this paper, we elucidate the abstract conditions under which generation of \( op_2(op_1(x)) \) is necessary. Assuming the validity of our predecessors’ arguments, we show that the cases above are only superficially different. They receive a uniform formal description: the same set of violation profiles and ranking arguments characterizes their successful derivation in OT, and failed derivation in HS. These cases are all instances of a general process interaction: do Operation 1 followed by Operation 2 unless the result is a marked structure, in which case start over and do Operation 3, which is different from Operation 1. To express this interaction, we argue, generation of \( op_2(op_1(x)) \) is necessary.

2. Lithuanian assimilation-epenthesis. Verbal prefixes (1) undergo voicing and palatal assimilation to following obstruents (2) unless it would result in a geminate, in which case epenthesis (with subsequent assimilation to [i]) takes place instead (3).

   (1) ap-rafi\textsuperscript{t}i,‘describe’ (2) ab-gau\textsuperscript{t}i,‘deceive’ (3) api\textsuperscript{t}bar\textsuperscript{t}i (*ab-bar\textsuperscript{t}i),‘spill on’

   ap-tar\textsuperscript{t}i,‘describe’

   \( \text{ab}^{d}d^{e}g^{h}i,‘get’ \)

   \( \text{ap}^{i}b^{f}er^{t}i (*ab^{f}b^{f}er^{t}i),‘strew’ \)

Parallel OT can express this interaction: \( \text{DEP} \gg \text{IDENT} \) broadly favors assimilation to epenthesis (4b), but \( \text{NOGEM} \gg \text{DEP} \) favors epenthesis where assimilation would yield a geminate (4d).\textsuperscript{1}

\begin{tabular}{|c|c|c|c|c|c|}
\hline
Input & Winner & Loser & AGR & NOGEM & DEP & IDENT \\
\hline
a. & p+d\textsuperscript{l} & b\textsuperscript{-}d\textsuperscript{l} & p-d\textsuperscript{t} & W & L \\
\hline
b. & p+d\textsuperscript{l} & b\textsuperscript{-}d\textsuperscript{l} & p-i\textsuperscript{d} & W & L \\
\hline
c. & p+b\textsuperscript{t} & p\textsuperscript{i}-b\textsuperscript{t} & p-b\textsuperscript{t} & W & L \\
\hline
d. & p+b\textsuperscript{t} & p\textsuperscript{i}-b\textsuperscript{t} & b\textsuperscript{t}-b\textsuperscript{t} & W & L & W \\
\hline
\end{tabular}

However, HS fails\textsuperscript{2} (Albright & Flemming 2013). Assimilation requires two steps to fully satisfy AGR while epenthesis only one, so DEP must rank higher than AGR for assimilation to ever apply (5a). This incorrectly predicts that epenthesis never applies. And, NOGEM cannot block assimilation since the geminate candidate cannot be compared against the epenthetic candidate (5c). With this ranking, the derivation converges on the pathological form *[b-b\textsuperscript{t}] (5d). Thus, the desired forms can only be derived if multiply assimilated candidates are generated in Step 1.

\begin{tabular}{|c|c|c|c|c|c|}
\hline
Step & Input & Winner & Loser & NOGEM & DEP & AGR & IDENT \\
\hline
a. & 1 & p+d\textsuperscript{l} & b\textsuperscript{-}d\textsuperscript{l} & pi-d\textsuperscript{t} & W & L & L \\
\hline
b. & 2 & b+d\textsuperscript{l} & b\textsuperscript{-}d\textsuperscript{l} & b-d\textsuperscript{t} & W & L \\
\hline
c. & 1 & p+b\textsuperscript{t} & \textsuperscript{□} b\textsuperscript{-}b\textsuperscript{t} & \textsuperscript{□} pi-d\textsuperscript{t} & W & L & L \\
\hline
d. & 2 & b+b\textsuperscript{t} & \textsuperscript{□} b\textsuperscript{-}b\textsuperscript{t} & b\textsuperscript{t}-b\textsuperscript{t} & W & L & W \\
\hline
\end{tabular}

\textsuperscript{1} We collapse AGR[VOI] and AGR[PAL] to highlight the essential rankings.

\textsuperscript{2} An HS analysis with constraints banning similar but non-identical adjacent obstruents might succeed, but see Baković (2005), Pajak & Baković (2010) for arguments against the existence of such constraints.
3. Conspiracy of procedures. The above case is an example of a *conspiracy of procedures*, in which the same driving constraint (AGR above) is satisfied by two distinct sequences of operations (multiple assimilation vs. epanthesis). The driving constraint is ordinarily satisfied by Procedure A, which consists of Operation 1 followed by Operation 2. But in environments where Procedure A would result in a marked structure, the driving constraint is satisfied by Procedure B, which consists of Operation 3, different from Operation 1. The expression of conspiracy of procedures involves the following constraints: DRIVER, which drives the application of Procedures A & B (AGR in Lithuanian); *PROCA, which is violated in the application of Procedure A repair (IDENT); *PROC B, which is violated in the application of Procedure B repair (DEP); and BLOCKER, which prefers a Procedure 2 output over a Procedure 1 output (NOGEM). Let \( x \) and \( y \) be inputs whose faithful candidates violate DRIVER. Schematically:

- \( x \) undergoes Procedure A: \( /x/ \rightarrow op_1(x) \rightarrow op_2(op_1(x)) \rightarrow \ldots \), \( op_1, op_2, op_3 \) are single changes
- \( y \) undergoes Procedure B: \( /y/ \rightarrow op_3(y) \rightarrow \ldots \), (McCarthy 2016), \( op_1 \neq op_3 \)

Parallel OT can express these mappings, since it can compare whole outputs. Procedure A is generally preferred to Procedure B (*PROC B > *PROC A; 6b) unless the Procedure A output violates BLOCKER, in which case Procedure B is preferred (BLOCKER > *PROC B; 6d).

<table>
<thead>
<tr>
<th>Input</th>
<th>Winner</th>
<th>Loser</th>
<th>DRIVER</th>
<th>BLOCKER</th>
<th>*PROC B</th>
<th>*PROC A</th>
</tr>
</thead>
<tbody>
<tr>
<td>x</td>
<td>( op_2(op_1(x)) )</td>
<td>x</td>
<td>W</td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>( op_3(y) )</td>
<td>y</td>
<td>W</td>
<td></td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>y</td>
<td>( op_3(y) )</td>
<td>( op_2(op_1(y)) )</td>
<td>W</td>
<td>L</td>
<td>W</td>
<td></td>
</tr>
</tbody>
</table>

HS, on the other hand, cannot express the conspiracy. At the first step of the derivation of \( op_2(op_1(x)) \), \( op_1(x) \) must win over \( op_3(x) \). \( op_1(x) \sim op_3(x) \) entails a ranking that demotes the constraint that favors \( op_3 \), DRIVER, below the constraint that disfavors it, *PROC B (7a). This predicts that \( y \) maps to \( op_1(y) \) in Stage 1 rather than to the desired \( op_3(y) \) (7c), thereby missing the generalization that \( op_3 \) applies when \( op_1 \) followed by \( op_2 \) results in a violation of BLOCKER. GEN therefore must be able to generate candidates that undergo \( op_1 \) and \( op_2 \) in the same stage so that they can be compared against those that undergo \( op_3 \).

<table>
<thead>
<tr>
<th>Step</th>
<th>Input</th>
<th>Winner</th>
<th>Loser</th>
<th>BLOCKER</th>
<th>*PROC B</th>
<th>DRIVER</th>
<th>*PROC A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>( x )</td>
<td>( op_1(x) )</td>
<td>( op_3(x) )</td>
<td>W</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>( op_1(x) )</td>
<td>( op_2(op_1(x)) )</td>
<td>( op_1(x) )</td>
<td>W</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>( y )</td>
<td>( \circ ) ( op_1(y) )</td>
<td>( \otimes ) ( op_3(y) )</td>
<td>W</td>
<td>L</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>( op_1(y) )</td>
<td>( \circ ) ( op_1(y) )</td>
<td>( op_2(op_1(y)) )</td>
<td>W</td>
<td>L</td>
<td>W</td>
<td></td>
</tr>
</tbody>
</table>

4. Attested cases. We show that each of the cases below fits the formal characterization above.

<table>
<thead>
<tr>
<th>Language</th>
<th>Driver constraint(s):</th>
<th>do Proced. A…</th>
<th>unless result is…</th>
<th>else do Proced. B:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lithuanian</td>
<td>Adjacent obstruents agree on [pal] and [voi]</td>
<td>Palat. assim. &amp; voic. assim.</td>
<td>Geminate</td>
<td>[i] epanthesis</td>
</tr>
<tr>
<td>Maragoli</td>
<td>Reduplicants are realized; no hiatuses</td>
<td>Gliding ( \rightarrow ) reduplication</td>
<td>Complex reduplicant onset</td>
<td>Reduplication ( \rightarrow ) gliding</td>
</tr>
<tr>
<td>Mohawk</td>
<td>Feet are bimoraic</td>
<td>Monosyl. footing ( \rightarrow ) V lengthening</td>
<td>Long epenthetic vowel</td>
<td>Disyllabic footing</td>
</tr>
<tr>
<td>Gurindji</td>
<td>Pre-nasal segments are nasal</td>
<td>Iterative [nasal] spreading</td>
<td>NC(_0)V sequence</td>
<td>[nasal] deletion</td>
</tr>
</tbody>
</table>
Sour grapes cyclicity: derivational gaps in Yiddish

Introduction. It is well known that regular phonological processes may misapply in morphologically complex words. Within Optimality Theory, various analyses have been proposed, including some that rely on cyclic phonological evaluation triggered by affixes or phrase heads, and others that enforce Output-Output (OO) Faithfulness to morphologically related surface based forms. The debate between these approaches has focused almost exclusively on cases where phonologically misapplies in derived words. In this paper, I describe a different type of misapplication effect (‘sour grapes cyclicity’), in which morphology fails when affixation cannot simultaneously preserve properties of the base and obey regular phonological requirements. I provide data from Yiddish showing that derivational morphology is blocked whenever affixation would require moving stress in order to keep it within the last three syllables of the word. The result is derivational gaps: some roots permit only limited derivation, and some cannot be affixed at all. These gaps are straightforwardly analyzed using OO-Faithfulness, confirming a typological prediction of the approach. On the other hand, this effect is impossible to analyze or poses difficult learnability challenges in a cyclic account.

Yiddish stress and affixation. Stress falls within the last three syllables in Yiddish monomorphic words. The predominant placement is penultimate (1a), but antepenultimate also occurs frequently (1b). Final stress also occurs, primarily in loanwords (1c). The three-syllable window is absolute, and stress in loanwords is adapted to conform: [aliˈqatə] ‘alligator’ [he-liˈkəptə] ‘helicopter’. This can be formalized with an undominated *EXTENDED-LAPSE(R) constraint, banning sequences of three or more stressless syllables at the right edge of the word.

(1) Yiddish stress

a. Penultimate b. Antepenultimate c. Final
piˈjamə ‘pajamas’ kəˈpokət ‘pocket’ məˈnɪk ‘engineer’
koˈpuxə ‘toad’ ˈja[t]əɾkə ‘lizard’ kəˈkələ ‘crocodile’
ˈhel-fand ‘elephant’ ˈhalibot ‘halibut’ peliˈkan ‘pelican’

With the exception of a small number of non-native affixes that shift or attract stress (verbal -iəs, nominal -aˈtsa), suffixed forms generally preserve the stress of their corresponding base: [ˈhel-fənd] ~ [ˈhel-fənd]-[ ‘elephant’/DIMIN vs. [peliˈkan] ~ [peliˈkan-dl] ‘pelican’/DIMIN. In inflected forms, stress remains invariant event when it must fall outside the three-syllable window: [teˈa-tənɪk] ~ [teˈa-tənɪk-əs] ‘theater enthusiast’ (SG./PL.), [ˈkatəvən] ~ [ˈkatəvən-dik] ‘rescue (infin./pres.ppl)’; [ˈle-bədik] ~ [ˈle-bədi-k-a] ‘lively (MASC/FEM).’

The situation is different for derived forms. If preserving the stress of the base would require placing stress too far from the right edge of the word, derivation is blocked. This can be illustrated with diminutive derivation, which is extremely productive. There are two diminutive affixes: a ‘first diminutive’ -al or -l (one syllable; contextual variants -dl, -xl) and a ‘second diminutive’ -ole (two syllables; variants -dala, -xala). As (2) shows, diminutive affixation is possible only when the resulting form satisfies two conditions: stress must fall on the same syllable as in the base (non-diminutive), and it must fall within the three-syllable window. The missing forms, such as *[ˈhel-fəndala] ‘elephant-DIMIN2’, *[ˈvevəkala] ‘squirrel-DIMIN2’, *[ˈhalibot] ‘halibut-DIMINI, and *[ˈhalibotala] ‘halibut-DIMIN2’ do not occur (Jacobs 2005), and are judged ungrammatical. Strikingly, this effect holds not only for diminutives, but for virtually all affixation in the language. For example, -nik can be suffixed to [teˈa-tənɪk] ‘theater enthusiast’, but it cannot be suffixed to [ˈsi-ne мə] ‘cinema’: *[ˈsi-ne manik]. When the stress of a base does not permit further suffication, a different root must be used.
(2) Yiddish diminutives

<table>
<thead>
<tr>
<th>Base sg.</th>
<th>1st DIMIN SG.</th>
<th>2nd DIMIN SG.</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>ىژژاً</td>
<td>ىژژاً</td>
<td>ىژژاً</td>
<td>‘engineer’</td>
</tr>
<tr>
<td>peli’kan</td>
<td>peli’kandl</td>
<td>peli’kandlo</td>
<td>‘pelican’</td>
</tr>
<tr>
<td>'helfand</td>
<td>'helfandl</td>
<td>—</td>
<td>‘elephant’</td>
</tr>
<tr>
<td>'vevik</td>
<td>‘vevikl</td>
<td>—</td>
<td>‘squirrel’</td>
</tr>
<tr>
<td>halibut</td>
<td>—</td>
<td>—</td>
<td>‘halibut’</td>
</tr>
<tr>
<td>te’atamnik</td>
<td>—</td>
<td>—</td>
<td>‘theater-nik’</td>
</tr>
</tbody>
</table>

The analysis of gaps poses a challenge in OT. Following Wolf and McCarthy (2009), I assume that morphology operates freely, but that phonology may select a null output (O). The null output violates the constraint MParse(suffix), but satisfies other faithfulness constraints; thus, if MParse is ranked low, a gap is selected.

**OO-Faithfulness.** The requirement that affixed forms preserve the stress of their corresponding base is easily formalized using a OO-Faithfulness constraint, such as Base-Ident([±stress]) (Benua 1997). By ranking Base-Ident([±stress]) and *Extended-Lapse(R) above MParse, gaps are favored rather than moving stress or violating the three-syllable window. Furthermore, for independent learnability reasons, McCarthy (1998) argues that OO-Faithfulness constraints must initially be ranked above Markedness, and Wolf and McCarthy (2009) argue that MParse must be ranked below Markedness. Thus, the Yiddish ranking is actually predicted to be the default state. Yiddish inflected forms require demoting Markedness below MParse for the relevant suffixes; evidence for this would be most abundant for highly frequent inflectional suffixes, so the inflection/derivation asymmetry is consistent with the assumed learning scenario.

**Cyclic accounts.** This pattern is harder to capture in a cyclic account, which uses Input-Output Ident([±stress]) to preserve stress. Underived loanwords are repaired ([a’li’qatɔ]) while derived forms are blocked. This creates a ranking paradox for a phase-based approach, which uses the same grammar for each cycle. Stratal OT permits re-ranking, so could posit rankings that repair stress at the root level (MParse, *ExtLapse(R) ⊃ Ident([±stress])), preserve stress with gaps at the stem level for derivation (*ExtLapse(R), Ident([±stress]) ⊃ MParse), and preserve stress with no gaps at the word level for inflection (Ident([±stress]), MParse ⊃ *ExtLapse(R)). This derives the correct result, but how would a learner recover these rankings? There is no overt evidence for the difference between the root and word level; high-ranked Ident([±stress]) is consistent with native roots, but incorrectly predicts that longer lapses would be tolerated in loanwords. There is also no overt evidence for lower-ranked MParse at the stem level; this can be inferred only from non-occurring affixations. There is no positive evidence favoring three distinct rankings.

**Conclusion** This paper expands the empirical typology of ‘cyclicity’ effects, showing that preservation of base properties can lead not only to misapplication of phonology, but also non-application of morphology. Such cases have attracted little attention in the literature, but this may be due to the fact that they are characterized by forms that do not occur. Properties of the Yiddish data fall straightforwardly into the predicted typology under an OO-Faithfulness account, but raise difficult learning challenges for cyclic accounts.

Arabic Emphatics are Uvularized

A comprehensive theory of distinctive features must provide a direct relationship between phonetic and phonological representations of speech sounds, and must provide a phonetic explanation for the phonological processes which frequently occur by the sounds that constitute a natural class (Archangeli & Pulleyblank 1994, McCarthy 1994). A common analysis of the emphatic consonants in Arabic is that they are pharyngealised (Davis 1995; Rose 1996; Laufer & Baer 1988, etc.), where this approach predicts that both emphatics and pharyngeals should have a similar effect on neighboring vowels. This analysis, however, does not meet the above criteria. For instance, while there is a general ban on co-occurring pharyngeal consonants in roots (McCarthy 1994), pharyngeals are free to co-occur with emphatic consonants, suggesting that their phonetic properties are different. This leaves open the question of what feature specification makes the emphatics distinctive. This paper presents articulatory and acoustic evidence to suggest that emphatics are uvularized.

The claim that emphatics involve a secondary uvular articulation is not novel; articulatory evidence has been marshalled in support of this view in the past (cf. Zawaydeh 1999, Shar 2012), though these studies were based on only a single dialect of Arabic (each), and suffered methodological limitations associated with endoscopy and fMRI, respectively. These limitations motivate an approach that employs ultrasound imaging, as it provides a clear and dynamic imaging of the tongue and a relatively high sampling rate. The present study investigated tongue retraction of the emphatic coronal obstruents /t/, /s/, the pharyngeal glides /ħ/, /ʕ/, the uvular fricatives /q/, /ʁ/ and their effect on neighboring vowels in 260 monosyllabic words in Yemeni, Egyptian, Palestinian and Saudi Arabic. A total of 26 words was repeated 10 times in the carrier phrase /qaːˈɛː/ ‘he said to me’, spoken by 8 subjects, yielding 2080 consonant tokens and 2080 vowel tokens (examples include /tæːb/, /tɪːb/, /tuːb/, etc.). Images of the target segment midpoints were extracted and tongue profiles were drawn with Edge Trak (Li et al. 2003), where each token was traced with 33 points x 10 repetitions (= 330 points total). By using SSANOVA (Davidson 2006), the contour data were compared to the neutral tongue rest position between utterances (ISP; Gick et al. 2004:223).

Figure 1 represents the mean of all of the target consonants (/h/, /s/, /ħ/, /ʕ/, /q/, /ʁ/) before /aː/, /iː/ as well as all of the target consonants (except /s/, /u/) before /uː/, each of which are compared to the ISP (for one speaker). Figures 2 and 3 illustrate tongue positions for /aː/ and /iː/ preceded by all the target consonants. Figure 4 shows /uː/ preceded by /t/, /ħ/, /ʕ/, /q/. (For reference, the tongue apex is on the left). Findings reveal that emphatics are articulated with tongue dorsum retraction similar to that of uvulars; cf. Fig. 1, which also illustrates how the tongue dorsum is lowered in pharyngeals, where there is a significant difference in tongue root retraction compared to emphatics and uvulars. Emphatics and uvulars induce backing when preceding the vowels /aː/ and /uː/ (Figs. 2 and 4 respectively), while pharyngeals do not induce such backing. Figure 3 demonstrates that /iː/ is slightly backed when preceded by emphatics. The tongue retraction and different coarticulatory effect of the emphatics and pharyngeals suggest that these sounds are phonetically distinct, implying a distinct phonological representation, supported by the acoustic results.

These findings have implications for the phonological representations of the emphatics. The study shows that tongue dorsum retraction is the active articulator for the emphatics, while the active articulator for the pharyngeals is the tongue root. This explains the retraction of vowels induced by emphatics and the lowering induced by gutturals in Yemeni, but not the wholesale lowering of vowels adjacent to gutturals and emphatics in dialects such as Palestinian. Such variability indicates that while speakers produce these consonants across dialects to achieve fairly unified acoustic targets, the articulatory command, and by extension distinctive feature specification, can be dialect-specific.
References
Obligatorily Parallel Metathesis in Maltese?

This paper examines the distribution of metathesis and syncope in Maltese imperfective verbs and shows that it supports parallelism, though it is inconsistent with the principle of gradual harmonic improvement in Harmonic Serialism (HS) (McCarthy 2000 et seq.). Specifically, no HS derivation can be constructed for these data without sacrificing the empirical generalization that metathesis occurs as the next-best alternative to syncope. Parallel constraint interaction, however, captures this observation readily.

Maltese stress assignment is weight-sensitive and exhibits a preference for right-aligned trochaic feet, motivating the high-ranking constraints Weight-to-Stress, All-Foot-Right, Trochee, and FootBinarity (Wolf, 2012). Sonorant-obstruent onset clusters and obstruent-sonorant coda clusters are unattested in Maltese (Borg and Azzopardi-Alexander, 1997), motivating the Sonority Sequencing Principle (SSP), which disprefers sonority plateaus and reversals.

Now consider the imperfective verbs in (1) and (2). The former exhibit syncope of the stem vowel under suffixation of the plural marker -u, while the latter exhibit metathesis of the stem vowel and the middle sonorant consonant (underlined). Crucially, syncope in the forms in (2) would create an illegal SSP-violating cluster (Hume, 1990)\(^1\).

<table>
<thead>
<tr>
<th></th>
<th>Singular</th>
<th>Plural</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>‘jib.dil’</td>
<td>‘jib.dlu’</td>
<td>‘he/they change(s)’</td>
</tr>
<tr>
<td>2</td>
<td>‘jik.fif’</td>
<td>‘jik.jfu’</td>
<td>‘he/they uncover(s)’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>Singular</th>
<th>Plural</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>‘jif.rb’</td>
<td>‘jir.fbu’</td>
<td>(*jif.rbu) ‘he/they drink(s)’</td>
</tr>
<tr>
<td>b.</td>
<td>‘jit.lif’</td>
<td>‘jit.il.fu’</td>
<td>(*jit.lfu) ‘he/they lose(s)’</td>
</tr>
<tr>
<td>c.</td>
<td>‘jid.nb’</td>
<td>‘jid.dm.fu’</td>
<td>(*jid.nbu) ‘he/they sin(s)’</td>
</tr>
</tbody>
</table>

These facts can be captured straightforwardly in parallel OT. The tableaux below assume the high-ranking constraints Trochee and FtBin. In (3) the ranking Parse-\(\sigma\) \(\gg\) Max favors a candidate in which syncope has occurred, creating a single binary foot. In the derivation of the metathesizing verb in (4), SSP rules out syncope while WSP and All-Foot-Right override the violations of Linearity and Parse-\(\sigma\) accrued by the winner.

<table>
<thead>
<tr>
<th></th>
<th>/ji-bdl-u/</th>
<th>SSP</th>
<th>WSP</th>
<th>All-Ft-R</th>
<th>Linearity</th>
<th>Parse-(\sigma)</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>(jib.dlu)</td>
<td></td>
<td></td>
<td>1 W</td>
<td>1 W</td>
<td>L</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>(jib.dlu)</td>
<td></td>
<td></td>
<td>1 W</td>
<td>1 W</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(jib.dlu)</td>
<td></td>
<td></td>
<td>1 W</td>
<td>1 W</td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>/ji-(\text{frb})-u/</th>
<th>SSP</th>
<th>WSP</th>
<th>All-Ft-R</th>
<th>Linearity</th>
<th>Parse-(\sigma)</th>
<th>Max</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>(jif.rbu)</td>
<td>1 W</td>
<td></td>
<td>L</td>
<td>L</td>
<td>1 W</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(jir.bu)</td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(jir.ro)bu</td>
<td></td>
<td></td>
<td>1 W</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(jir.ta)bu</td>
<td></td>
<td></td>
<td>1 W</td>
<td>1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

\(^1\)All data are drawn from Borg and Azzopardi-Alexander (1997) and Hume (1990).
Though readily captured in a parallel derivation, these generalizations are inconsistent with the predictions of Harmonic Serialism. Consider the derivation of a syncopating verb in (5). The constraints \textsc{trochee} and \textsc{ftbin} favor building a binary trochaic foot in the first iteration. In the second iteration, syncope and re-syllabification resolve the violations of \textsc{all-ft-right} and \textsc{parse-}\textsc{sigma} and the derivation converges on the third iteration (not shown).

\begin{tabular}{|c|c|c|c|c|c|}
\hline
(5) & \textit{First Iteration} & & & & \\
& /jib-dhlu/ & SSP & WSP & \textsc{all-ft-right} & \textsc{linearity} & \textsc{parse-}\textsc{sigma} & \textsc{max} \\
\hline
\texttt{E} & (jib.dlu) & 1 & 1 & & & & \\
\texttt{jib(dh.lu)} & 1 & W & L & 1 & & & \\
\hline
\textit{Second Iteration} & & & & & & & \\
\hline
(jib.dlu) & 1 & W & 1 & W & L & & \\
\texttt{E} & (jib.dlu) & 1 & W & 1 & & & \\
(jib.dlu) & 1 & W & 1 & W & 1 & W & L \\
\hline
\end{tabular}

Now consider the derivation of the metathesizing verb in (6). The first iteration proceeds as above, outputting \textstress{(jif.r\rlap{o})bu}. SSP will prevent syncope in the second iteration. However, unless re-footing and metathesis can occur in the same iteration, the desired candidate, \textstress{jj(jor.bu)}, will not be produced by Gen. Metathesis without concomitant re-footing, \textstress{(ji.for)bu}, is not harmonically improving because it accrues a violation of WSP. Instead, HS predicts that both syncope and metathesis will fail and the derivation will converge, outputting \textasteriskcentered*(jif.r\rlap{o})bu.

\begin{tabular}{|c|c|c|c|c|c|}
\hline
(6) & & & & & \\
& (jif.r\rlap{o})bu & SSP & WSP & \textsc{all-ft-right} & \textsc{linearity} & \textsc{parse-}\textsc{sigma} & \textsc{max} \\
\hline
\texttt{E} & (jif.r\rlap{o})bu & 1 & 1 & 1 & & & \\
\texttt{jif(r\rlap{o})bu} & 1 & W & L & 1 & W & \\
\texttt{jir.f\rlap{o}bu} & 1 & W & 1 & W & 1 & & \\
\hline
\end{tabular}

Other serial analyses are possible; independent factors could drive metathesis before footing, avoiding the paradox noted above. However, this sacrifices the observation that metathesis occurs as the next-best alternative to syncope, which obligatorily occurs after footing. In sum, Maltese verbs support a parallelist framework and constitute a potential counterexample to the strictly gradual structure of Harmonic Serialism.

References

**Polysynthetic words are like sentences: evidence from pause placement and acceptability**

**Background.** Pause location and duration provide important evidence for the psychological reality of linguistic structures (Goldman-Eisler 1972; Gee & Grosjean 1983). Indeed, studies of pause reconstruction (Martin & Strange, 1968) and detection (Boomer & Dittman, 1962; Butcher, 1981; Mattys & Clark, 2002) suggest that pauses are important for speech planning (Gee & Grosjean, 1983) and the interpretation of utterances (McGregor et al., 2010). Pause location is highly correlated with the location of ‘psychological’ pauses (Mattys & Clark, 2002), and pauses >130ms reflect linguistic planning and syntactic and semantic complexity (Hieke et al., 1983). Polysynthetic languages are claimed to be complex at the prosodic (and semantic and syntactic) level (Russell 1999; Baker 2008; Dyck 2009), showing evidence of word-internal pauses (not normally found in non-polysynthetic languages): in Dalabon pause insertion is found between the initial argument prefix string and the following verb stem (Fletcher et al. 2004, Evans et al. 2008). We present 2 preliminary studies of (1) pausing in fluent utterances and (2) preference judgements of utterances with natural and manipulated pause durations, in Wubuy, a highly polysynthetic, highly endangered Australian language. We show that speakers accept such pauses, as long as they fall at highly salient morpheme boundaries. **Method.** In Study 1, we measured silent periods in fluent repetitions of 14 Wubuy utterances of varying complexity (N = 66) by a literate female speaker. We measured durations of silence between complex words (word boundaries) (N = 24); within words, between noun and verb stems (N = 37); between stem and different kinds of non-stem morphemes (N = 31); and within morphemes (stop constrictions) (N = 44). We predicted that pauses between complex words and lexical stems within a word would be ‘long’ (>150 ms), while pauses between lexical stem and non-stem morphemes, and within morphemes would be ‘short’ (<100ms). **Study 2 elicited 2-alternate forced choice preference judgements of 34 pairs of fluent utterances (from Study 1) involving complex (multi-stem) words by 6 Wubuy listeners. In each pair, one or both utterances had a 500ms pause inserted at one of a range of positions: (A) between an incorporated noun and a following verb stem; (B) between the two halves of an inherently (frozen) reduplicated verb-stem; (C) between the roots in a lexicalised compound; or (D) within a morpheme (Table 1). We predicted that 'natural' (unmodified) utterances and utterances with pause at a 'legal' (A) boundary would be preferred over utterances with pause at an 'illegal' boundary (B, C, D). We also predicted that natural utterances should be preferred over legal ones. **Results.** Study 1 (Figure 1) is consistent with our predictions: Pause duration (1) between words and (2) within-word lexical stems exceeds 200ms, while pauses elsewhere are <100ms. A one-way ANOVA of the duration differences between the three categories showed a main effect of pause type ($F(3, 119) = 23.142, p < .001$). Post-hoc comparisons show that this is due to a duration difference between the two 'long' categories (inter-word and A) vs. the 'short' categories ($p < .001$), but showed no significant difference within these categories. The Study 2 (Figure 2) results also fit our predictions: Natural and legal pause-utterances are preferred over illegal pause-utterances, while the pattern for legal vs. natural utterances differed among the six participants: W1, W4, W5, and W6 preferred natural utterances, but W2 and W3 preferred legal (containing artificially inserted pauses) utterances over the natural ones. **Discussion.** The results show that (1) pauses are highly frequent in Wubuy and occur at word-boundaries and within words; (2) within-word pauses are just as acceptable as words lacking pause when the pause occurs at a ‘legal’ morpheme boundary. These preliminary studies suggest that morphemes differ in their level of ‘attachment’ to the surrounding word (Baker, 2008). Some morphemes are so tightly integrated with neighbouring material that pause insertion is unacceptable. Other morphemes are much more loosely attached, constituting in effect ‘word-internal words’. Like words in English, word-internal word-boundaries are licit
positions for pause insertion. More generally, the studies show that words in these languages constitute prosodic domains complex at the intonation phrase level (c.f. Fletcher 2014). These prosodic constituents are closely associated to the morphological structure (Baker 2014), but the acceptability of pause cannot be predicted from the locations of pitch accents alone, demonstrating that speakers access knowledge of word-internal structure. This casts doubt on morphological models where word-internal boundaries are erased at the output of word formation (e.g. Stump 2001).

Figure 1. Duration of silent periods between words, and within words in a range of morphological positions

Figure 2. Utterance preferences by listeners of natural (N) and manipulated (legal pauses: L; illegal pauses: IL) utterances.

Table 1. Examples of pause placement (’#’ indicates position of inserted pause)

| (A) ŋa-ˌɻuluc−kul’ŋaŋi | 1sg-shade-cut.through.pastcont | ‘I cut the bough shade’ |
| (B) ŋani-ˌjina-ŋu-ˌkucu’caani | 3masc/1sg-head-Ø-tickle.pastcont | ‘He tickled my head’ |
| (C) ŋa-ˌɻuluc−kal’ŋaŋi | 1sg-shade-cut.through.past | ‘I cut the bough shade’ |
| (D) ŋani-ˌjina-ŋu-ˌkucuku’caani | 3masc/1sg-head-Ø-tickle.pastcont | ‘He tickled my head’ |

Inconspicuous unfaithfulness in Slovenian

Positional faithfulness to stressed syllables (Beckman 1997, 1998) predicts that a language might shift stress away from its default position in order to eliminate marked segments inconspicuously (the Noyer-Beckman pathology, Beckman 1998). Arguing that this pattern is pathological, McCarthy (2007, 2010) and Jesney (2011) suggest that it can be ruled out in Harmonic Serialism, with positional faithfulness referring to the input to each derivational step. In this paper, we show that Slovenian displays the purported pathology. In Slovenian masculine nouns, stress is shifted away from underlyingly stressed [ε, ɔ] to eliminate them inconspicuously; stress is not shifted away from other vowels. We establish the productivity of the pattern experimentally. We propose that a Harmonic Serialist analysis of the language can proceed in two steps: stress removal followed by stress reassignment.

The lexicon: Slovenian masculine nouns with penultimate stress in the nominative can either keep the stress fixed in the genitive, or shift it to the stem-final syllable (1), with concomitant tensing of unstressed lax vowels. Tenseness is contrastive only under stress in the language.

<table>
<thead>
<tr>
<th></th>
<th>nominative</th>
<th>genitive</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>fixed stress</td>
<td>anew</td>
</tr>
<tr>
<td>b.</td>
<td>tense</td>
<td>sever</td>
</tr>
<tr>
<td>c.</td>
<td>mobile stress</td>
<td>j upgraded</td>
</tr>
<tr>
<td>d.</td>
<td>tense</td>
<td>trebux</td>
</tr>
</tbody>
</table>

We collected all nouns with [ε, ɔ] and samples of other vowels from a dictionary (Toporišič 2001). As seen in (2a), stress shift from the penult to the ultima impacts the majority of mid lax vowel nouns, but penultimate stress stays fixed on most nouns with other vowels, as in (1b, 1c). The existence of exceptions in both directions (1a, 1d), and in particular the relatively large number of mobile stress items with [a], clouds the generalization in the lexicon.

The experiment: To establish that [ε, ɔ] are productively singled out, 145 native speakers judged a total of 70 nonce paradigms (“wugs”, Berko 1958). In each trial, participants were given a nonce nominative with two genitives in random order, e.g. [xe.3a ~ xe.3a.da] and [xe.3a ~ xo.3a.da], and were asked to judge each as acceptable or unacceptable. Participants accepted mobile stress significantly more often with mid lax vowels (2b), confirmed with a fully crossed
mixed effects logistic regression with random slopes for items and participants. The low vowel [a] prefers fixed stress just as much as the tense [e o i u], singling out the mid lax vowels.

**Analysis:** The marked vowels [ɛ, ɔ] are banned from genitives and other derived forms by *LAX (Jurgec 2010). They are protected in the nominative by specific faithfulness to underived forms. Tensing the vowel under stress, e.g. *['je.zik ~ 'je.zi.ka] (3b), is blocked by the positional faithfulness constraint IDENT(ATR)/ˈσ1. The solution is to move stress away from the lax vowel (3c), allowing the vowel to tense in the inconspicuous unstressed position.

<table>
<thead>
<tr>
<th>(3)</th>
<th>/ˈje.zik + a/</th>
<th>IDENT(ATR)/ˈσ1</th>
<th>*LAX</th>
<th>IDENT(stress)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>'je.zi.ka</td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>'je.zi.ka</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>je.'zi.ka</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>d.</td>
<td>je.'zi.ka</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>e.</td>
<td>je.zi.ka</td>
<td>*</td>
<td></td>
<td>*</td>
</tr>
</tbody>
</table>

The situation in (3) is the one deemed pathological in Jesney (2011), except for the low-ranking constraint that determines the location of stress. Our analysis is unproblematic in parallel OT. To maintain a serialist analysis, a different constraint would be needed: *LAX/stress. Then the analysis could go from the fully faithful candidate (3a) to a stressless candidate (3e), reassign stress to an available non-lax vowel (3d), followed by tensing (3c). Without *LAX/stress, a harmonically improving path to (3c) is blocked. An alternative analysis without positional faithfulness seems unlikely; positional faithfulness is crucial to ensure the intended winner (3c) is not harmonically bounded by the tensing-only candidate (3b).

**Further support for the interaction of *LAX with positional faithfulness:** In roots with final stress, mid lax vowels remain faithful in most monosyllabic nouns (76% of 299 nouns, e.g. ['ʧʋɛk ~ 'ʧʋɛ.ka] ‘chatter’) but the vowel tenses under stress in most polysyllables (61% of 399 nouns e.g. [us.ˈpɛx ~ us.ˈpe.xa] ‘success’). This difference suggests that *LAX again eliminates the marked lax vowels, but positional faithfulness counteracts the effect in the stressed initial position (cf. *Initial syllable faithfulness*, Beckman 1997, Becker et al. 2011, a.o). The same position is protected in ['je.zik ~ je.zi.ka] and ['ʧʋɛk] ~ ['ʧʋɛ.ka], forbidding the [ɛ → e] mapping in a stressed initial syllable, causing stress shift if a following syllable is available. In contrast, the non-initial stressed syllable in [us.ˈpɛx ~ us.ˈpe.xa] is only protected by weaker general faithfulness, and thus the derived genitive succumbs to *LAX.

**Conclusions:** Positional faithfulness predicts, correctly, that stress may be shifted away from its default position in order to eliminate marked segments inconspicuously, contra Jesney (2011). The serialist analysis can only be maintained using *LAX/stress, a rather surprising constraint in a language that only allows lax vowels in stressed syllables. Positional faithfulness constraints make strong typological predictions, yet the predictions cannot be tested systematically using the available tools (e.g. the rule-based P-base, Mielke 2007). It is possible that Slovenian-like cases aren’t rare. Furthermore, grammatically relevant generalizations may be masked by the presence of lexical exceptions, as we have shown here, requiring resource-intensive nonce word studies. The current study expands the known typology, confirming a formerly surprising prediction of positional faithfulness. While presenting a challenge to Harmonic Serialism, a serial analysis is still possible without giving up any of the strength of positional faithfulness.
Inherently Weighted Constraints

The ability to derive typological predictions has long been a strength of Optimality Theory (OT) and OT-related theories. Typological predictions are primarily achieved by restraining constraint inventory (CON): most commonly only phonetically motivated constraints are admitted into CON. This constraint architecture, however, brings several problematic predictions. First, it undergenerates and excludes cases of unnatural phonological alternation, such as post-nasal devoicing in Tswana and Shekgalagari (Coetzee and Pretorius 2010). If we exclude the unnatural *ND from CON, we cannot derive the phonological system in these two languages. Secondly, the current constraint architecture produces the Too Many Solutions / Too Few Solutions problem: for some markedness constraints, there exist several different repair strategies, whereas some markedness constraints seem to allow only one repair strategy (or to rely on one strategy considerably more frequently than others).

This paper proposes a new constraint interaction architecture: Inherently Weighted Constraints (IWC). The proposed theoretical device aims to preserve the main architecture and typological predictions of OT while also solving the problems that OT brings: deriving unnatural processes, encoding the rarity of those processes, and providing an answer to the Too Many Solutions / Too Few Solutions problem. The IWC framework also provides a theoretical device to encode typology, quantify factors that influence phonological typology, and provide grounds for disambiguating between different factors that influence typology.

Cases of unnatural alternations and unnatural phonotactics, such as post-nasal devoicing in Tswana and Shekgalagari or restrictions against intervocalic voiced stops in the Berawan dialects, provide evidence that unnatural constraints (such as *ND or *VDV) should be admitted into CON. Without such constraints, undergeneration occurs, with the result that we cannot derive the Tswana mapping of /nd/ → [nt] or the Berawan phonotactic constraint that favors the unnatural variant — voiceless stop — intervocally.

However, if we admit both natural (*X) and unnatural (*−X) constraints, we lose the important generalization that natural processes are more frequent than unnatural ones. In other words, even though unnatural constraints such as *ND or *VDV are independently needed to derive processes such as ND → NN (in Tswana) or VDV → VZV, we still need to be able to encode, for instance, that *NT ∫ Id-IO(voi) is more frequent than *ND ∫ Id-IO(voi). That is, *ND is usually ranked below *NT in the world’s languages.

Related to this problem is the problem of Too Many and Too Few Solutions. For some markedness constraints, such as *D#, by far the most common repair (ranking) is *D# ∫ IDENT-IO(voi). There is no device within OT itself that can encode this generalization. A proposed solution to this problem, P-map (Steriade 2001), posits that ranking is determined by minimal perceptual distance. P-map thus assumes that voiceless stops are perceptually closest to voiced stops in word-final contexts and predicts the ranking *D# ∫ IDENT-IO(voi). However, this apparatus faces a problem within the repair strategies for *D# itself: to take just one example, there exists a productive process of final nasalization of voiced stops in Noon (D# → N#; Merrill 2015) despite the fact that the pair D ~ N is more distant, perceptually, than the pair D ~ T. In other words, there’s a strong tendency to repair *D# with devoicing, although other rankings are attested too. These data pose a problem for P-map.

Moreover, some markedness constraints appear to allow several (more or less equally) common repair strategies. The most famous case is the conspiracy of *NT, which has several attested and common repair strategies, including rankings such as *NT ∫ Id-IO(voi), *NT ∫ Id-IO(nas), *NT ∫ MAX (Pater 1999).

To my knowledge, no existing theory captures these generalizations within the OT-framework. I propose a new constraint interaction architecture that captures the generalizations and provides grounds for calculating typological priors. These calculations, in turn, provide a quantifiational basis for disambiguating channel and learning bias (Moreton 2008) in phonological typology.

I propose that constraints are inherently weighted, with each constraint subject to normal distribution (similar in nature to the system used to derive variation in Stochastic OT; see Boersma and Hayes 2001). The mean (µ) of the normal distribution equals the Inherent Weight (W) of a constraint. The variance of normal distribution (σ) differs for each faithfulness and markedness constraint.
All constraints (natural, unmotivated, and unnatural) are admitted to CON. Relative distances among Inherent Weights yield typological patterns. Conversely, Inherent Weights can be calculated based on surface typological observations. For example, the (natural) post-nasal voicing pattern is attested in 15 languages, while the (unnatural) post-nasal devoicing pattern is attested in 2 languages (Hayes and Stivers 2000). The probability of an unnatural process arising is determined by the probability of the ranking $*\text{ND} \gg *\text{NT}$. The relative distance between the inherent weights of $*\text{NT}$ and $*\text{ND}$ for the probability $\frac{1}{17}$ is calculated at 1.67. Thus, we solve the first problem stated above: IWC captures the fact that unnatural alternations do exist, but are less common than natural ones. The distances between Inherent Weights therefore result in typology.

If we include faithfulness constraints in IWC, we get a solution for the Too Many / Too Few Solutions problem. The most common repair for $*\text{D#}$ is devoicing, but nasalization is also attested once. For $*\text{NT}$, several repair strategies are more or less equally common. We can build a network of Inherently Weighted Constraints that precisely captures this typology. Markedness constraints that feature fewer repair strategies will have smaller variance, whereas constraint with several repair strategies will have greater variance.

From the IWC network in the figure (right), it follows that the probability of $*\text{D#}$ being ranked above $\text{Id-Io}(\text{ voi})$ will be comparatively high, whereas $P(*\text{D#} \gg \text{Id-Io}(\text{nas}))$ will be comparatively low, but high enough to be possible or attested in a given sample. $P(*\text{NT} \gg \text{Id-Io}(\text{ voi})), P(*\text{NT} \gg \text{Id-Io}(\text{nas})), \text{ and } P(*\text{NT} \gg \text{MAX})$ will be similar, because the variance in $*\text{NT}$ is greater than that of $*\text{D#}$.

Such IWC networks also bring predictions: for instance, voicing is predicted to be one of the most common repair strategies. However, for some constraints, this does not hold true. This problem is easily repaired by introducing independently motivated positional faithfulness constraints.

IWC provides grounds for disambiguating channel and learning biases in phonological typology. The MaxEnt framework allows non-zero initial weights or differential variance among initial constraint rankings (Wilson 2006). IWC proposes that both these factors can be exploited (along the lines described above). We can test experimentally how means and variance of initial weights in the MaxEnt learner correspond to typological priors calculated using the IWC. This can be compared with historical scores of phonological alternations (Author 1), where the probability of each alternation depends on the number of sound changes needed for a process to arise. Based on this quantified comparison, we can disambiguate channel bias from analytical bias, and thus make steps to solve one of the most discussed questions in phonology.

**Appendix: Calculating Inherent Weights** (C = constraint; Green 2000, Reiser and Guttman 1986)

$$\frac{W_1 - W_2}{\sqrt{\sigma_1^2 + \sigma_2^2}} = \sqrt{2} \text{erf}^{-1} \left(1 - 2P(C_2 \gg C_1)\right); \quad P(C_2 \gg C_1) = 1 - \frac{1}{\sqrt{2\pi}} \int_{-\infty}^{\infty} e^{-\frac{t^2}{2}} dt$$

**Selected References**

Against phonetic realism as the source of root co-occurrence restrictions

Introduction: Kaqchikel is a K’ichean-branch Mayan language spoken in southern Guatemala. Like all Mayan languages, Kaqchikel has a phonemic contrast between plain voiceless stops (/p t k q/) and ‘glottalized’ stops at corresponding places of articulation (implosive /b/ and ejective /t’/ vs. /t’/ k’ q’/). As in other Mayan languages, stops in underived /CVC/ roots are subject to a long-distance co-occurrence restriction: multiple ejectives are not allowed in a /CVC/ root, unless they are identical (Edmonson 1988:60-72). Hence */q’aqʔ/ ‘fire’ and */t’otʔ/ ‘snail’ are attested roots, but */q’aʔʔ/ */ʔokʔ/, etc. are not; schematically, */T’aVT’/p/ROOT, α ≠ β. The labial implosive /b/ and glottal stop /ʔ/ are exempt from this restriction, and freely combine with ejectives at any place of articulation in /CVC/ roots (e.g. */-biqʔʔ/ ‘to swallow’, /k’aʔʔ/ ‘incense’, etc.; Brown et. al 2010).

Previous approaches: Existing analyses of this type of root-based morpheme structure constraint (MSC) fall into one of two categories. Some authors have treated this pattern as a case of dissimilation for the articulatory feature [CONSTRIC TED GLOTTIS], essentially reducing the MSC to some form of the Obligatory Contour Principle (MacEachern 1999, Mackenzie 2009). The non-participation of /b /ʔ/ and the exemption of identical ejectives from the MSC are accounted for by additional mechanisms. An alternative is offered by Gallagher (2010), who proposes that this type of root MSC is grounded in considerations of acoustic similarity. In Gallagher’s system, stops are classified according to acoustic features which reflect their surface phonetic properties: most importantly [LONG VOT], [LOUD BURST], and [CREASE]. Roughly speaking, Gallagher proposes that the root MSC described above amounts to dissimilation in the auditory feature [LOUD BURST]. Since Gallagher assumes that ejectives, but not /b /ʔ/, are characterized by loud bursts in languages like Kaqchikel, the exemption of /b /ʔ/ from the root MSC follows naturally. However, Gallagher (2010:131) acknowledges that the validity of this analysis hinges on the precise phonetics of the stop consonants, which have not yet been studied for Kaqchikel. This study aims to assess the predictions of Gallagher (2010) by directly examining the phonetics of stop consonants in Kaqchikel.

Acoustic corpus: To assess an acoustically-grounded analysis of the Kaqchikel root MSC, we conducted an acoustic analysis of stop consonants in a corpus of semi-spontaneous spoken Kaqchikel, gathered in Sololá, Guatemala. Sixteen native speakers contributed to the corpus (19-84 years old, mean=33, median=28; 6 male); they were recorded using a headset microphone at a 48kHz sampling rate and 24 bit quantization rate. Speakers were asked to share a spontaneous narrative of their own choosing for the recording. The entirety of the corpus was transcribed by a native-speaker linguist, and a subset of the corpus (~1 hour) was annotated with forced alignment (Gorman et al. 2011) for the purposes of acoustic analysis.

Acoustic results: Focusing on the three phonetic features most pertinent to the acoustic theory of root MSCs (burst intensity, creak, and burst duration), we find that the surface phonetic patterning of the Kaqchikel stop series consistently fails to reflect their phonological classhhood. Ejectives in Kaqchikel have relatively weak bursts, which are comparable in their intensity to the burst of the implosive /b/, or even weaker (Fig. 1). Both ejectives and the implosive /b/ induce creaky phonation on adjacent vowels, as indicated by relatively low values for H1-H2 in the CV or VC transition (Gordon & Ladefoged 2001; figure omitted for space). The acoustic features [LOUD BURST] and [CREASE] therefore fail to characterize a natural class which includes /b/ but not the ejectives. While there are distinctions in release duration (≈VOT) which separate implosive /b/ from most ejectives, glottalized /qʔ/ is typically realized with a short release phase (Fig. 2). Phonetically, this groups /qʔ/ together with implosive /b/ rather than the other ejectives /t’/ ts’ tʃ’ k’. This is consistent with previous claims that uvular /qʔ/ may be at least variably realized as implosive [q], [ʃ], or [q] in Kaqchikel (e.g. Pinkerton 1986). The acoustic feature [LONG VOT] therefore also fails to generate the natural classes needed for the root MSC.
Fig. 1: burst intensity for glottalized /b\(t|^2)/ts\(t|^2)/, tf\(t|^2)/, k\(t|^2)/, and q\(t|^2)/.

Fig. 2: release duration for glottalized /b\(t|^2)/ts\(t|^2)/, tf\(t|^2)/, k\(t|^2)/, and q\(t|^2)/.

**Conclusions:** The natural class consisting of ejective /t\(t|^2)/ts\(t|^2)/, tf\(t|^2)/, k\(t|^2)/, and q\(t|^2)/, but not /b\(t|^2)/, cannot be neatly characterized in terms of the acoustic features proposed by Gallagher (2010). In a sense, this is unsurprising: while the phonetics and allophonic patterning of glottalized stops have been reported to vary rather widely between Mayan languages (e.g. Pinkerton 1986), the root MSC described here is quite stable. For example, the glottalized labial in some varieties of Poqomam (also K’ichean) is consistently realized as ejective [p\(t|^2)/] rather than implosive [b\(t|^2)/], but for historical reasons [p\(t|^2)/] is still exempt from the root MSC considered here (Smith-Stark 1983). Although the fine phonetics of glottalized stops in Mayan remain to be studied in detail, at least for Kaqchikel we can conclude that the synchronic morpho-phonology of root MSCs cannot be reduced to the synchronic phonetics of the consonant series. The analytical consequence of this result is that not all root MSCs can be analyzed in acoustic terms: for at least some languages, root MSCs must be stated in terms of abstract (articulatory) features like [CONSTRICTED GLOTTIS] and [VOICE]. For Kaqchikel, the operative restriction appears to be a ban on non-identical [-VOICE,+C.G.] oral stops within the same /CVC/ root.

**References:**
The double identity of doubling

Phonological forms with doubling are open to conflicting structural interpretations — either as products of morphological reduplication (e.g. Manam panána ‘run’ ↔ pána ‘chase’; Lichtenberk 1983), or as exponents of coincidental phonological identity (e.g. English banana). These two analyses of doubling differ in their reference to the constraint CONTIGUITY (CONTIG; McCarthy & Prince 1995); morphological reduplication is constrained by CONTIG but phonological identity is not.

In this talk we will present the first experimental evidence to suggest that CONTIG constrains human behavior. We show that the effect of CONTIG emerges despite minimal linguistic experience with morphological reduplication, and it is selective to the morphological level (but not the phonology). Nonetheless, linguistic experience determines the default interpretation of doubling. Given bare meaningless forms, Hebrew speakers immediately enforce CONTIG, whereas English speakers (whose language does not systematically employ morphological reduplication) ignore it. The contrast between the two languages suggests that, by default, Hebrew speakers parse doubling as morphological reduplication, whereas English speakers represent it as phonological identity. Remarkably, once a morphological analysis is forced, CONTIG spontaneously emerges even in English, suggesting that knowledge of CONTIG could be universal.

As a first step, we examined the sensitivity to CONTIG in Hebrew — a language in which morphological reduplication is prevalent (Bat-El 2006). To determine whether Hebrew speakers enforce CONTIG, we elicited rating of three types of novel words. One type with licit reduplication that satisfies CONTIG (e.g. bloglog), a second reduplicated form that violates CONTIG (e.g. blogbog), and a control with no reduplication (e.g. blogmot). Results (Figure 1; N=30 per experiment) showed that Hebrew speakers were sensitive to CONTIG, as they reliably favored licit reduplication (bloglog) to illicit and no-reduplication controls, and this preferences was obtained irrespective of the rating procedure (the rating of matched triplets relative to each other, or the absolute rating of each word in a randomized list). Since Hebrew employs reduplication, these results could suggest that the source of CONTIG is merely linguistic experience.

To determine the origin of CONTIG — whether it is due to linguistic experience, or whether it is potentially a universal principle — we next probed for similar restrictions among speakers of English, a language that does not use morphological reduplication (at least not systematically). A series of rating experiments (Figure 2; N=30 per experiment) found no effects of CONTIG, as both bloglog and blogbog were equally rated. In addition, the CONTIG-obeying bloglog-type forms were rated as less acceptable than the blogmot controls. This suggests that the English speakers viewed the doubling in bloglog (and blogbog) as accidental phonological identity, which is relatively disfavored due to the OCP.

Figure 1. Acceptability ratings in Exp. 1. Error bars are 95% confidence intervals for the difference between the means.

Figure 2. Acceptability ratings in Exp. 2a-b. Error bars are 95% confidence intervals for the difference between the means.
The indifference of the English speakers to CONTIG could either suggest that (a) CONTIG is language-particular, not universal; or (b) that the enforcement of CONTIG hinges on the analysis of reduplication as a morphological operation. Unlike Hebrew speakers, English speakers require explicit pairing of phonological form and meaning to entertain a morphological analysis for doubling.

Thus, to distinguish between these possibilities, our final experiment presented the same materials in a morphological context. Participants first saw the base form (e.g. blog) along with a picture of a novel object. They were next presented with the same object in a smaller size, and asked to select its name (Figure 3a). Accordingly, the experimental context implicitly presented reduplication as a morphological operation for the formation of diminutives.

Results (Figure 3b) now showed significant preference for CONTIG (i.e. blogblog > blogbog). In addition, the dislike of bloglog (found in Experiment 2 within the phonological analysis of doubling) has disappeared. Furthermore, the robust preference in the entire sample (N=30) remained even when divided in half (N=15).

Taken as a whole, our findings suggest that English and Hebrew speakers are both sensitive to CONTIG, and they selectively enforce it only at the morphological level. However, the ability to entertain a morphological parse of bare meaningless forms depends on linguistic experience. These conclusions suggest that CONTIG is broad (possibly, universal) in its application, yet narrow in scope (i.e. it is selective to the morphological, but not phonological level). Unique, universal design that is narrowly-constrained is the hallmark of specialized biological systems. Accordingly, the existence of putatively universal constraints on the design of the language faculty is consistent with its view as a specialized biological system.

References
Driving Derived Environment Effects with Alignment Constraints

Overview This paper proposes an account in which Alignment constraints drive derived environment effects (DEEs; Kiparsky 1973, Mohanan 1982), demonstrated by a case study of Korean. This unified account allows for different choices of repair for prefix and suffix DEEs using the same basic constraint schema, without the need for Local conjunction, Comparative Markedness, or other constraints that are meant to deal with opacity (cf. Łubowicz 2002, McCarthy 1999, 2002). This approach allows different degrees of variable application of prefix-only and suffix-only DEEs within a language.

Case Study: Korean In Korean, the sequence of a coronal consonant followed by a high-front vocoid (e.g. [ti]) is repaired at morpheme boundaries, but not within stems (1a) (Ahn 1985, Kim 1976). When such a sequence is derived through suffixation, the marked structure is repaired through palatalization (1b). When the illicit structure is derived by prefixation, an epenthetic [n] appears between the prefix and stem (1c) (Jun 2014). Pre-nasal obstruents are nasalized in Korean, so /hotʰ-ipul/ becomes [honnipul], not *[hotnipul].

(1) a. /tʃanʃi/ [ʃan̩di] ‘grass’ /tʰi/ /ti/ ‘dust’
   b. /mat-ɾi/ [madɾi] ‘firstborn’ /ktʰɾi/ [kaɾfɾi] ‘together’
   c. /hotʰ-ipul/ [honnipul] ‘unlined comforter’ /taɾʃ-jaŋmal/ [taɾʃjaŋmal] ‘anklet socks’

[n]-epenthesis occurs at prefix-stem boundaries for most prefix-final obstruents, not just coronal stops, whereas palatalization in suffixes only occurs with coronal stops (Jun 2014). A complete grammar must account for why coronals palatalize before suffix-initial /-i/ and /-j/, but never at prefix boundaries. [n]-epenthesis never occurs with suffixes, and must also be accounted for.

Formal Account — Constraints I propose that Alignment constraints can capture the asymmetry described above. The driving constraints are ALIGN(L, Suffix, L, Syllable) (or ALIGN(suffix)) and ALIGN(R, Prefix, R, Syllable) (or ALIGN(prefix)), defined below.

(2) ALIGN(L, Suffix, L, Syllable) — Assign a violation mark when no part of a suffix (i.e. feature or segment) is aligned to the left edge of a syllable.

(3) ALIGN(R, Prefix, R, Syllable) — Assign a violation mark when no part of a prefix (i.e. feature or segment) is aligned to the right edge of a syllable.

Formal Account — Implementation For DEEs to occur, Alignment constraints pertaining to affix material must be ranked above conflicting Faithfulness constraints. The following tableaux illustrate how this constraint set applies to Korean suffixation (4) and prefixation (5). In each case, the environment derived is /tʰ-i/. Candidate (a) is the fully faithful candidate, candidate (b) palatalizes, and candidate (c) undergoes epenthesis.

The tableau in (4) shows the violations for suffixation. In Korean palatalization, Alignment is satisfied by spreading a feature of the suffix onto the stem-final consonant: [ɾ] is a palatal sound (Ladefoged and Maddieson 1998), so it spreads its palatal quality to /t/, creating [ɾʃ]. The epenthetic candidate (4c) is harmonically bounded by the fully faithful candidate (4a): epenthesis fails to get part of the suffix closer to the left edge of a syllable, and it needlessly violates a Faithfulness constraint. Palatalization (4b) is the correct and winning DEE for Korean suffixes.

(4) /katʰ-i/ ALIGN(prefix) ALIGN(suffix) DEP IDENT(pal)  
   a. ka.tʰi *!
   b. ka.fʰi * *
   c. kan.ni *! *
Tableau (5) shows the violations assigned for prefixation. In this case, the palatalized candidate (5b) is harmonically bounded by the fully faithful candidate (5a). Palatalization cannot be an appropriate repair for /t-i/ sequences at prefixes because it fails to move the right edge of the prefix closer to the right edge of a syllable. In the epenthetic candidate (5c), [n]-epenthesis fills the syllable onset position, keeping the prefix contained to its own syllable. Once again, the repair seen in Korean is the only possible repair, given this constraint set.

<table>
<thead>
<tr>
<th></th>
<th>ALIGN(prefix)</th>
<th>ALIGN(suffix)</th>
<th>DEP</th>
<th>IDENT(pal)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>ho.tʰi.pul</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>ho.ʧi.pul</td>
<td>*!</td>
<td></td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>hon.ni.pul</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

**Formal Account — Conclusions** With the Alignment approach, the contexts of [n]-epenthesis and palatalization can never overlap: the unused repair is harmonically bounded by the fully faithful candidate. Furthermore, Alignment appears to drive the type of repair observed in the DEE. Alignment is the cause of derived palatalization, eliminating the need for a palatalization-driving constraint (e.g. *TI or PAL), Locally Conjoined constraints (Łubowicz 2002), Comparative Markedness constraints (McCarthy 2002), or other constraints designed to address opacity (e.g. Sympathy Theory, McCarthy 1999).

**Implications** This account predicts that there should be many suffix DEEs that do not apply in prefixation contexts, and vice versa. It also predicts that there will likely be more suffix-based DEEs than prefix-based DEEs overall: most languages require syllable onsets, so prefixes are more likely to satisfy Alignment constraints without repair.

Extending this account to a framework that allows variability (e.g. a MaxEnt grammar), the degree of variable application of prefix DEEs will be independent of the variability of suffix DEE application, because the two effects are independent of each other. Likewise, variability of application to loan words would also be independent for each type of affix, as found in Korean.

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The interfaces in French textsetting: evidence from the songs of Georges Brassens

Summary. In this talk I will investigate the textsetting system in the songs of Georges Brassens (1921–1981). The central finding is that Brassens employs line-internal matching of prominence between the text and the metrical grid of the music, independently of the text-melody matching. I will relate the findings to the theory of interfaces in textsetting.

Interfaces. At least three structures are typically present in sung verse in the Western idiom: the phonology of the text, the sequence of pitches that forms the melody, and the rhythmic grid of the music, to which I will refer as rhythm. Together, these representations and their interfaces constitute the textsetting system.

(1) Text
       /\
      /  \
Melody ---- Rhythm

How the components in (1) interact is an empirical question. I will set aside the melody-rhythm interaction here, focusing on the interaction of the text with the two components of the musical representation. The interface between text and melody is well-established as a locus of correspondence rules/constraints (cf. Chen 1983; Halle 2005; Proto & Dell 2013; Dell 2015). On the other hand, in the classic investigations of textsetting in English, the text-rhythm interface was taken to be the primary one, so much so that melody is often not discussed at all (cf. Halle & Lerdahl 1993; Hayes & Kaun 1996; Hayes 2009).

Antagonistic constraints. In previous work on French, Dell (2015) argues that French folk songs do not require a direct interface between text and rhythm: “The mapping of the text onto the grid [i.e. rhythm] is not a direct one; it is mediated by pitches. Syllables are matched with pitches and pitches are in turn matched with positions of the grid.” In this work I will argue against this position. The system employed by Brassens requires both text-melody and text-rhythm interfaces as loci of rules/constraints. The text-melody constraints enforce what Dell & Halle (2009) call “template invariance”, or melodic invariance from line to line, while text-rhythm constraints enforce prominence matching. The two sets of constraints are antagonistic; textsetting systems may favor one or the other set of preferences. While it is true, as Dell & Halle (2009) observe, that English favors prominence matching while French favors template invariance, I will argue that French employs some degree of prominence matching as well.

The argument. The argument is based on an analysis of a corpus of songs by Georges Brassens. As I will show, there is a pattern of line-internal avoidance of schwa on certain
prominent positions that points to direct text-rhythm matching, unmediated by melody. Consider the first line of the song *Le grand chêne*, whose textsetting is illustrated below. The line consists of 12 syllables, set in four groups of three syllables such that each third syllable occupies a strong position (\(\frac{2}{1}\)). The structure below shows the grid of the music; the numbers correspond to the syllables of the line.

\[
\begin{array}{cccccccccccc}
\ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast \\
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \\
\end{array}
\]

Il viva\(\textit{it}t\) en de\(\textit{hors}\) de che\(\textit{mins}\) fo\(\textit{res-tiers}\)

\(\text{‘It lived outside of forested roads’}\)

The song contains 14 stanzas, and the 14 first lines of each stanza are set to the same melody. Under perfect template invariance, they would always have the same setting as (2). However, in six of the 14 lines Brassens deviates from that pattern by shifting a three-syllable group rightward by one slot in the grid, thus placing the second, not the third syllable of the group on a strong beat (\(\frac{1}{2}\)). However, in *every* such case, the third syllable of the group contains a schwa—a weak vowel that would be placed in strong position under the setting in (2). The line (3) contains two such cases: the groups *un triste* and *ce couple* end in schwas, and are shifted rightward by one position in the grid to avoid placing that schwa on a strong beat. The syllables with schwas are shown in boxes in (3).

\[
\begin{array}{cccccccccccc}
\ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast & \ast \\
1 & 2 & 3 & 4 & 5 & 6 & 7 & 8 & 9 & 10 & 11 & 12 \\
\end{array}
\]

Un tris\(\textit{te}\) jour, en\(\textit{fin},\) ce cou\(\textit{ple}\) sans a\(\textit{veu}\)

\(\text{‘Finally, a sad day, a vagrant couple...’}\)

(An additional complexity, also observed in other songs, is that schwa is only avoided on the strongest of the strong beats, those with a stack of three gridmarks in (2) and (3): there are lines where it occurs in the intermediate beats dominated by two gridmarks.)

Crucially, however, the melody stays in place: the same note (and harmony) occupies strong positions in (3) as in (2), and thus the effect is due to a direct interface between text and rhythm, unmediated by melody. I will show that while many songs by Brassens employ perfect template invariance, a significant number, such as *Auvergnat*, *Rien à jeter*, *L’orage*, show the same pattern of prominence matching as illustrated above. I will offer a formal analysis of this system that treats the antagonism between text-melody and text-rhythm constraints in OT terms.

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Acoustic Correlates of Gujarati Stress

The stress system of Gujarati (Indo-Aryan, India and Pakistan) has received attention for its putative sensitivity to vowel sonority (Cardona 1965, de Lacy 2002, 2006, *inter alia*). However, a recent acoustic study casts doubt on earlier descriptions of the language, failing to find a position-independent correlation between intensity and maximally sonorous [a] versus other vowels (Shih 2016). This poster casts further doubt on the earlier descriptions, conducting a rigorous test of the putative stressed/unstressed contrast for several vowels, but finding at best a weak effect of stress on several acoustic parameters. We propose that stress may not be a necessary category to explain our results, and suggest that what appears to be an effect of stress is in fact the result of coarticulation. This negative result suggests an urgent need for closer examinations of other ostensibly sonority-driven stress systems.

Following de Lacy (2002, 2006) vowel sonority is the main determiner of stress, following the hierarchy [a] ≻ [ɛ, ɔ, e, o, i, u] ≻ [a]. That is, main stress preferentially falls on the low vowel [a] over mid and high vowels [ɛ, ɔ, e, o, i, u] which are in turn stressed over [a]. For instance, in a word like [pɔrik'ɑ] ‘exam’, the final [a] attracts stress over the two non-low vowels, but in a word like [ˈvisməran] ‘forgetfulness’, the initial [i] attracts stress over the two schwas. Following de Lacy (2002, 2006), syllable position in the word is the deciding factor when multiple vowels could receive primary stress, following the hierarchy PENULTIMATE ≻ INITIAL ≻ FINAL. Hence, in a word like [a'kaʃi] ‘sky’, penultimate [a] trumps initial [a], but in a word like [ˈpᵃkستان] ‘Pakistan’, the initial [a] receives stress at the expense of the final [a].

A variety of acoustic correlates of stress have been proposed by de Lacy (2002, 2006) and Cardona (1965). These include vowel intensity, F0 contours, and vowel duration. Vowel quality is also mentioned as a potential correlate, with [i, u] and potentially [a] being centralized when unstressed.

To test these claims, 26 speakers of Gujarati in Bangalore, India were interviewed. Twelve target words were elicited in a carrier sentence, with a pair of words for each of 6 vowels. Each pair consisted of words where a target vowel was stressed/unstressed, with the target vowel being flanked by the same consonants in each word. Syllabic position (typically penultimate) was held constant for all pairs. For instance, the target pair for [ɛ] was [tə'bele] ‘horse stable’ (stressed [ɛ] and [ˈsəmbele] ‘rod’ (unstressed [ɛ]).

Acoustic measures fail to robustly confirm the sonority-driven stress hypothesis. An effect of stress was found for vowel intensity and F0 measures (minimum,
maximum, range), but the effect sizes were smaller than 1 dB (intensity) or 3 Hz (F0). Very weak effects of stress were found for vowel quality (see figure), though the expected centralization of unstressed \([i, u, \partial]\) is not readily discernable. Osten-
sibly unstressed vowels varied between being 2.1% longer ([a]) and 11.6% shorter ([u]) than their stressed counterparts.

Rather than ascribe such weak and counter-intuitive results to putative stress, we suggest that the results are caused by coarticulation. Low vowels generally preceded unstressed vowels, and may have been the cause of the modest lowering seen in the above figure. Furthermore, the only unstressed vowels that were shortened were also preceded by [a], which is a substantially long vowel in Gujarati. It is possible that some of the duration for these “unstressed” vowels was allocated to an intrinsically longer vowel.

More studies are needed to truly ascertain that Gujarati does not in fact have sonority-driven stress, but the results here suggest that it does not. Given the prominence of Gujarati stress in the broader theory of scale-based constraints in de Lacy (2002, 2006), it is important that this and other ostensibly sonority-driven stress systems receive closer attention.

2

Figure 1: F1 by F2 plot for vowels produced by male speakers. Error bars are standard deviations. Expected centralization of unstressed \([i, u, \partial]\) is not apparent.
An Anti-Dispersive Contrast: 
Xitsonga’s ‘Whistled’ Fricative vs. [ʃ]

Introduction and background
Languages make use of a variety of acoustic and phonetic distinctions to create contrasts. Dispersion Theory (Lindblom 1986) and related approaches predict that languages balance two competing demands: (a) ease of articulation and (b) maximization of contrast perceptibility. Xitsonga (Bantu) employs a contrast that seems on its face to violate the principle of maximal perceptibility without any concomitant reduction in articulatory difficulty.

Xitsonga’s consonant inventory contains a palato-alveolar fricative [ʃ] and a ‘whistled’ fricative, denoted here by the symbol [ʂ], since it contains a retroflex closure. In spite of its name, the whistled fricative rarely manifests with a whistle peak, and impressionistically sounds similar to [ʃ] (see Lee-Kim, Kawahara, and Lee 2014 for details on the acoustic similarity of these sounds in Xitsonga). The perception of similarity between [ʃ] and [ʂ] is mirrored in cross-linguistic research, which finds that palatal and retroflex fricatives are perceptually similar (see Nowak 2006 on Polish and Bladon et al. 1987 on Shona). In spite of their potential for confusion, the contrast between [ʃ] and [ʂ] carries a heavy morphological load—for example, the class 7 singular prefix [ʃi-] contrasts with its plural form [ɕi-].

We present an experiment which shows that, in spite of their striking acoustic similarity, Xitsonga speakers can reliably distinguish between [ʃ] and [ʂ], while speakers of English perform near chance. We argue that this contrast is ‘anti-dispersive’ since it violates Dispersion Theoretic demands. Further, Xitsonga speakers’ ability to distinguish this contrast suggests that acoustically and perceptually similar sounds can be capitalized for phonemic contrasts.

Stimuli
12 Xitsonga nouns were selected for use as stimuli. Each noun was given the singular class 7 prefix [ʃi-] and the corresponding plural prefix [ɕi-], resulting in 24 total stimulus items. 6 native speakers of Xitsonga were asked to read the singular and plural nouns in a carrier sentence. For example, speakers were asked to pronounce [ʃi-milana] (plant) and [ɕi-milana] (plants). From these 6 speakers, the productions from one male speaker and one female speaker were chosen to be used in the experiment.

Method
21 native speakers of Xitsonga and 15 native speakers of English participated in the experiment. Each participant heard the 24 stimulus items from the female speaker in random order, followed by the 24 stimulus items from the male speaker, also randomized. For each item, participants were asked to indicate whether the word was singular (i.e., started with [ʃi-]) or plural (i.e., started with [ɕi-]).

Results
Xitsonga speakers were able to distinguish between [ʃ] and [ʂ] with a high degree of accuracy: participants correctly identified the sound 85.66% of the time (mean d’ score: 4.56, Wilcoxon V = 231, p < 0.001). The graph in (1) shows the hit vs. false alarm rate for these speakers (above the x=y line indicates ability to discriminate).
English speakers did not fare as well: they correctly identified the sound only 55.48% of the time (mean d’ score: 0.50, Wilcoxon V = 86, n.s.). The graph in (2) shows the hit vs. false alarm rate for these speakers.

To summarize the results: Xitsonga speakers were able to correctly identify [ʃ] and [ʂ] (all of the speakers’ hit vs. false alarm rate was above the x=y line), English speakers were largely unable to identify these sounds (the speakers’ hit vs. false alarm rates cluster near the x=y line).

**Discussion**

Languages make use of a variety of acoustic and phonetic distinctions to create contrasts. Under Dispersion Theory (Lindblom 1986) and related approaches, it is assumed that languages balance two competing demands: that articulation should not be prohibitively difficult, and that contrasts should be maximally perceptible. The Xitsonga whistled fricative [ʂ] and palatal fricative [ʃ] would seem on their face to violate the demand for maximum perceptibility: they are acoustically very similar (again, see Lee-Kim, Kawahara, and Lee 2014 for details), and related distinctions in other languages such as Polish and Shona (Nowak 2006, Bladon et al. 1987) show limited perceptibility.

That Xitsonga makes use of this small contrast suggests that Dispersion Theoretic demands are, sometimes, violated. Further, Xitsonga speakers’ ability to perceive this distinction shows that languages can capitalize on acoustically and perceptually similar sounds for phonemic contrasts.

**References**


Layered feet laid bare in Copperbelt Bemba tone

Layered feet. Recent literature has called for a foot inventory that includes minimally layered feet, where a binary foot is parsed with a stray syllable into a higher foot layer, yielding e.g. the dactyl \((\sigma\sigma\sigma)\). Layered feet have been argued to account for a variety of foot-conditioned phonotactics, as well as typologies of stress windows and rhythmic stress (Bennett 2012; Kager 2012; Martínez-Paricio and Kager 2015). One limitation in these studies is that the phenomena involved tend to be expressed only at a particular position in the foot, leaving the door open for ‘weak layering’-style interpretations based on binary feet and stray syllables (Ito and Mester 1992; Hayes 1995). This talk fills the evidence gap by presenting a case where a large, quantity-sensitive, domain is marked overtly, posing a problem for weak layering and providing evidence for the necessity of layered feet.

Copperbelt Bemba. Evidence comes from Copperbelt Bemba (CB), where High tone \((H)\) spreading can cover a trisyllabic domain (Bickmore and Kula 2013 \textit{et seq}), as shown in (1). Syllables sponsoring a lexical tone are underlined, and vowels with surface \(H\) are accented. Phrase-final tones such as on [kó] behave differently and are ignored here.

\begin{align*}
\text{(1)} & \quad \text{a. } \underline{bá-ká-pá}-t-a-kó \quad \text{‘they will hate’} \\
& \quad \text{b. } \underline{bá-mú-lük-il-a-kó} \quad \text{‘they will weave for’}
\end{align*}

In (1), tone spreads from the sponsor onto the next two syllables. Hence, CB is sometimes referred to as having ‘ternary’ spreading. However, strings with heavy syllables show there is more going on. If the sponsor syllable is heavy, tone merely extends to the next syllable:

\begin{align*}
\text{(2)} & \quad \text{a. } \underline{tu-ka-\underline{léé}-ṯ-ḻ-án-a-kó} \quad \text{‘we will bring for each other’} \\
& \quad \text{b. } \underline{tu-\underline{léé}-mú-shiik-il-a} \underline{bwiino} \quad \text{‘we are burying for him well’}
\end{align*}

So far, it seems possible to say that the process aims at a trimoraic tone span. However, if a heavy syllable immediately follows the sponsor, tone will spread beyond it to the syllable after that, as shown in (3).

\begin{align*}
\text{(3)} & \quad \underline{bá-ké-\underline{émb}-fl-a-kó} \quad \text{‘they will dig for’} \\
& \quad \underline{bá-lóóndōlōl-ō} \quad \text{‘that they introduce’}
\end{align*}

In this case, tone spreading covers four morae. A descriptive generalization for CB tone spreading, then, can be neither syllable-counting (3/2/3 respectively in the examples above) nor mora-counting (3/3/4). Rather, the generalization should account for the fact that the domain for CB tone is sensitive to the presence or absence of heavy syllables and their position in the string. Hence, we turn to a metrical analysis.

A layered feet analysis. We propose that the domain of CB tone is an extended iamb: a layered foot with an iambic head. Thus, the forms discussed above are footed as follows: \((H=\text{heavy}, L=\text{light syllable})\)

\begin{enumerate}
\item \((\text{LL}L)\) \((\underline{bá-ká})\text{-pá}t-a-kó\)
\item \((\text{H}L)\) \(\underline{tu-ka-}(\underline{léé})ṯḻ-\text{a-kó}\)
\item \((\text{LH}L)\) \((\underline{bá-ké-émb})\text{-mb-})t-a-kó\)
\end{enumerate}

The basic generalization for CB tone is now straightforward: every sponsor is left-aligned with an extended iamb, and all footed positions are \(H\).
The problem for weak layering. Under a weak layering approach, ternary effects arise when prosodic conditions force the presence of an unparsed syllable next to a binary foot. Thus, antepenultimate stress is structured as ⟨σσ⟩σ#, and ternary prosodic minimality follows from similar structures. However, because ternary follows only from trapping a stray syllable at an edge, weak layering does not predict ternary domains to occur freely throughout the phrase, as is the case in CB. For example, supposing a binary feet analysis for the form (bá-mú)-lúk-il-a-kó, weak layering does not explain why tone would spread to [lú], nor why it stops there instead of spreading on to [ki].

Evidence for layering. The layered foot allows for the expression of asymmetries between the inner foot and the dependent. The case for a layered foot analysis, then, can be strengthened by evidence suggesting such an asymmetry. This evidence exists for CB: In cases involving tone contact, partial but not full spreading is allowed.

Consider first the case where two tone sponsors are separated by one syllable, shown in (4a). In such cases, binary spreading occurs (with downstep) despite the resulting tone contact. In contrast, (4b) shows cases where a ternary domain is available for spreading, yet not fully occupied, avoiding tone contact.

(4) a. 
\[
\begin{align*}
\text{bá-ká-láš-á} & \quad \text{‘they will hit’} \\
\text{kálip-í-á} & \quad \text{‘be nervous!’}
\end{align*}
\]

b. 
\[
\begin{align*}
\text{bá-ká-mú-láš-á} & \quad \text{‘they will hit him/her’} \\
\text{kálip-il-á} & \quad \text{‘be upset at!’}
\end{align*}
\]

The layered feet analysis accounts for this spreading asymmetry using the inherent asymmetry in foot structure: Spreading across the inner foot is more important than avoiding tone contact, while spreading across the outer foot is not.

Conclusion. In conclusion, this talk presents a case of a large metrical domain whose edges are overtly marked, favoring a layered feet interpretation over one that uses weak layering. Asymmetric spreading behavior further confirms the layered structure. The full talk will incorporate further facts of CB in the analysis, namely tone shift and the creation of falling tones on some heavy syllables.

References


Alternatives to Stricture-Driven Assimilation

Work on assimilation involving nasals, notably by Padgett (1994), has indicated that nasal place assimilation not only involves agreement in place of articulation, but often also agreement in stricture. Padgett’s observation is that while nasals assimilate in place of articulation to a following stop, post-nasal fricatives induce other processes. According to Padgett, this marked structure can surface unaltered in some languages, or can be repaired by either (a) the nasal becoming a continuant, (b) the nasal deleting, or (c) nasal place assimilation with simultaneous hardening of the fricative to an affricate or stop. Padgett identifies the source of this marked configuration as the co-occurrence of conflicting values for continuancy: a [-cont] nasal is followed by a [+cont] fricative. The same problem does not arise with stops because they are specified [-cont], identical to the nasals. These observations give rise to what might be termed “Padgett’s generalization”:

(1) Padgett’s generalization: If a language exhibits nasal place assimilation with fricatives, it also exhibits nasal place assimilation with stops.

In other words, if there is stricture agreement, there must be place agreement. The explanation for the generalization in (1) crucially rests on the assumption that nasals are universally defined as [-cont] segments (cf. Chomsky & Halle 1968, Anderson 1976). Padgett (1994) expresses this as a marking condition “If [+nas, +cons], then [-cont]”, which Pulleyblank (1997) and Baković (2007) formalize as constraints banning continuant nasals. Recent work by Mielke (2005, 2008), however, has claimed that nasals are ambivalent with respect to the feature [continuant], and can pattern as either [-cont] or [+cont] on a language-specific basis. In fact, Mielke has demonstrated that nasals pattern as [+cont] more than [-cont] (in 63.8% of the languages in his database; cf. Mielke 2008). Languages identified by Mielke with this specification for nasals include systems where the nasals pattern with the fricatives and other continuant sonorants, to the exclusion of stops.

A revised conception of Padgett’s generalization which assumes that in some languages nasals can be specified as [+cont] generates novel predictions, specifically, that languages with [+cont] nasals which display place assimilation triggered by stops must also display place assimilation with fricatives. This is the inverse of the prediction made with nasals that are specified as [-cont]. A corollary to this is that some subset of these languages will involve nasal place assimilation triggered by fricatives, but where stops are repaired because the disagreeing sequence of values for [continuant] is marked.

Finnish is one of the languages identified by Mielke (2005, 2008) as having [+cont] nasals. The argument for this specification comes from the patterning of the sonorants /n, l, r/ and the fricative /s/ in triggering deletion of a following /e/ (specifically, in some infinitives, the passive, the second participle active, the imperative, and the potential; Sulkala & Karjalainen 1992:394). This illustrated in (2) with the process triggered by a nasal through the paradigm:

(2) mennä go-1INF (cf. menen ‘go-1SG’)
    mennään go-P-PAS
    mennyt go-2PTC
    menkää go-IMP+2PL
    mennee go-POT-3SG
In addition, nasals tend to agree in place of articulation with a following stop. Suomi et al. (2008) provide a detailed discussion of this phenomenon, including in postlexical contexts. Across word boundaries, there is place assimilation of a word-final nasal to a word-initial stop:

(3)  
tytön pää  ‘a girl’s head’  [tytomæ:]  
tytön takki ‘a girl’s coat’  [tytonk:i]  
tytön kello ‘a girl at’  [tytøñklo]

Suomi et al. go on to explain that /n/ can be deleted before the fricatives /h/ and /s/ (and also possibly before /f/) in these contexts, and that this is especially true for informal or rapid speech:

(4)  
järven hiekka  [jærvehiekka]  ‘lake sand’  
järven selkä  [jærveselkæ]  ‘back of the lake’  
pojan farkut  [pojal farkut]  ~ [pojøn farkut]  ‘boy in jeans’

Suomi et al. note that [m] is rare, as both the phoneme /f/ and the sequence /mf/ are rare to begin with in Finnish, and that these tend to show up in loanwords (kamferi ‘camphor’). Thus, despite Finnish having a set of nasals that class with the [+cont] segments, nasal+fricative sequences behave as marked structures, and are repaired through deletion, one of the strategies originally observed by Padgett.

The interesting result derived from this case study is the discovery of the fact that even when the value for [cont] on nasals is inverted (to [+cont]) within a system, Padgett’s generalization still holds true. This proves to be problematic for approaches like Padgett’s, which rely on the grammar enforcing a continuancy agreement on nasals and obstruents. That is, the generalization is not due simply to the contiuancy value of the nasal; instead, it is symptomatic of a deeper problem with the ordered sequence of nasals and fricatives. The fact that none of the “[+cont] nasal” languages exhibit repairs with postnasal stops supports this. The conclusion is that nasal-fricative sequences must be marked structures, a possible explanation for phenomena such as intrusive stops interrupting these sequences in English.

References
Examining the lexicon in derived-environment effects: Korean and Turkish

Background: Morphologically derived environment (MDEE) patterns are examples in which sequences that are “repaired” by a phonological alternation across a morphological boundary are nonetheless attested within stems. For example in Korean, stem-final /t/ and /tʰ/ palatalize to [c] and [ɕʰ] respectively before /i/ and /j/ as shown in (1) (Cho 2001; Kiparsky 1993; Iverson and Wheeler 1988; Kiparsky 1973, a.o.). The exact same sequences (/ti/ and /tʰi/), however, fail to palatalize when they fall within the same morpheme as in (2).

(1) Korean palatalization across morpheme boundaries: /t, tʰ/ → /c, ɕʰ/ before /i/
   a. /mat-i/ → [maci] ‘eldest-NOM’
   b. /patʰ-i/ → [paeʰi] ‘field-NOM’

(2) Blocking of palatalization tautomorphemically:
   a. /mati/ → [mati] ‘knot, joint’
   b. /tʰim/ → [tʰim] ‘team’

Analyses of MDEEs (e.g. Łubowicz 2002; Wolf 2008; a.o.) often assume that both the alternation as well as the static phonotactic patterns are productive. That is, these models predict that stem-internal sequences, such as /ti/ in (2) above are perfectly phonotactically well-formed, just as the alternation repairing these sequences is productive heteromorphemically. In this paper, I present the results of a series of corpus studies and phonotactic modeling simulations examining the nature of stem-internal phonotactic patterns in two languages with well-known cases of MDEE: Korean palatalization and Turkish intervocalic velar deletion (e.g. Sezer 1981).

If sequences “repaired” through alternations are well-formed stem-internally, we expect to find no under-representation of forms with such sequences in the lexicons of these languages. Surprisingly, however, stem-internal /ti/ and /tʰi/ sequences in Korean were under-represented as well as phonotactically penalized. Contrastively, while intervocalic velars were under-represented in Turkish, they were not phonotactically penalized by a phonotactic learner.

Study 1. Korean: In the first study, lexical statistics of Korean were examined using two corpora that differed by register. The first was the National Academy of the Korean Language corpus (NAKL; 2003), which contains approximately 50,000 commonly used words (native, Sino-Korean and loanwords) collated largely from print sources. The second was two corpora of Child-Directed Speech (CDS) from CHILDES (~40,000 words; MacWhinney 2000). The type frequency of /t, tʰ, t* and /i, j/ sequences (TI) was calculated for each corpus, as well as the type frequency of /t, tʰ, t* and other vowels (TV), other consonants and /i, j/ (CI), and all other consonants and vowels (CV). Observed/Expected (O/E) scores were calculated for each of these sequences. Thus given the independent occurrence of coronal stops and high-front vocoids /i, j/, we can calculate how often we expect their co-occurrence. An O/E of 1 indicates an expected rate of occurrence. An O/E above 1 indicates over-representation and an O/E under 1 indicates under-representation. In both the adult and CDS corpora, there was a significant under-representation of TI sequences (Table 1. NAKL: χ²(1) = 7625.1, p < 0.001; CDS: χ²(1) = 3895, p < 0.001).

To ascertain whether the statistical under-representation of TI translates to a phonotactic penalty, learning simulations were conducted using the UCLA Phonotactic Learner (Hayes and Wilson 2008) with the NAKL and CDS corpora as learning data. In both cases, the learner was set to find bigram constraints with O/E values under 0.3 (following Hayes & Wilson 2008). In both simulations, the phonotactic learner successfully infers a constraint penalizing TI sequences, assigning it a weight of 1.916 in the NAKL corpus and 1.599 in the CDS corpus.
Thus despite being attested, TI words are both under-represented and phonotactically penalized in Korean.

Study 2. Turkish: In the second study, the lexical statistics of Turkish were examined using the Turkish Electronic Living Lexicon (TELL; ~30,000 words; Inkelas et al. 2000) and two CDS corpora from CHILDES (~6,000 words; MacWhinney 2000). The frequency of intervocalic velars was compared against that of other stops and affricates in the same position. In both corpora, there was a significant under-representation of intervocalic velars (Table 2.; TELL: \( \chi^2(1) = 406.06, p < 0.001 \); CDS: \( \chi^2(1) = 311.74, p < 0.001 \)), although the degree of under-representation is much smaller when compared to TI in Korean, as indicated by the larger O/E values (closer to 1). Another set of learning simulations with both corpora were conducted with the learner set to find trigram constraints. In this case, despite the statistical under-representation, the phonotactic learner failed to infer a phonotactic constraint banning intervocalic velars. This indicates that the statistical under-representation was not strong enough to translate into a well-formedness penalty for intervocalic velars.

### Table 1. O/E by consonant type and vowel type in Korean. Expected values are in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>NAKL</th>
<th></th>
<th></th>
<th>CDS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/i/, /V/</td>
<td>other Vs</td>
<td>/i/, /j/</td>
<td>other Vs</td>
<td></td>
</tr>
<tr>
<td>/t, tʰ, t*/</td>
<td>454 (5798)</td>
<td>27424 (22073)</td>
<td>524 (3607)</td>
<td>15936 (12853)</td>
<td></td>
</tr>
<tr>
<td>O/E = 0.08</td>
<td>O/E = 1.24</td>
<td>O/E = 0.15</td>
<td>O/E = 1.24</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other Cs</td>
<td>31247 (25903)</td>
<td>93112 (98463)</td>
<td>26415 (23332)</td>
<td>80058 (83140)</td>
<td></td>
</tr>
<tr>
<td>O/E = 1.21</td>
<td>O/E = 0.95</td>
<td>O/E = 1.13</td>
<td>O/E = 0.96</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 2. O/E by consonant type and context in Turkish. Expected values are in parentheses.

<table>
<thead>
<tr>
<th></th>
<th>TELL</th>
<th></th>
<th></th>
<th>CDS</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V-V</td>
<td>Other contexts</td>
<td>V-V</td>
<td>Other contexts</td>
<td></td>
</tr>
<tr>
<td>/k, g/</td>
<td>1703 (2410)</td>
<td>10548 (9841)</td>
<td>369 (699)</td>
<td>2297 (1967)</td>
<td></td>
</tr>
<tr>
<td>O/E = 0.71</td>
<td>O/E = 1.07</td>
<td>O/E = 0.53</td>
<td>O/E = 1.17</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Other stops/aff.</td>
<td>4884 (4177)</td>
<td>16356 (17063)</td>
<td>1791 (1461)</td>
<td>3778 (4108)</td>
<td></td>
</tr>
<tr>
<td>O/E = 1.17</td>
<td>O/E = 0.96</td>
<td>O/E = 1.23</td>
<td>O/E = 0.92</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Discussion: Our results have three main implications. First, they challenge the assumption that stem-internal sequences such as TI are phonotactically well-formed. In Korean, such sequences are under-represented and phonotactically penalized. Thus, the predictions of previous models that stem-internal sequences are well-formed are not borne out (see also Anttila 2006; Inkelas 2011). Second, they reinforce the observation that MDEEs are not a unitary phenomenon. In one case (Korean), a constraint that motivates alternations is available from pure phonotactic learning. This follows from the fact that forms violating *TI are under-represented in the lexicon (i.e. gradient exceptionality). This contrasts with Turkish where the relevant alternation-motivating constraint is unavailable from pure phonotactic learning. Thus, their surface similarity belies stark differences in generalizations. Third, while there is a surface mismatch in static phonotactic generalizations and alternations, at a deeper level, these actually accord with each other. In Korean, TI sequences are dispreferred in the lexicon just as they are “repaired” via palatalization heteromorphemically. In Turkish, there is no phonotactic dispreference for intervocalic velars in stems, and the alternation is much more morphologically constrained (Inkelas 2011). Together, this suggests at the very least a bias to have similar generalizations across both levels.
Major place harmony in ABC and the (reduced) role of representation: evidence from Ngbaka

The apparent lack of cases of major place harmony, where the harmonizing feature is [labial], [dorsal], or [coronal], has led Rose & Walker 2004 to suggest it should not be possible theoretically, while Bennett 2013 suggests it is simply an accidental gap in the empirical typology. A third option is argued here: that it is possible and it is empirically attested.

Ngbaka (Atlantic-Congo, Central African Republic, [nga]) places various consonant co-occurrence restrictions on roots: two identical segments are allowed in a root, homorganic segments must agree in voicing and nasality, and crucially, a labial segment cannot co-occur with a labial-dorsal segment, while a dorsal segment can (regardless of order):

(1) k-\textit{k}\textsubscript{p} g-\textit{k}\textsubscript{p} *p-\textit{k}\textsubscript{p} *b-\textit{k}\textsubscript{p} k-gb g-gb *p-gb *b-gb

(Thomas 1963; Sagey 1986)

Generalizations for nasality pattern like voicing (see van de Weijer 1994; Rose & Walker 2004).

This project proposes that the place restrictions in Ngbaka roots are due to the same grammatical mechanism as the voicing and nasality restrictions: it is an instance of major place harmony. Labial segments must agree in place, while labial, coronal, and dorsal segments must agree in voicing and nasality.

This analysis proposes a flat structure for labial-dorsal segments with respect to place features: each contains a [labial] and [dorsal] feature under the C-place node. Previous analyses of Ngbaka co-occurrence restrictions either focused only on purely homorganic combinations, or proposed that labial-dorsal segments have a primary labial place (Sagey 1986). Phonetically, however, each articulation is of equal, consonantal stricture, as opposed to one being consonantal and the other vocalic. This, then, is a case of double articulation rather than secondary articulation (see van de Weijer 2011 for a review).

With this representational structure, place asymmetries in the generalizations are best captured via the ranking itself. Using the framework of Agreement by Correspondence (ABC, Rose & Walker 2004; Hansson 2010; Bennett 2013 a.o.), Corr constraints, those that demand correspondence among segments, must refer to individual place features: there is a Corr[labial] constraint, a Corr[dorsal], and a Corr[coronal]. In Ngbaka, Corr[labial] crucially dominates Corr[dorsal]. The ranking for Ngbaka place and voice harmony is given in (2).

The generalization for Ngbaka is now straightforwardly expressed: labials correspond, and agree in place (crucially, for the feature [dorsal]). Thus the optima [p\textsubscript{1},p\textsubscript{2}] and [kp\textsubscript{1},kp\textsubscript{2}] have segments in correspondence (indicated via indices) and are allowed, as each is either both [−dorsal] or both [+dorsal]. The output [p\textsubscript{1},kp\textsubscript{1/2}] is disallowed with any correspondence relation as the segments would either violate Ident-CC-[place] having segments with mismatched place in correspondence, or would violate undominated Corr-[lab] through having two [labial] segments not in correspondence. All simple dorsals and coronals correspond and agree for the feature [voice]. However, because Ident-IO-[place] dominates Corr-[dor], simple dorsals can surface with labial-dorsals of the opposite voicing value (e.g. [k\textsubscript{1},gb\textsubscript{2}, g\textsubscript{1},kp\textsubscript{2}]), as is desired. These optima do not contain segments in correspondence—if they did, they would be subject to Ident-CC-[place] as well, which would (undesirably) prohibit all K-KP combinations.

This analysis is significant cross-linguistically, as neither Rose & Walker 2004 nor Hansson 2010 find any definite cases of major C-place harmony, with Rose & Walker 2004 going as far as saying "a possible implementation would be to suppose that Ident-IO(Place) regularly supersedes Ident-CC(Place), or the constraint Ident-CC(Place) does not exist" (Rose & Walker 2004:520). Notice that in the presented Hasse diagram for Ngbaka, Ident-CC-[place] crucially dominates Ident-IO-[place]. While Rose & Walker 2004 do discuss (nasal) harmony in Ngbaka,
their assumptions about place follow that of Sagey 1986 which utilizes the notion of abstract primary place. Here, the asymmetries in distribution between k-\k and p-\k is captured through the ranking rather than through the representation of the segments themselves. Bennett 2013 suggests that place harmony should be theoretically possible but the lack of it is an empirical gap—Ngbaka then fills that gap.

While major place harmony may still be rare cross-linguistically, empirical patterns like those in Ngbaka occur elsewhere as well. Cahill 2006 discusses similar distributions in Kuku and Kaanse, and Bennett 2013 and Hansson 2010 discuss a case with labials and labial-velarized labials [p^v] in Ponapean which show parallel distributions. One major issue is the relationship between labial-velars and their significance in place harmony.

In summary, Ngbaka is best analyzed as a case of major place harmony, which until now has been claimed to be largely unattested. The structure of labial-velar complex involves two structurally equal place features, and distributional effects are captured via the ranking of ABC constraints referring to individual place features. All empirical generalizations are supported by a new, searchable digitization of an Ngbaka dictionary (Maes 1959), of which the full results will be presented.

\[(2) \quad \textit{Ngbaka ranking}\]

\[
\begin{array}{c}
\text{Corr-[lab]} \\
\text{Ident-CC-[place]} \\
\text{Ident-CC-[place]} \\
\text{Corr-[cor]} \\
\text{Ident-CC-[voice]} \\
\text{[voice]} \\
\end{array}
\]

Bennett, Wm G. 2013. Dissimilation, Consonant Harmony, and Surface Correspondence. Rutgers University.
Sagey, Elizabeth. 1986. The Representation of Features and Relations in Non-Linear Phonology. Massachusetts Institute of Technology.
Perceptually Based Constraints and Metathesis: Evidence from Artificial Grammar

Sonority-based syllable contact constraints have been used to explain cross-linguistic preferences regarding syllable boundaries (Vennemann 1988); Languages tend to optimize syllable boundaries so that the coda of $\sigma_1$ is more sonorous than the onset of $\sigma_2$ (e.g., /el.pæ/ is preferred to /ep.læ/). Recent research has suggested that syllable contact and sonority are better explained in terms of syllable structure and perceptibility constraints (Henke et al. 2012), which may explain violations of syllable contact across various languages (Rose 2000). The present study tests whether learners of a novel consonant-consonant metathesis pattern will be more likely to generalize the pattern based on small changes in sonority (stop-fricative) that improve syllable contact, or changes in coda voicing (e.g., to satisfy *VoicedObstruentCoda). Participants were more likely to select metathesis (as opposed to a faithful option) when metathesis resulted in avoidance of a voiced obstruent coda, but were not more likely to metathesize when metathesis resulted in improved syllable contact. These results support a view of perceptually motivated syllable constraints, rather than strict sonority-based syllable contact constraints.

Participants were adult, native speakers of American English and were divided into one of four training conditions. In each condition, participants were exposed to two single syllable words and their combined form (e.g., /VC$C_1$/ /C$C_2$V/ → [VC$C_2$C$1$V]), based on the triad training design (Davidson et al. 2004) that allows exposure to both input and output. Each training condition involved metathesis between /f/ or /v/ and the stop consonants /p, t, k, b, d, g/. The stop and fricative maintained constant syllable structure position throughout training, as shown in Table 1. Thus, metathesis resulted in either a fricative onset (Onset-f/Onset-v) or a fricative Coda (Coda-f/Coda-v).

Training consisted of 24 randomly ordered triads, repeated five times each. Following training, participants were given a two-alternative forced-choice test in which participants chose between two identical triads, one in which metathesis applied (e.g., /et/+ /fo/ → [efto]) and one in which metathesis did not apply (no change) (e.g., /et/+ /fo/ → [etfo]). Items were divided into four types: Old– identical to the training set, New– items with the same fricative and fricative position, New-Fricative– items with the same fricative position, but a different fricative (either /f/ or /v/), and New-Position– items with the same fricative, but with the fricative appearing in a novel syllable.

Table 1: Examples of Training Conditions and Test Items (Shading Refers to Voicing of Coda: No Change, Voiced Coda, Voiceless Coda)

<table>
<thead>
<tr>
<th>Training</th>
<th>Coda-v</th>
<th>Onset-v</th>
<th>Coda-f</th>
<th>Onset-f</th>
</tr>
</thead>
<tbody>
<tr>
<td>Old/New</td>
<td>ep + vo → evpo</td>
<td>ev po → epvo</td>
<td>ep + fo → efpo</td>
<td>ef po → epfo</td>
</tr>
<tr>
<td></td>
<td>eb + vo → evbo</td>
<td>ev bo → ebvo</td>
<td>eb + fo → efbo</td>
<td>ef bo → ebfo</td>
</tr>
<tr>
<td>New-Fricative</td>
<td>ob + fu → ofbu</td>
<td>of + bu → obfu</td>
<td>ob + vu → ovbu</td>
<td>ov + bu → obvu</td>
</tr>
<tr>
<td></td>
<td>op + fu → opfu</td>
<td>of + pu → opfu</td>
<td>op + vu → ovpu</td>
<td>ov + pu → opvu</td>
</tr>
<tr>
<td>New-Position</td>
<td>ov + bu → obvu</td>
<td>ob + vu → ovbu</td>
<td>of + bu → obfu</td>
<td>ob + vu → ovbu</td>
</tr>
<tr>
<td></td>
<td>ov + pu → opvu</td>
<td>op + vu → ovpu</td>
<td>of + pu → opfu</td>
<td>op + vu → ovpu</td>
</tr>
</tbody>
</table>

If participants learn the metathesis pattern in terms of syllable contact, participants will be more likely to generalize the metathesis pattern to the preferred
syllable contact (decreased sonority; when a fricative becomes the coda). However, if participants learn the metathesis pattern in terms of perceptually-based constraints on obstruent voicing, participants will be more likely to apply metathesis to novel items that result in a voiceless coda.

The proportion of metathesis (as opposed to ‘no change’) responses was recorded for all participants combined across all conditions. Ten participants (of 70) were excluded because they failed to metathesize to more than 50% of Old and New items. In order to test generalization to novel items, Old items were not excluded from statistical analyses. All items were coded in terms of sonority and voicing. Sonority was coded in terms of whether metathesis resulted in increased sonority (mean = 0.77) or decreased sonority across the syllable boundary (mean = 0.76). Voicing was coded in terms of how the obstruent coda changed in voicing as a result of metathesis, and marked in Table 1 using shading. Items were coded as No Change (mean = 0.75) when metathesis did not alter the voicing of the coda. Items were coded as Voiced Coda (mean = 0.43) when metathesis resulted in a voiced coda. Items were coded as Voiceless Coda (mean = 0.83) when metathesis resulted in a voiceless coda. A mixed effects logistic regression that used random intercepts for voicing, subjects and fixed effects for sonority and stop voicing (random slopes failed to converge) showed a significant effect for coda voicing ($\chi^2(2) = 11.05, p = 0.0040$), but not sonority ($\chi^2(1) = 1.22, p = 0.27$). In addition, there were significantly more metathesis responses to Voiceless Coda items compared to both Voiced Coda ($\beta=0.51, z =2.60, p = 0.0093$) and No Change ($\beta=0.57, z =3.23, p = 0.0012$) items.

The results of the present artificial grammar learning experiment demonstrates that English speakers are more likely to use perceptually motivated constraints on obstruent coda voicing over sonority-based syllable contact constraints when differences between sonority of onset and coda were small. This result was true regardless of training condition, as there was effect of training condition ($\chi^2(3) = 2.54, p = 0.47$).

While sonority-based syllable contact constraints can play a role in metathesis (Vennemann 1988), these constraints generally require a larger sonority difference with a robust perceptual component. When the sonority difference does not result in a large perceptual change, as in the present experiment, other perceptually based constraints (such as *VoicedObstruentCoda) will play a larger role in driving phonological processes.

References:
Distinguishing phonotactic restrictions and accidental gaps

Much experimental work has found that native speakers respond differently to phonotactically legal and illegal stimuli on a range of tasks, supporting the ‘psychological reality’ of static phonological generalizations (Frisch & Zawaydeh 2001; Berent et al. 2007; Daland et al. 2011), though it is often undetermined whether these effects derive from abstract, grammatical generalizations or from the phonetic novelty of the stimuli (Davidson 2010; Wilson et al. 2015). Here I explore the status of two categorical phonotactic restrictions in Bolivian Quechua that have previously been found to not trigger errors on perception and production tasks, and find that these structures are also not treated differently from other accidentally absent structures.

Background: Bolivian Quechua contrasts ejective [p’ t’ k’ q’], aspirate [ph th khqh] and plain [p t th k q] stops. Ejectives and aspirates occur exclusively in pre-vocalic position within roots, and are subject to a range of combinatorial restrictions. First, ejectives and aspirates are prohibited from occurring in medial position in roots with an initial stop (1). Second, ejectives are absent from [ʔ] initial roots and aspirates are absent from [h] initial roots (2).

(1) a. k’atʃa ‘pretty’ b. *kat’a *k’at’a *k’h at’a
    rit’i ‘snow’ jut’h u ‘sparrow’ *kat’h a *k’h at’h a

(2) a. hak’u ‘flour’ b. *ʔak’a
    ?uk’h u ‘inside’ *hak’h a

Previous work has found evidence for the restrictions in (1) from a variety of production, perception and metalinguistic tasks with native Quechua speakers (Gallagher 2013, 2014, 2015). In contrast, the studies in Gallagher (2015) found that the restrictions in (2) do not elicit production or perception errors, though an effect was found in a metalinguistic, forced choice judgment task. The forced choice experiment found a preference for [h]-ejective forms over unattested [ʔ]-ejective minimal pairs (e.g., [hak’a] preferred to *[ʔak’a]), and a preference for [ʔ]-aspirate forms over unattested [h]-aspirate minimal pairs (e.g., [ʔak’h a] preferred to *[hak’h a]). This result does not distinguish between a preference for phonotactically legal forms and a preference for frequent forms, however. While [ʔ]-ejective and [h]-aspirate forms are both unattested and phonotactically restricted, [h]-ejective (O/E = 4.3) and [ʔ]-aspirate (O/E = 2.7) forms are both highly overattested and phonotactically unrestricted.

General methods: The two experiments presented here test for evidence of true phonotactic restrictions on [ʔ]-ejective and [h]-aspirate combinations by comparing forms violating these potential restrictions to frequency matched forms that are hypothesized to be accidental gaps (following, e.g., Rose & King 2007). The expectation is that phonotactically restricted forms should be dispreferred more than accidental gaps.

The experiments compare the unattested [ʔ]-ejective combinations to [j]-ejective combinations, which are also unattested in Quechua. The absence of [j]-ejective combinations is not hypothesized to be a phonotactic restriction because [j] and ejectives
do not form a natural class. Test forms with ejectives are compared to minimal pairs with plain stops, both of which are well attested: [ʔ]-plain O/E = 0.87, [j]-plain O/E = 1.25. [h]-aspirate forms were also compared with [j]-aspirate forms, which are infrequent (n=2), though not underattested (O/E=1.36).

**Forced choice:** In the forced choice study, participants were presented with minimal pairs of C1V(C)C2V nonce words and asked to choose which of the two words sounded more natural as a potential word of Quechua. The stimuli were 20 test pairs, 20 control pairs and 30 filler pairs. The test pairs compared a form with a [ʔ]-ejective or [h]-aspirate combination with a minimal pair with [j] as the initial consonant, e.g., [ʔak’u] vs. [jak’u] or [hak’u] vs. [jak’u]. The control pairs were matched with the test pairs, except that they contained a plain stop instead of an ejective/aspirate, e.g., [aku] vs. [jaku] and [haku] vs. [jaku]. The preference for the [j] initial forms was then compared between the control and test trials. If the glottal combinations are subject to a phonotactic restriction - above and beyond being unattested - then the preference for [j] initial forms should be stronger in the test forms than the control forms. Instead, a comparable preference for [j] initial forms was found across trial types (ejectives: 67% test vs. 56% control, p = 0.39; aspirates: 61% test vs. 61% control, p = 0.89), revealing no effect of the phonotactic restrictions. This result suggests that [ʔ]-ejective and [h]-aspirate pairs were dispreferred in the forced choice study in Gallagher (2015) because they were compared with highly frequent structures, not because of a truly phonological restriction.

**Lexical decision:** The second experiment was a lexical decision task and focused exclusively on [ʔ]-ejective forms. The test items of interest were nonce words with either a [ʔ]-ejective, [j]-ejective, [ʔ]-plain or [j]-plain combination. There were 10 words of each type, for a total of 40 test items. An additional 40 nonce words with varied segmental content were included, as well as 80 real words.

Accuracy and response times were analyzed. For accuracy, there was a significant effect of attestation, but no additional effect of a phonotactic restriction. Nonce words with unattested [ʔ]-ejective (85% accurate) and [j]-ejective (88%) combinations were correctly rejected at higher rates than nonce words with attested [ʔ]-plain (74%) and [j]-plain (73%) combinations (p < 0.01). The difference between [ʔ]-ejective and [ʔ]-plain combinations was comparable to the difference between [j]-ejective and [j]-plain combinations (p = 0.32 for the interaction term), revealing no additional effect of a phonotactic restriction on [ʔ]-ejective forms. Filler nonce forms were rejected at a comparable rate (75%) found for the unrestricted nonce forms, and did not differ between forms with and without an ejective. Reaction times did not differ between stimulus types.

**Discussion:** The absence of support for phonotactic generalizations against [ʔ]-ejective and [h]-aspirate pairs contrasts with two positive results. First, the lexical decision task revealed an effect of frequency. Second, previous work has found effects of other phonotactic restrictions (those in (1)) on production, perception and metalinguistic tasks. These results suggest that the two generalizations studied here have gone un- or under-learned by Quechua speakers, despite being both categorical and based on natural classes (c.f. Hayes et al. 2009; Hayes & White 2013).
Learning complex surface phonotactics: sequence memorization vs. statistical expectation

Successful phonotactic learning requires generalization beyond attested forms: the grammar that results from learning must, minimally, distinguish novel combinations that are legal from those that are illegal (Halle 1962). For this reason, phonotactic learning cannot be reduced to memorization of a lexicon of words. A recent computational model proposes that learning instead involves memorizing a set of attested substrings (or subsequences), which can be recombined to create legal nonce forms (Heinz 2010; Heinz et al. 2011; Jardine & Heinz 2016). This approach has interesting mathematical and computational properties (e.g., de la Higuera 2010), and has been fruitfully applied to the results of artificial grammar experiments (e.g., McMullin & Hansson 2014, 2015; McMullin 2015, 2016; Lai 2015), but it has so far not been comprehensively evaluated on the phonotactic pattern of any natural language.

Using South Bolivian Quechua (SBQ) as a test case, we compare a tier-based version of the substring memorization model (TSL) with a maximum entropy model that learns constraints by comparing observed and expected frequencies (Maxent; Hayes & Wilson 2008). We begin by establishing that both models must use complex (trigram) constraints to describe the phonotactic pattern of Quechua, in particular the complementary distribution of high and mid vowels. We then show that this leaves the TSL model susceptible to accidental gaps: trigrams that fail to appear in the learning data, not because they are illegal, but because one or more of their segments are independently rare. The Maxent model avoids this problem by only learning constraints against sequences that are observed significantly less often than would be expected by chance. Our results provide evidence against memorization of attested structures, and in favor of statistical inference (e.g., Pierrehumbert 1994, 2001), as a basis for phonotactic learning.

The pattern: In SBQ, mid vowels [e o] are found adjacent to a uvular, or preceding a uvular across an intervening coda (Bills et al. 1971). High vowels are found elsewhere.

(1) a. q’epij ‘to carry’ peqaj ‘to grind’ wesq’aj ‘to close’ b. misi ‘cat’ q’oni ‘hot’ noqa ‘I’ toqqa ‘son-in-law’ kułku ‘neck’

In an SPE-style analysis of this pattern, mid vowels would be excluded from underlying representations and derived by rule in uvular contexts. In an OT analysis, a general constraint penalizing mid vowels would outrank faithfulness to height, but in turn be outranked by more specific constraints against high vowels in uvular contexts (e.g., *[+high][uvular] >> *[low]). Both of these analyses specify the environment for the more restricted allophones (mid vowels) via a context-specific rule or constraint, with the less restricted allophones (high vowels) simply left to occur elsewhere.

The two phonotactic models we consider here are purely surface-based, in the sense that the grammar applies directly to outputs without reference to a mapping from underlying representations or other inputs. The elegant 'elsewhere' analysis of SBQ height allophony is not available to models of this type. High vowels can be excluded from uvular contexts with bigram constraints (2a). However, mid vowels must be restricted by trigram constraints that penalize them in contexts where a uvular neither precedes nor follows (2b). The constraints sketched in (2) are assumed to be stated on a dorsal tier, which includes uvular and velar consonants as well as all vowels. Note that simpler constraints on mid vowels (e.g., *E, or *E K and *K E) would undergenerate, as they are violated by legal words. Because mid vowels can be licensed by context on either side, surface-based grammars must 'look both ways' before ruling them out.

(2) a. *Q I *I Q b. *K E *V E #
   *K # E K V
   *E K # V E K
   *E V K V E V
The models: As discussed above, the TSL model learns a phonotactic grammar by memorizing the substrings (up to a specified maximum length and on one or more tiers) that occur in attested forms. For example, having observed the form [peqa], the model records the following substrings as legal on the dorsal tier: # e, e, q, a (unigrams); #e, eq, qa, q# (bigrams); #eq, eqa, qa# (trigrams); etc. Once the learning data has been processed in this way, a novel form is evaluated by decomposing it into substrings (again on one or more tiers) and checking whether each substring is attested. Any unattested substring suffices to render a form ungrammatical (Heinz et al., 2011): for example, *[piqqa] would be correctly rejected because its dorsal-tier trigrams *[#iq] and *[iqa] never appear in the SBQ lexicon. Since the set of unattested substrings is the complement (over a predefined alphabet) of the attested set, the TSL model can also be thought of as learning an inviolable constraint against each substring that does not occur in the lexicon; the expressions in (2) are then simply convenient abbreviations for such constraints.

The Maxent model does not learn a prohibition on every unattested substring. Instead, it induces constraints on combinations that have observed frequencies significantly lower than their expected frequencies. Because the distribution of segments in SBQ is highly skewed (as in other languages, Tambovtsev & Martindale 2007), we use a version of Maxent in which expected violations of bigram and trigram constraints are calculated with segment relative frequencies. For example, the sequence [qqe] (and several others containing aspirated or glottalized uvulars) happens not to occur on the dorsal tier in the SBQ lexicon. The TSL model inevitably learns a constraint against this sequence, which conforms to the vowel height pattern, in the same way that it penalizes *[iqa]. The Maxent model instead attributes the non-occurrence of [qqe] and the like to rarity of the intervocalic consonant—laryngeally-specified uvulars being among the least frequent segments in the language—rather than to specific constraints against these sequences.

Learning results: The ability of each model to correctly generalize beyond the phonotactic learning data was evaluated with cross-validation (e.g., Hastie et al. 2001). Both models were provided with several tiers that support learning of a wide variety of phonotactics (e.g., a laryngeal tier to capture cooccurrence restrictions on aspirates and ejectives). The lexicon consisted of a set of 1104 bare roots (from Laime Ajacopa 2007) and forms derived by combining these roots with three representative suffixes, [spa], [nku] and [rqa] (with high root vowels immediately preceding the last suffix lowered to mid by rule). The lexicon was divided into five parts or 'folds', and each model was trained on all possible ways on four folds and tested on the remaining 'held out' fold. The testing set further included a large number of forms intended to assess learning of all known SBQ phonotactics (e.g., all possible VCV combinations were tested); complete results and error analysis will be included in our conference presentation.

On the dorsal tier, the Maxent model consistently learned the constraints in (2) or close equivalents. More generally, this model successfully classified every single held-out form as legal and distinguished between legal and illegal nonce words with high accuracy. The TSL model, on the other hand, undergeneralized, judging many legal forms to be ungrammatical (about 5% of held-out words and over 40% of legal nonce words). As anticipated above, the TSL model fails because many phonotactically legal trigrams, particularly those containing infrequent segments, have low or zero frequencies in the lexicon. The Maxent model succeeds by using elementary statistical computations to discriminate accidental from systematic phonotactic gaps.

Implications: The problem for phonotactic learning identified here is not limited to SBQ.

Trigram constraints will be required in surface-based analyses of other vowel allophones that are conditioned from both directions (e.g., in Chichewa: Cook 1992; Arabic: Watson 2002), 'double triggers' in vowel harmony systems (e.g., Walker 2001), and conjunctive (both-side) environments for fronting and lenition (e.g., Flemming 1995; Kirchner 1998). Study of these patterns should provide further evidence against simple memorization, and in favor of statistical comparison of observed and expected frequencies, in surface-based phonotactic learning.
Grammar trumps lexicon: Typologically inconsistent weight effects are not generalized

Background: In the vast majority of languages that are sensitive to weight, syllable weight is binary, i.e., a syllable is either light or heavy (see Gordon (2007) for a comprehensive review). In such languages, heavy syllables are more likely to attract stress. This is the case for Latin and English, for example. As well, if a language is weight-sensitive, weight cannot have a negative effect on stress, by definition.

Portuguese, like Latin and English, is also weight-sensitive, and is traditionally analysed as having a binary weight distinction: syllables that have a complex rhyme are heavy (H); all other syllables are light (L). Furthermore, Portuguese weight effects have long been assumed to be constrained to the word-final syllable (Bisol 1994, 2013; Lee 2007). The standard generalization regarding stress assignment in the language is given in (1).

(1) Portuguese stress: standard generalization
Final if the final syllable is heavy (H):
   moral ‘morale’, pomár ‘orchard’
Penult otherwise:
caválo ‘horse’, martélo ‘hammer’, piménta ‘pepper’
Antepenult stress is irregular:
pántano ‘swamp’, atónito ‘astonished’

However, once we examine a comprehensive corpus, the generalizations in (1) do not hold. First, weight-sensitivity is not constrained to the word-final syllable. Second, it is not binary: syllable weight gradiently affects all three syllables in the stress domain—even though weight effects weaken as we move away from the right edge of the word. Crucially, the weight effects of antepenult syllables found in the Portuguese lexicon (Houaiss et al. (2001), 154,610 entries) contradict the typological prediction mentioned above, in that weight has a negative effect on antepenult stress, i.e., LLL words are significantly more likely to attract antepenult stress than HLL words.

Questions: The two questions this paper investigates are:

i. Do speakers’ grammars capture the weight gradience present in the data, given the subtlety involved? I show that speakers’ grammars mirror the weight gradience found in the Portuguese lexicon, thus confirming that weight is not binary in the language.

ii. How do speakers’ grammars deal with typologically inconsistent weight-stress patterns such as the negative weight effect in antepenult syllables? I show that speakers’ grammars regularize the typologically inconsistent weight pattern present in the input available to speakers.

Methods: As a baseline, smaller lexica (20,000 words) were randomly simulated (n = 1,000) from the Houaiss corpus to ensure that the typologically contradictory pattern observed in the data is not restricted to a specific subset of words in the lexicon. The distribution of effects found in all simulated lexica confirm both the weight gradience and the negative antepenult weight effects.

An auditory judgment experiment was run containing trisyllabic nonce words (n = 240) and different weight profiles (LLL, HLL, LHL), where H = (C)CVC and L = (C)CV. LLH words were used as control, given that weight effects are most robust word-finally. Participants were all native speakers of Brazilian Portuguese (n = 27). They were presented minimal pairs differing only with regard to the position of stress. They were then asked to choose which version of the word sounded more natural to them—all choices were binary and no orthographic forms were provided. Participants were also asked to indicate their level of confidence in their judgment using a 6-point scale. To confirm that the results found were robust, the experiment was replicated months later with a different group of participants (n = 27). The experimental data were modelled using multilevel logistic regression in R (R Core Team 2016).

Results: In Fig. 1, we can see that participants in both Version A and Version B (replication) preferred final stress (U) in the control condition (LLH words), as expected: $\hat{\beta}_A = 0.84, p < 0.0001; \hat{\beta}_B =$
0.89, \( p < 0.0001 \). To determine whether these results mirror the weight gradience observed in the lexicon, we compare both \( \text{HLL} \) and \( \text{LHL} \) words to the neutral weight profile, i.e., \( \text{LLL} \). In both versions of the experiment, penult stress is significantly more likely in \( \text{LHL} \) words (relative to \( \text{LLL} \)): \( \hat{\beta}_A = 0.75, p < 0.0001; \hat{\beta}_B = 0.70, p < 0.0001 \). Antepenult stress is also more likely in \( \text{HLL} \) words than in \( \text{LLL} \) words: \( \hat{\beta}_A = 0.23, p < 0.05 \). In Version B, a significant effect was not found (\( \hat{\beta}_B = 0.16, p = 0.19 \)), but the effect of a heavy antepenult syllable is positive, which is consistent with Version A and confirms the trend in Fig. 1. Finally, speakers’ confidence levels are in line with the response patterns found in the data, in that stress on heavy syllables yielded more confident responses.

**Figure 1**: Experimental results. \( y \)-axis represents the mean percentage of participants’ responses by stress pattern (\( x \)-axis): \( \text{APU} \) = antepenult stress; \( \text{PU} \) = penult stress; \( \text{U} \) = final stress.

**Discussion**: Table 1 summarises the results. The effect sizes (\( \hat{\beta} \)) confirm the trends observed in Fig. 1, namely, that weight does play a role in all three positions in the stress domain, a fact which mirrors the patterns found in the Portuguese lexicon as well as in the simulated lexica used as baseline. Crucially, the negative weight effects of antepenult syllables found in the Portuguese lexicon are not mirrored in speakers’ responses. Rather, the behaviour observed indicates that participants’ grammars have regularized the weight effects in the language, i.e., weight positively impacts stress across all positions in the stress domain. Finally, these data not only show that the grammar generates patterns that are consistent with the typology, but also that even statistically subtle lexical effects (such as the weight gradience observed) can be captured and, importantly, generalized to novel words.

**Table 1**: Gradient weight effects in the stress domain (\( \sigma_3 \sigma_2 \sigma_1 \mid W_A \)): Version A and Version B

<table>
<thead>
<tr>
<th>Stress</th>
<th>Contrast</th>
<th>Effect (( \hat{\beta}_A ))</th>
<th>Effect (( \hat{\beta}_B ))</th>
<th>Effects in simulated lexica</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. Antepenult</td>
<td>( \text{HLL} ) vs. ( \text{LLL} )</td>
<td>Positive: 0.23</td>
<td>Positive: 0.16</td>
<td>*Negative</td>
</tr>
<tr>
<td>2. Penult</td>
<td>( \text{LHL} ) vs. ( \text{LLL} )</td>
<td>Positive: 0.75</td>
<td>Positive: 0.70</td>
<td>Positive</td>
</tr>
<tr>
<td>1. Final</td>
<td>( \text{LLH} ) vs. ( \text{LHH} )</td>
<td>Positive: 0.84</td>
<td>Positive: 0.89</td>
<td>Positive</td>
</tr>
</tbody>
</table>

The probabilistic analysis proposed here can be formalized within a Maximum Entropy Grammar (Hayes and Wilson 2008) with positionally defined weight constraints (WEIGHT-TO-STRESS PRINCIPLE, \( \text{WSP} \) (Prince 1990, Gordon 2004, Ryan 2011)), which assigns violation marks to heavy syllables that are not stressed. The constraint in question is defined as \( \text{WSP}_n \), where \( n \) represents any position in the stress domain—which is determined by the interaction of other constraints in the grammar. Crucially, the cost of violating \( \text{WSP}_n \) depends on how strong weight effects are in position \( n \) (Table 1).

Weight effects are strongest at the right edge of the word (final syllable, position 1; Fig. 1), and weakest at the left edge of the stress domain (antepenult syllable, position 3). As a result, the gradient weight effects in Portuguese would be captured by assigning relative weights to \( \text{WSP}_3 < \text{WSP}_2 < \text{WSP}_1 \). This analysis predicts the typologically consistent behaviour observed in speakers’ judgments.
Footing is not always about stress: Formalizing variable high vowel deletion in Québec French

Overview: Prosodic domains are identified on the basis of the phonological processes they exhibit (Nespor & Vogel 1986; McCarthy & Prince 1995). Lexical stress, for example, is realized in the foot and computed in the phonological word (PWD), motivating these two domains. Although the foot and PWD are typically assumed to be universal (Selkirk 1996), the validity of this assumption has been questioned for French: the only position of obligatory prominence in this language is the right edge of the phonological phrase, regardless of how many lexical words it contains (e.g. Dell 1984). This has led some researchers to analyse French ‘stress’ as intonational prominence, and French as a language without the foot (Jun & Fougeron 2000 on European French; see also Thibault & Ouellet 1996 on Québec French). We focus on Québec French (QF).

In this paper, we argue that, although the typical signatures of word level stress are absent in QF, a different phonological process, high vowel deletion (HVD), motivates the existence of foot structure. HVD never targets vowels in final prominent position, indicating that it is sensitive to rhythmic structure in some way. However, there is disagreement about whether high vowels in some or all positions upstream of the final vowel are (equally) targeted. Cedergren (1986) argues that high vowels in any position to the left of the final vowel can be targeted while Verluyten (1982) argues that deletion preferably targets vowels in alternating fashion from the right edge.

This disagreement likely stems from the fact that HVD applies variably. Indeed, we show that when the conditions on variation are experimentally probed, evidence for iterative iambic footing emerges, supporting Verluyten. Further, we show that there are competing factors that regulate the (non)application of HVD. We formalise these observations in a MaxEnt Grammar (Hayes & Wilson 2008), which (i) allows candidates to be probabilistically assessed, thus capturing the variation, and (ii) allows for gang-up effects, where two or more lower-ranked constraints can trump the effects of a higher-ranked constraint, thus capturing the competing factors.

Experiment: Ten native speakers of QF rated how natural 355 2-6 syllable words sounded with deletion or non-deletion of [i] in various non-final positions in the word; see (1).

(1) HVD site (underlined) Position of HVD from R edge
kõ.bi.ne; e.k.s.kl.y.zi.vj.te ‘to combine’; ‘exclusivity’ Syllable 2
ɔr.qa.ni.za.tør; ma.ni.fes.tå ‘organizer’; ‘demonstrator’ Syllable 3
ma.ni.fes.ta.sjø; ɔs.pi.ta.li.te ‘demonstration’; ‘hospitality’ Syllable 4
y.ni.ver.sa.li.te; e.li.zi.bi.li.te ‘universality’; ‘eligibility’ Syllable 5

The data were modelled with multilevel ordinal regressions (by-speaker and by-item random intercepts). Significant effects (α = 0.05) are discussed below—\( \hat{\beta} \) values (i.e., effect sizes) are in parentheses.

(a) Non-deletion is preferred over deletion (\( \hat{\beta} = 1.82 \)): kõbïne > kõbØne.
(b) HVD is preferred in positions 2 and 4 over positions 3 and 5 (\( \hat{\beta} = 0.70 \)): ma.nØ.fes.ta.sjø > ma.nØ.fes.tå, consistent with Verluyten (1982). If French builds iterative iambic feet from right to left, HVD will optimally target foot-dependent positions: ma(nØ.fes)(ta.sjø) > (ma.nØ)(fes.tå). This is consistent with the observation that faithfulness to prominent positions is cross-linguistically preferred (Beckman 1998).
(c) HVD is preferred when it yields a string mirroring an illicit complex onset ($\beta = 1.13$): k3bØne > supØre ‘to sigh’; *[bn] vs. [pr]. This indicates that syllabification and footing remain intact after HVD: the deletion site can be recovered in a string like [k3bne] but not in [supre]; the former can only be reconstructed as /k3bVne/, while the latter could be /supre/ or /supVre/.

(d) Even though non-deletion is preferred over deletion (see (a)), the opposite is true in one context: when foot-dependent [i] is at the left edge of a suffix ($\beta = 0.31$): [ks(klyzi)(v-Øte)] > [ɔr(gan-Ø)(zatœr)]. We propose that this is because the deleted high vowel is easily recovered in this context.

**Formalization:** We formalise our analysis with a MaxEnt Grammar, where constraints are weighted and candidates are assigned probabilities. The main constraints we employ are in (2).

(2) Constraints

MAX: Do not delete segments

*i*: Low sonority vowels are disfavoured

*$_A$[i]: Low sonority vowels are disfavoured in affix-initial position

MAXHD: Do not delete in foot-head position

As HVD is overall dispreferred, the weight of MAX ($w_{MAX}$) is predicted to be higher than $w_{*i}$: $w_{MAX} > w_{*i}$. To account for the preference for HVD in foot-dependent position, we employ the positional faithfulness constraint MAXHD in (2). Violating MAXHD as well as MAX ensures that HVD is dispreferred in foot-head position ($w_{MAXHD} + w_{MAX} > w_{*i}$).

The gang-up effect observed in (d) above arises from violating both $*i$ and $*_A[i$, in which case the candidate with HVD has a higher probability of surfacing when [i] is at the left edge of a suffix and in foot-dependent position. As a result, $w_{*i} + w_{*_A[i} > w_{MAX}$; see tableau in (3). If deletion of affix-initial [i] occurs in foot-head position, as in (4), then MAXHD comes into play and the weight of this constraint mitigates the gang-up effect. In this case, deletion is as likely as non-deletion. (In tableaux (3)-(4), we show candidates’ probabilities ($p$), which are computed from the constraint weights, and proportions arising from the patterns in the data (Actual $p$)).

<table>
<thead>
<tr>
<th>/eks</th>
<th>Max</th>
<th>*i</th>
<th>*$_A$[i]</th>
<th>MAXHD</th>
<th>$p$</th>
<th>Actual $p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>/ks</td>
<td>klyzi/v-ite</td>
<td>2</td>
<td>1</td>
<td></td>
<td>0.4</td>
<td>0.44</td>
</tr>
<tr>
<td>/ks</td>
<td>klyzi/v-Øte</td>
<td>1</td>
<td>1</td>
<td></td>
<td>0.6</td>
<td>0.56</td>
</tr>
</tbody>
</table>

With regard to the preference for HVD yielding strings mirroring illicit over licit complex onsets, k3bØne > supØre in (c) above, an additional constraint is needed. We propose that this constraint is RECOVERABILITY ($w = 1.1$), which we define as: In a segmental string, immediate precedence relations in the Input are recoverable in the Output. This effectively means that if there is deletion, the deletion site must be recoverable, which will only be the case if the resulting cluster is illicit.

In sum, the constraints and weightings proposed capture the patterns of HVD based on speakers’ ratings. They also appropriately formalise the gang-up effect discussed. Given that HVD applies variably, our probabilistic approach was able to uncover evidence for the foot in QF, despite the absence of the typical signatures for footing and stress in the language.
An OT Analysis of Efik Contrastive Verbal Reduplication

This paper provides an Optimality Theoretic analysis of two types of Efik verbal reduplication based on new data from a native speaker. In Efik, a Cross River language of Nigeria, two kinds of contrastive focus on the verb can be expressed with reduplication. Lexical contrast reduplication puts contrastive focus on the meaning of the verb (‘he’s drinking’ → 3-ǹọ-ǹọ ‘he’s drinking (as opposed to eating’)). Performance contrast reduplication puts contrastive focus on the tense/aspect of the verb (‘I bought’ → [method] ‘I bought already, so I don’t still need to buy’)) (Cook 1985).

Lexical contrast and performance contrast reduplication have distinct phonological patterns in the affirmative but do not contrast in the negative, giving rise to just three patterns (Cook 1985). Efik has two tones, H and L, which may combine to form contour tones. It also has downstep (=) (Welmers 1968). In the single negative reduplication pattern, the reduplicant is a complete, non-local copy of the verb root, including tone (i-ki-wàt-kà~wàt ‘he didn’t ride’). If the verb has the tonal shape L-H, though, the negative reduplicant is low-toned throughout (i-ki-kûrè-kè~kûrè ‘he didn’t finish’).

In affirmative lexical contrast reduplication, the reduplicant is a CV syllable whose C and V respectively copy the first C and V of the verb. The lexical contrast reduplicant exhibits tonal polarity: its tone is the opposite of the (first) tone of the verb root. The form 3-ǹà~ǹjìny ‘he’s tall’ illustrates the complex onset simplification, coda deletion, and polar tone of the lexical contrast reduplicant. Under lexical contrast reduplication, a L-H verb root surfaces as low-toned throughout. Additionally, the vowel of the reduplicant is always [+high], even if the vowel it copies is [+high]. These facts are exemplified by i-ki-’nò~núgò ‘we bent down’ (cf. núgò ‘bend down’).

Finally, in affirmative performance contrast reduplication, the reduplicant is a CV syllable with the same segmental properties as the lexical contrast reduplicant. Instead of having polar tone, though, the performance contrast reduplicant has a fixed high tone (i-mà i-’kò~kòt ‘we read’). A L-H verb root also becomes low-toned throughout under performance contrast reduplication (á- mà 3-ǹò-ǹúgò ‘he bent down’). Based on the three phonological patterns described here, I posit three verbal reduplicants: RED\text{NEG}, RED\text{LEX}, and RED\text{PRF}. Their properties are summarized in Table 1.

<table>
<thead>
<tr>
<th>Shape</th>
<th>RED\text{NEG}</th>
<th>RED\text{LEX}</th>
<th>RED\text{PRF}</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complete copy</td>
<td>Faithful</td>
<td>Always [-high]</td>
<td>Always [-high]</td>
</tr>
<tr>
<td>Vowel Height</td>
<td>Faithful</td>
<td>Polar</td>
<td>High</td>
</tr>
<tr>
<td>Tone(s)</td>
<td>CV</td>
<td>CV</td>
<td>CV</td>
</tr>
<tr>
<td>Tones w/ L-H verb</td>
<td>Reduplicant is L-L</td>
<td>Verb root is L-L</td>
<td>Verb root is L-L</td>
</tr>
</tbody>
</table>

My analysis is couched in Generalized Template Theory (McCarthy & Prince 1995). On the segmental level, there are only two patterns; RED\text{LEX} and RED\text{PRF} differ only in tone. To derive the segmental patterns of RED\text{NEG} on the one hand and RED\text{LEX} and RED\text{PRF} on the other, I propose that the former is a root, subject to root faithfulness, while the latter are affixes, subject only to general faithfulness (Urbanczyk 2006). RED\text{LEX} and RED\text{PRF} exhibit TETU effects that RED\text{NEG} does not: they do not have complex onsets or coda consonants, and they are monosyllabic regardless of the length of the verb root. The basic segmental properties of the
three verbal reduplicants can be derived with the ranking MAX-BR-ROOT >> *COMPLEXONSET, NOCODA, *STRUC-σ >> MAX-BR. Because it is a root and subject to MAX-BR-ROOT, REDNEG preserves the entire base, including complex onsets, coda consonants, and/or syllables beyond the first. As affixes, REDLEX and REDPRF are not subject to MAX-BR-ROOT, so their monosyllabicity and unmarked syllable structure emerge. By adopting *STRUC-σ, I avoid having to resort to a templatic constraint to derive REDLEX and REDPRF’s monosyllabicity. As long as reduplicants can be lexically specified as roots or affixes, root faithfulness is sufficient to derive the verbal reduplicants’ different shapes, and no morpheme-specific constraints are needed.

The absence of high vowels in REDLEX and REDPRF and their preservation in REDNEG can be derived with the TETU ranking IDENT(high)-BR-ROOT >> *[+high] >> IDENT(high)-BR. This TETU effect is unusual since typically high vowels are considered unmarked (Walker 1998 a.o.). In Efik, though, high vowels are barred from the affix reduplicants and mid vowels emerge.

On the tonal level, all three reduplicants exhibit different behavior. Setting L-H verb roots aside, REDNEG has faithful tones. As a root, REDNEG is subject to both IDENT(T)-BR-ROOT and IDENT(T)-BR, which enforce tonal identity between base and reduplicant. I derive the polar tone of REDLEX with the OCP, which militates against adjacent identical tones (highly ranked IDENT(T)-IO ensures that underlying tones do not change to satisfy the OCP). The TETU ranking IDENT(T)-BR-ROOT >> OCP >> IDENT(T)-BR causes the tone of REDLEX to take on the opposite value of the adjacent tone in the base but does not affect the tone of REDNEG. The polar tone of REDLEX is a case of alternating phonological fixed (auto)segmentism (Alderete et al. 1999).

The invariable high tone of REDPRF is also fixed autosegmentism and could be derived with a TETU ranking (IDENT(T)-BR-ROOT >> *L >> IDENT(T)-BR). The relative ranking of *L and the OCP is paradoxical, however: if *L >> OCP, REDLEX and REDPRF will both have fixed high tones, and if OCP >> *L, REDLEX and REDPRF will both have polar tones. Consequently, I analyze the fixed high tone of REDPRF not as a TETU effect but as morphological fixed autosegmentism (Alderete et al. 1999, Lee 2011). A morpheme consisting only of the tone H always appears with REDPRF, and undominated REALIZEMORPHEME compels this H to surface on the reduplicant, supplanting the tone copied from the base.

The last piece of the analysis accounts for the tonal behavior of L-H verbs. With REDLEX and REDPRF, a L-H verb becomes low-toned throughout (i-ki-’né–nùg3, not *i-ki-’né–nùg3), and with REDNEG, the reduplicant (second copy) becomes low-toned throughout (i-ki-kùr-ké–kùrê, not *i-ki-kùrê-ké–kùrê). These tonal changes are motivated by the constraint *HLH (Cahill 2007), which operates within a circumscribed domain that includes the verb root and its reduplicant. To satisfy *HLH, the H of a L-H verb or reduplicant delinks and the L spreads rightward, turning a H-L-H sequence into a H-L-L sequence. To prevent the L delinking and the H spreading leftward, yielding H-H-H, I use ANCHOR-L(T, M), which requires the leftmost tone of a morpheme to be associated to its leftmost TBU.

My analysis highlights some of the unusual phonological properties of Efik contrastive verbal reduplication. The system exhibits both alternating phonological fixed autosegmentism, arising from TETU effects, and morphological fixed autosegmentism. Additionally, the emergence of mid vowels as the less marked counterpart of high vowels runs counter to traditional conceptions of the markedness hierarchy in vowels.
Aspiration 'dissimilation' in Tangkhul Naga prefixation

In Tangkhul Naga (henceforth TN; Tibeto-Burman, Manipur), the verbal prefix /kʰə-/ deaspirates if followed by any stem-initial obstruent, and remains unrepaired before stem-initial sonorants (Arokianathan 1987, Mortensen 2003). This is to an extent reminiscent of cases in Klamath (Blevins 1993, Steriade 1997) and Khasi (Henderson 1976), where aspiration is only licensed in pre-sonorant or pre-vowel positions, and blocked elsewhere (kʰ.l, *kʰ.t) – but is substantially analytically distinct in being morphologically-restricted, non-positional, and operating at a distance.

Representative examples are provided in (1) below (note that TN has a two-way plain/aspirated laryngeal contrast, formalized as [spread glottis] [sg]):

Sonorant-initial roots allow aspirated prefixes; obstruent-initial roots force deaspirated prefixes.

\[
\begin{align*}
  kʰə.lum & \quad 'warm' & kə.pəm & \quad 'sit' \\
  kʰə.ŋə.ŋə & \quad 'hear' & kə.kə.ʃut & \quad 'brush' \\
  kʰə.riŋ & \quad 'live' & kə.hək & \quad '(to be) big' \\
  kə.pʰi & \quad 'to filter' & kə.kʰə.ra & \quad 'sharpen'
\end{align*}
\]

(1)

This is, arguably, analytically problematic. The ban on sequences of successive aspirates and the lack of application before sonorants suggests accounts of dissimilation penalizing similar sequences: OCP restrictions on featurally identical segments (Myers 1997, Suzuki 1998), self-conjunctive markedness constraints (e. g. Alderete 1997, Ito & Mester 1998), or similarity avoidance in Agreement by Correspondence (ABC; Hånsson 2001, Rose & Walker 2004, for dissimilation Bennett 2013, 2014). All of these analyses would this is not however consistent with the pattern in unaspirated root onsets – before such onsets, deaspiration is similarity-increasing, not classically dissimilatory, and penalties on similar sequences should not be invoked here.

How can we account for this? Gallagher (2010: 16) observes that the hypothetical language in which the coexistence of assimilatory and dissimilatory constraints generates the pattern [*Kʰ–Tʰ, *Kʰ–T, but ✗ K–T, ✗ Kʰ–N] is unattested, as partial support for the proposition (as in various implementations of assimilation and dissimilation in ABC) that it is not necessary to invoke any dissimilation-specific machinery to account for dissimilation – the interaction of surface correspondence constraints is sufficient. This observed gap in pattern may indeed be true in roots, but in TN prefixation, I argue that the ultimate pattern is the 'unattested' one, with high-ranking root faithfulness allowing K–Tʰ to surface (deaspiration in the root is blocked; a single aspirate is preferred to a sequence of two aspirates, so deaspiration is forced in the prefix). This is implemented as a conspiracy between constraints penalizing forms containing two aspirated stops *Kʰ–Tʰ, and constraints penalizing stops that disagree in laryngeal specification *Kʰ–T (outranked by root faithfulness).
To briefly illustrate this, consider a Generalized OCP constraint penalizing repeated occurrences of [+sg] (cf. McCarthy 1986, Suzuki 1998, etc): informally denoted by *[+sg] [+sg], and correspondence constraints enforcing agreement in [sg] specification between corresponding segments (e.g. CC-correspondence constraints), which I abbreviate here as *[±sg][±sg]. It is clear that these constraints do not militate against aspirates followed by sonorants. Then, the tableaux in (2) show that the analysis makes sensible predictions:

<table>
<thead>
<tr>
<th>/kʰə.pam/</th>
<th>IDENT-ROOT</th>
<th>*[+sg] [+sg]</th>
<th>*[±sg] [±sg]</th>
<th>IDENT-IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>→ka.pam</td>
<td></td>
<td></td>
<td>*</td>
<td></td>
</tr>
<tr>
<td>kʰa.pam</td>
<td></td>
<td>*[+sg]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ka.pʰam</td>
<td>*!</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Unaspirated roots force deaspiration, since we require that [sg] specification match across segments.

<table>
<thead>
<tr>
<th>/kʰə.pʰi/</th>
<th>IDENT-ROOT</th>
<th>*[+sg] [+sg]</th>
<th>*[±sg] [±sg]</th>
<th>IDENT-IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>→kʰa.pʰi</td>
<td></td>
<td>*[+sg]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>kʰa.pʰi</td>
<td></td>
<td>*[+sg]</td>
<td></td>
<td>*!</td>
</tr>
<tr>
<td>ka.pi</td>
<td>*!</td>
<td></td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

Aspirated roots force deaspiration, since repeated occurrences of [+sg] are penalised.

<table>
<thead>
<tr>
<th>/kʰə.lum/</th>
<th>IDENT-ROOT</th>
<th>*[+sg] [+sg]</th>
<th>*[±sg] [±sg]</th>
<th>IDENT-IO</th>
</tr>
</thead>
<tbody>
<tr>
<td>→kʰə.lum</td>
<td></td>
<td>*[+sg]</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ka.lum</td>
<td></td>
<td>*[+sg]</td>
<td>*</td>
<td>*!</td>
</tr>
</tbody>
</table>

Sonorant roots trigger neither constraint.

In Tangkhul Naga, then, we suggest that an interaction between constraints driving assimilation and constraints driving dissimilation generates an unexpected laryngeal pattern. We discuss possible implications for theories of dissimilation implemented in Agreement by Correspondence – is it damaging to our theory to be forced to implement anti-similarity/dissimilation-specific mechanisms 'on top of' the ABC machinery? It further remains to be seen whether a similar (typologically surprising) pattern arises in unaffixed forms (polysyllabic roots in TN are rare, so this may not be verifiable).
Phonological knowledge and phonetic details: the perception of non-native word-medial consonant sequences by monolingual Mandarin speakers

This study aims to examine the role that native phonotactics and phonetic details play in the perception of non-native word-medial consonant sequences. Previous research has shown that listeners perceive non-native sounds according to the phonotactics of their native language. For instance, Japanese listeners perceive a vowel between two consonants when they hear French consonant sequences (CC) (ebzo -> ebuo) (Dupoux et al. 1999). In addition, Wilson et al. (2014) show that phonetic details, such as voicing and release properties of the consonants, also contribute to adaptation. To test the respective role of native phonotactics and phonetic details, we conducted two perception experiments with monolingual Mandarin listeners. Mandarin is a language with simple phonotactics, allowing only one CC sequence: heterosyllabic “nasal+consonant”. Therefore, if native phonotactics play a dominant role, Mandarin listeners are predicted to perceive an epenthetic vowel between two consonants, except for the word-medial “nasal+consonant” sequence. On the other hand, if phonetic details influence the perception of non-native CC sequences, we expect that perceptual adaptation patterns will vary according to the phonetic properties of the consonants in CC sequences. For instance, a vowel-like acoustic cue, such as a longer and stronger C1 release, can lead to more frequent epenthesis.

**Experiment 1** was a vowel identification task. Monolingual Mandarin speakers (N=24) were asked to determine whether they heard a vowel between two consonants or not, after having heard target stimuli with a word medial CC sequence (e.g., /aklu/) and controls with a vowel /a/ between the two consonants (e.g., /akalu/). The stimuli were pseudo-words in Russian, recorded by a Russian native speaker, with 8 different CC sequences /kl, kn, km, ks, kt, kp, tp/. Results showed that Mandarin listeners heard an epenthetic vowel both for the target stimuli and for the controls (% V perception: target 56% vs. control 71%) without a significant difference between the two conditions, except for /aklu/ vs. /akalu/ (p < .001). In addition, different C1 yielded epenthetic responses to a varying extent: epenthetic responses were more frequent after C1 /k/ than after C1 /t/ (p < .001). In our stimuli, C1 /k/ release was longer than C1 /t/ release (/k/≈ avg. 33 ms vs. /t/≈ avg. 20 ms).

To better understand what happened when the listeners did not report an epenthetic vowel (e.g., whether they perceived two consonants or deleted one of the consonants (c.f., Davidson 2010)), we conducted Experiment 2, a transcription test.

In **Experiment 2**, the same participants were asked to transcribe the stimuli in Pinyin. Stimuli included not only non-native CC sequences (e.g., /atka/) but also a native sequence /nk/. Target stimuli with different CC sequences and their control counterparts with a vowel /a/ between two consonants were recorded by the same Russian speaker. Five different types of CC sequences were used: stop+liquid (SL), stop+nasal (SN), stop+stop (SS), nasal+stop (NS), and liquid+stop (LS). Three most frequently observed adaptation patterns in the transcription data were statistically analyzed with a series of mixed effects regression models: vowel epenthesis (aknu->akVnu), C2 deletion (aklu->ak u), and metathesis accompanying an epenthetic vowel (atka->akVta). First, vowel epenthesis was less frequently in the native sequence (NS) and the sequences including an /l/ (SL, LS) than other types of sequences (SN/SS) [NS < SN/SS (p’s < .005); LS < SN/SS (p’s < .05); SL < SN/SS (p’s < .05); see Figure 1(a)]. Second, C2 deletion was significantly more frequently in SL than in other sequences both for the targets and the controls (p’s < .05), with the target SL having more frequent C2 deletion than the control SL (β = 2.4, p < .05). Finally, SS had more frequent metathesis than the other sequences (p’s < .01).
While C1 deletion (atpa->a_pa) was not one of the frequently observed adaptation patterns, C1-/l/ in LS sequences was very frequently (mis-)perceived as a vowel /o/ (e.g., alpa -> aopa). This /l/-/o/ (mis-)perception was the most frequent adaptation for the LS sequences (> 65%). Finally, we did not find a significant effect of C1 release duration in this experiment.

Taken together, the current findings suggest that both native phonotactics and phonetic details of the stimuli influence the perception of consonant sequences by Mandarin listeners. First, the effects of phonetic details were evident in the results of Experiment 1: the listeners reported hearing an epenthetic vowel more frequently after C1 with longer release. This is consistent with Wilson et al.’s (2014) claim that a longer release is more likely to be (mis-)perceived as containing a vowel. Although the effects of C1 release duration were not found in Experiment 2, acoustic details of the stimuli still seem to influence the perception of CC sequences including /l/ (SL, LS). Since /l/ is dark in Russian, it is acoustically similar to vowel /u/: both have a very small distance between F1 and F2 (Sproat & Fujimura 1993). This may have led to frequent C2 deletion for the SL sequences. In addition, the /l/-/o/ misperception in Experiment 2 provides further evidence for the influence of phonetic details of the stimuli on consonant sequence perception.

At the same time, the phonotactics of listeners’ native language also play a non-negligible role. In Experiment 1, we found no difference between the target words containing a CC sequence and their control counterparts, except for /kl/. As mentioned above, the significant difference for /kl/ sequence in Experiment 1 may be due to the frequent C2 /l/ deletion. Furthermore, in Experiment 2, the participants transcribed an epenthetic vowel less frequently for NS (a native sequence) than other sequences that do not include a liquid. These findings suggest that native phonotactics influence Mandarin listeners’ perception of consonant sequences, but the influence of phonotactic knowledge can be “hidden” by that of phonetic details of the stimuli.

Autosegments Interact with Syntax-Prosody Mapping

Overview: The mapping of syntactic material onto prosodic structure has been shown to require sensitivity to some phonological factors, including binary branching (Selkirk 2011) and prosodic strength (Elfen 2012). Other phonological factors, such as segmental processes, do not seem to interact with the syntax-prosody mapping, and have been argued to occur after this mapping in a separate sub-module of the PF branch (Agbayani & Golston 2010). I show that data from Creek (Muskogean: SE USA) requires that autosegmental factors, e.g., constraints on docking floating tones, interact with the syntax-prosody mapping. I thus argue that docking of autosegments occurs in parallel with the syntax-prosody mapping in the same stage of PF.

Data: Verbs in Creek have an internal stress domain; material in the stress domain is completely parsed into iambic Feet, while material outside is not parsed (Haas 1977, Martin 2011). Creek verbs comprise both VP-material, including verb roots and argument and event structure (such as locative /a/-, spontaneous /-ip-/ and plural /-ak-/, and TP-material, including tense, mood and negation. Stress domains and morphosyntactic domains largely match: VP-material (underlined) is within the stress domain, while TP-material (italicized) is outside the stress domain ((1); the final consonant of VP-material lies outside the stress domain to form an onset). All data are from Martin (2011).

1 Match: TP-material not in Stress Domain

a. /wanay-as/  'tie'-IMP \rightarrow [(wa.'na).ya]\(\) “tie it!”
b. /homp-as/  ‘eat’-IMP \rightarrow [(hom).pa]\(\) “eat!”
c. /wanay-iko-s/  ‘tie’-NEG-IND \rightarrow [(wa.'na).yi.koo] “(s)he doesn’t tie it”

However, a mismatch is required when VP-material cannot be exhaustively parsed, as in (2). In order to parse the final syllable of VP-material, e.g., [na] in (2a), into a binary Foot, the following syllable of TP-material, e.g., [ya] in (2a), is also parsed into the stress domain.

2 Mismatch: TP-material in Stress Domain

a. /a-wanay-as/  LOC-’tie’-IMP \rightarrow [(a.’wa).(na.’ya)] “tie it to it!”
b. /homp-ip-as/  ‘eat’-SPON-IMP \rightarrow [(hom).(pi.’pa)] “please eat!”
c. /wanay-ak-iko-s/  ‘tie’-PL-NEG-IND \rightarrow [(wa.’na).(ya.’ki).koo] “they don’t tie it”

Aspect in Creek is encoded by tonal autosegments (Haas 1940, Martin 2011), which dock onto and lengthen the final vowel of VP-material. This lengthening allows the final syllable of VP-material to form a binary Foot on its own (3b-c), so that TP-material falls outside the stress domain.

3 Autosegmental Lengthening = Match

a. /wanay-il-iis/  ‘tie’-RES-IND \rightarrow [(wa.’na’il).yi] “(s)he has tied it”
b. /wanay-il-iis/  LOC-’tie’-RES-IND \rightarrow [(a.’wa).(na’il).yi] “(s)he has tied it to it”
c. /wanay-ak-il-iis/  ‘tie’-PL-RES-IND \rightarrow [(wa.’na).(ya’ili).kis] “they have tied it”

Syntax-to-Prosody Mapping: Syntactic material is transferred to phonology, or “spelled out,” cyclically (Chomsky 2000, 2001, Abels 2003, Samuels 2010). Cyclic spellout happens in different phases: the first phase spells out material in VP, and the second phase spells out material in TP (Chomsky 2000, 2001). Heads in the VP, such as verb roots, are spelled out twice: lower heads (e.g., V) move up to higher heads (e.g., T) (Travis 1984), and leave copies behind (Chomsky 1993). Thus there are copies of VP-level heads in both VP and TP; since VP and TP are spelled out in separate phases, both lower (4) and higher (5) copies of VP-level heads are spelled out.

4 First Phase Spellout: VP-level material (lower copies)

5 Second Phase Spellout: TP-level material and VP-level material (higher copies)

At PF, syntactic constituents, such as X0s, are matched to prosodic constituents, such as PWd, due to syntax-phonology mapping constraints, such as Match Word (Selkirk 2009, 2011). Head movement forms complex X0s, like in (4-5), which each must be matched to a PWd. When the input to PF contains two copies of the same material in different X0s (6), both copies of VP-level morphemes must be contained in different PWds matching the X0s.
(6) **PF Input = Two Copies:** /VP-level\(/x_{0i}, /VP-level+TP-level\(/x_{0j}"

In order to allow both copies to satisfy Match Word while only inserting one phonological exponent, the VP-level morphemes are dominated by two recursively-embedded PWDs (7); this parse is optimal in Creek (see Selkirk 1996, Ito & Mester 2012, Elfnor 2012 for prosodic recursion).

(7) **PF Output = Recursive PWDs:** [[VP-level]_{PWd} \ TP-level\]_{PWd}"

I argue that the internal (i.e., minimal) PWDs, which contains VP-level material, is the stress domain in Creek verbs. Material in the minimal PWD must be exhaustively parsed into Feets, while material outside it is left unparsed. This captures the generalization that VP-level morphemes are always inside the stress domain and TP-level morphemes typically outside, without stipulating a separate constituent like the Stem. The Creek verbs in (1) have the recursive PWD structure in (8)

(8) **Recursive PWDs:** [[(\text{wa}. \text{na})\]_{PWd} \ y{\text{as}}\]_{PWd} \ [(\text{hom})\]_{PWd} \ p{\text{a}}\]_{PWd} \ [(\text{wa}. \text{na})\]_{PWd} \ y{\text{ki}}\]_{PWd}"

When VP-level material cannot be exhaustively parsed, syntactic and prosodic constituents are mismatched in order to satisfy prosodic well-formedness conditions. For example, in (2a) above, the input in (9) forms a non-recursive PWD structure (10), violating Match Word but satisfying higher-ranked constraints against unparsed syllables, unary Feets, and crucially, vowel lengthening.

(9) **First Phase Spellout:** /\text{a-wa}n\text{ay}/_x_{0i}, Second Phase Spellout: /\text{a-wa}n\text{ay}-\text{as}/_x_{0j}"

(10) **PF Output = Non-Recursive PWD:** [(\text{a}. \text{wa}).(\text{na} \ y\text{as})]_{PWd}"

Floating tones in the input, as in (11) from (3b) above, must dock to output long vowels in Creek, which can compel vowel lengthening (Zoll 1996). Vowel lengthening enables all VP-level material to be parsed without forming unary Feets, allowing Match Word to be satisfied by PWD recursion (12).

(11) **First Phase Spellout:** /\text{a-wa}n\text{ay}/_x_{0i}, Second Phase Spellout: /\text{a-wa}n\text{ay}^{HL}-\text{isi}/_x_{0j}"

(12) **PF Output = Recursive PWDs:** [[(\text{a}. \text{wa}).(\text{na}^{HL})\]_{PWd} \ y\text{\text{i}}\]_{PWd}"

In order to form the recursive output in (12), constraints on autosegments, e.g., docking onto long vowels, must be active at the same time as the syntax-prosody mapping. If the syntax-prosody mapping occurs at a separate stage on the PF branch before autosegmental factors are active, the constraint requiring tones to dock to long vowels cannot influence how prosodic structure is built. Because vowel lengthening is not compelled at this stage, a non-recursive PWD (13) will be built in order to exhaustively parse VP material, similar to the non-recursive PWD mapping (9-10) above.

(13) **PF Output, First Stage = Non-Recursive PWD:** [(\text{a}. \text{wa}).(\text{na} \ ^{HL} \text{i})]_{PWd}"

If autosegmental constraints become active after the prosodic structure is built in (13), then recursive PWDs cannot be built. The input to the second stage is (13), which no longer has any syntactic information such as Xo constituency; Match Word cannot insert an internal PWD to match the copy of /\text{a-wa}n\text{ay}/_x_{0i} spelled out at the first phase. There is thus no impetus to form recursive PWDs, so the output of (13) will be a non-recursive PWD (14), with the lengthened vowel [\text{\text{i}}] to satisfy the autosegmental constraint on docking to long vowels.

(14) **PF Output, Second Stage: Unattested Non-Recursive PWD:** *[\text{a}. \text{wa} \text{.} \text{(na}^{HL}) \text{i}]_{PWd}"

Only if autosegmental constraints are active at the same stage of PF as the syntax-prosody mapping, is vowel lengthening available to allow PWD recursion and thus satisfy Match Word.

**Selected References:**


The domain of liquid coarticulation in American English

Background

Since Kelly & Local 1986, a series of experiments has found surprisingly long-range coarticulation effects for liquids in a variety of British dialects. Comparing sentence pairs like *We heard that it might be a berry/belly*, Heid & Hawkins 2000 found anticipatory effects of the r/l contrast as early as the word *it*, up to five syllables before the liquid itself. West 1999 showed that listeners can use these distributed coarticulatory properties on neighboring syllables to reconstruct the identity of a liquid that is acoustically obscured.

There are reasons to suspect that such long-range liquid effects might exist in American English as well. American English often displays long-range liquid dissimilation, deleting one /r/ or /l/ from words that contain two, such as *ful(l)fill*, *the(r)mometer*, and *su(r)prise*. Such dissimilation has been proposed to stem from perceptual hypercorrection for long-range liquid coarticulation, which would imply that it should only occur in languages that have such coarticulation (Ohala 1981).

However, to our knowledge there have been no experimental studies on long-range liquid coarticulation in American dialects.

Questions

1. How far do anticipatory coarticulatory effects of /l/ and /r/ extend in American English?
2. Is the range of liquid coarticulation affected by whether the liquid is stressed?
3. Is the range of liquid coarticulation affected by the liquid’s position in the syllable?

Methods

One male speaker from Southern California read three repetitions of 359 items. Most items formed triplets contrasting /r/ vs. /l/ vs. neither; some formed pairs if an appropriate third member could not be found. The liquids were varied for stress and for position within the first syllable of the word. Sample items include:

<table>
<thead>
<tr>
<th>Position:</th>
<th>Onset</th>
<th>Complex onset</th>
<th>Syllabic</th>
<th>Postvocalic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress: (+)</td>
<td>lock / rock / hock</td>
<td>pray / play / pay</td>
<td>purr / pull / pott</td>
<td>par / Paul / pa</td>
</tr>
<tr>
<td>(-)</td>
<td>lagoon / Ragu</td>
<td>proceeding / placebo</td>
<td>parade / paid</td>
<td>---</td>
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</tbody>
</table>

Items were produced in the frame sentence *He said it oughta be _____.* For each of the six frame sentence vowels in each of the 1077 sentence tokens, F1, F2 and F3 were measured. A
series of three-way ANOVAs analyzed the effects of the independent factors Liquid Identity, Liquid Position, and Liquid Stress on each formant in each vowel.

**Preliminary results**

Data analysis is still ongoing (in particular, manual corrections to formant readings that were mistracked in Praat), but preliminary results suggest that liquid coarticulation may have a shorter range than has been found in British English. Only the word *be* shows reliable anticipatory coarticulation with the liquid. The r/l contrast has a weakly significant effect on F3 values in the second vowel of *oughta*. No significant effects have yet been found more than two syllables from the liquid, although it is possible that more effects will emerge after formant corrections are complete.

**Implications**

These preliminary results are consistent with the results of our earlier pilot study (REF REMOVED), with a different Southern California speaker and different frame sentence, which also found that liquids affected only the immediately preceding syllable. However, the results are unexpected in light of the robust findings of long-range coarticulation in speakers from diverse British dialects.

We consider possible reasons that American speakers might have shorter coarticulatory ranges for liquids. In American English, a high percentage of /r/s as well as some /l/s are pronounced as syllabic in casual speech. This means that liquids tend to have relatively loud and long local acoustic cues, compared to British dialects in which /r/ occurs only in onset position. It is possible that there is less need for long-range coarticulation to bolster the perceptibility of the r/l contrast in American English for this reason.

**References**


Analyzing opacity with faithfulness constraints in Harmonic Serialism

Introduction

Opaque interactions are easily described with ordered rules, but have proven difficult to capture with constraint-based grammars. In this paper, we propose a framework for analyzing opacity in Harmonic Serialism (HS, McCarthy 2000) which relies solely on faithfulness constraints. HS is a serial version of Optimality Theory in which GEN is limited to making one change at a time. Unlike some previous approaches, this analysis successfully captures rule-ordering effects in a constraint-based system without needing to add new mechanisms to the grammar (see McCarthy 2007 and Jarosz 2014 for alternative opacity analyses in HS). Two types of faithfulness constraints are used: faithfulness between the underlying representation and the output at every step of the derivation (\text{FAITH}_{UO}) and faithfulness in a specific input context (contextual faithfulness). Both types of faithfulness constraints have been used in some form in the phonological literature, but never for analyzing opacity. Faithfulness to a specific context in the input allows for the analysis of counterbleeding. Faithfulness between the UR and the output of the current stage of the derivation allows for the analysis of counterfeeding on focus. The combination of these, faithfulness between the UR and the current stage of the derivation in a specific context in the UR, accounts for counterfeeding on environment.

Counterbleeding

Counterbleeding occurs when Rule B removes the conditioning environment for Rule A so it looks like Rule A has overapplied. The problem with analyzing counterbleeding in serial constraint based grammars has been that applying two changes over two steps to satisfy two markedness constraints is less harmonic when there exists the simpler solution of applying one change to satisfy both. Contextual faithfulness constraints provide a way to derive this type of rule ordering effect in a serial system with gradual evaluation because they can specify a context which ceases to exist at an intermediate step, essentially rendering the constraint inactive after application of a certain process. These constraints are like positional faithfulness (Beckman 1997, Lombardi 1999) except the context they specify does not have to be linked to a prosodically prominent position. In the case of Bedouin Arabic /hackim-in/ → hacklimin → [haklimin], the /i/ deletes after palatalization has applied, removing the original conditioning environment for palatalization on the surface. The problem in standard HS is that deleting the /i/ at Step 1 satisfies both markedness constraints with only one change. A contextual faithfulness constraint requiring specific faithfulness to /i/ when it follows an unpalatalized consonant in the input (\text{MAX}_{IO}(i)/k_) prevents deletion from applying until after palatalization has applied. The crucial Step 1 is given below.

<table>
<thead>
<tr>
<th>/hackim-in/</th>
<th>\text{MAX}<em>{IO}(i)/k</em></th>
<th>*iCV</th>
<th>*ki</th>
<th>\text{IDENT}[bk]</th>
<th>\text{MAX}_{IO}</th>
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<tbody>
<tr>
<td>→ 1. hacklimin</td>
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<tr>
<td>2. hackmin</td>
<td>*W</td>
<td>L</td>
<td>L</td>
<td>*W</td>
<td></td>
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<tr>
<td>3. hackimin</td>
<td>*</td>
<td>*W</td>
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</table>

The candidate which simply deletes the /i/, candidate 2, is ruled out by the contextual faithfulness constraint \text{MAX}_{IO}(i)/k_. Now that the [k] is palatalized, the contextual faithfulness constraint no longer applies and [i] is free to delete at Step 2. This constraint does not cause problems for the transparent cases /\text{jaribat}/ → [\text{jarbat}] or /\text{hackim}/ → [\text{hacklim}]. Contextual faithfulness constraints are enough to analyze any type of overapplication opacity, including layered opacity such as double counterbleeding.

Counterfeeding

Counterfeeding interactions result in apparent surface underapplication. Rule A does not apply, even though Rule B has created the relevant environment for the application of Rule A. In a sequential theory such as HS, this type of interaction can be analyzed...
by introducing faithfulness to the UR, in addition to faithfulness to the most recent input. In counterfeeding on focus interactions (chain shifts) Rule A and Rule B target the same segment.

In Mwera, voiceless obstruents become voiced after nasals, and voiced obstruents delete after nasals, but underlyingly voiceless obstruents do not delete after nasals. Thus, /m-pundo/ → [m-bundo], and /ŋ-gomo/ → [ŋ-omo], but /m-pundo/ → [m-bundo] /≠*m-undo/. The constraint used here, $\text{MAX}_{UO}[-\text{voice}]$, assigns violations for segments which are $[-\text{voice}]$ in the UR that do not have a correspondent in the output. In the derivation for /m-pundo/ → [m-bundo], the voiceless obstruent becomes voiced in Step 1 in order to satisfy *[^nas][−voice], which is ranked above *[^nas][+voice]. In Step 2, the now voiced obstruent is crucially blocked from deleting by the high-ranked $\text{MAX}_{UO}[-\text{voice}]$, and the derivation converges on output [m-bundo]. Step 2 is shown in the tableau below.

<table>
<thead>
<tr>
<th>/m-pundo/</th>
<th>m-bundo</th>
<th>MAX$_{UO}$[-voice]</th>
<th>*[nas][-voice]</th>
<th>*[nas][+voice]</th>
<th>ID$_{IO}$[voice]</th>
<th>MAX$_{IO}$</th>
</tr>
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<tr>
<td>→ 1. m-bundo</td>
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<tr>
<td>2. m-pundo</td>
<td></td>
<td></td>
<td>*W</td>
<td>L</td>
<td>*W</td>
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<tr>
<td>3. m-undo</td>
<td></td>
<td></td>
<td>*W</td>
<td>L</td>
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<td>*W</td>
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</table>

In the case of /ŋ-gomo/ → [ŋ-omo], where the obstruent is underlyingly voiced, the $\text{MAX}_{UO}[-\text{voice}]$ constraint will not assign violations, and the obstruent will delete as expected.

In counterfeeding on environment interactions, the output of Rule B creates the environment for the application of Rule A, but Rule A does not apply. In Lomongo, intervocalic obstruents delete, and vowels become glides prevocally, but gliding does not apply in vowel-vowel sequences derived from intervocalic deletion. Thus, /o-bina/ → [o-ina], and /o-isa/ → [w-isa], but /o-bina/ → [o-ina] /≠*w-ina/. This pattern can be analyzed using a constraint which combines faithfulness to the UR, proposed in the analysis of counterfeeding on focus, with contextual faithfulness, proposed in the analysis of counterbleeding. This type of constraint requires faithfulness between the UR and the current output, for some feature, in a specified context in the UR. The constraint used here, $\text{IDENT}_{UO}[^{\text{voc}}/_{-	ext{son}}]$, requires faithfulness to the underlying specification for [voc] in segments which precede a [−son] segment in the UR. In the derivation /o-bina/ → [o-ina], the intervocalic obstruent deletes in Step 1 in order to satisfy *[^+voi,−son]/V_V, which is ranked above *HIATUS. In Step 2 (shown below), the initial vowel is crucially blocked from gliding by high-ranked $\text{IDENT}_{UO}[^{\text{voc}}/_{-	ext{son}}]$, and the derivation converges on output [o-ina].

<table>
<thead>
<tr>
<th>/o-bina/</th>
<th>o-ina</th>
<th>IDENT$<em>{UO}[^{\text{voc}}/</em>{-	ext{son}}]$</th>
<th>*[+voi,−son]/V_V</th>
<th>*HIATUS</th>
<th>MAX</th>
<th>IDENT$_{IO}[^{\text{voc}}]$</th>
</tr>
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<tr>
<td>→ 1. o-ina</td>
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<tr>
<td>2. w-ina</td>
<td>*W</td>
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</table>

In the transparent case of /o-isa/ → [w-isa], where the vowel-vowel sequence is underlying, the constraint $\text{IDENT}_{UO}[^{\text{voc}}/_{-	ext{son}}]$ will be inactive, and gliding will apply as expected.

**Conclusion** We have proposed the use of two types of faithfulness constraints for analyzing opacity. $\text{FAITH}_{UO}$ and contextual faithfulness constraints use general faithfulness correspondence relations, and are able to capture rule ordering effects in a sequential, constraint-based system without additional innovations in the grammar. Because these are simply faithfulness constraints, adding them to the system extends the typology to include the counterbleeding and counterfeeding patterns, without allowing additional undesirable patterns.
Break-down of phonological syllable patterns in Essential Tremor patients

Chronic deep brain stimulation (DBS) of the nucleus ventralis intermedius (VIM) is an effective treatment for patients with medication-resistant Essential Tremor (ET). However, these patients report that stimulation has a deleterious effect on their speech, severely impacting their quality of life and social functioning (cf. Flora et al. 2010, Mücke et al. 2014, Pützer et al. 2007 for stimulation-induced dysarthria in patients with MS). The present study investigates the articulatory timing in a fast motor task and a sentence production task for ET patients with and without stimulation as well as for healthy control speakers.

Method: We recorded 12 ET patients treated with deep brain stimulation in stimulation-ON and stimulation-OFF as well as 12 age-matched healthy controls (German speakers) with a 3-D EMA. Sensors were placed on upper and lower lips, tongue tip and tongue dorsum. (i) In a first step, we used an artificial movement paradigm, i.e. a fast motor task of CV syllables, such as /papapa, tatata, kakakaka/ (Ziegler & Wessel 1996). The aim was to push the system to its limits. For the intragestural coordination, we computed variables used in a mass-spring model such as stiffness, displacement, peak velocity, and the duration of the gestural activation interval. (ii) In a second step, we used a sentence production task in order to have more natural speech. Target words varied from low to high complexity, such as <Lima> /lima/ (capital of Peru) and <Klima> /klima/ (‘climate’). These target words were embedded in carrier sentences such as “Er hat wieder ___ gesagt” (‘He said ___ again’). We labelled gestural landmarks of consonantal and vocalic gestures, i.e. onset, peak velocity and maximum target by identifying zero-crossings in the respective velocity and acceleration traces. We analysed gestural coordination patterns within the coupling hypothesis of syllable structure (Browman & Goldstein 2000; Nam et al. 2009). We calculated the temporal intervals between the gestural onsets of C and V gestures, i.e. CV lag and CC lag. It is assumed in a CV syllable that C and V are coupled in-phase, leading to a simultaneous initiation of the consonantal and vocalic gesture, resulting in a CV lag which is zero. In CCV syllables, where a more complex competitive coupling structure is assumed, both Cs are coupled in-phase with V and at the same time in anti-phase with each other, leading to a sequential activation of the consonantal gestures (measured in CC lag).

Results: (i) Results for the fast motor task reveal a high variability comparing each syllable cycle in the patient’s production, especially in stimulation-ON condition. Further, there is a significant effect on the gestural activation interval (longer movements: Control < OFF < ON), on the peak velocity (slower movements: Control = OFF < ON), on the displacement (smaller movements: Control = OFF < ON) and on the stiffness (less stiffness: CONTROL < OFF < ON).

(ii) Results for the sentence production task reveal that ET patients show a timing deficit in the phonetic realisation of syllables with a high level of complexity such as /kli/, indicating a lack of complex coupling relations (non-innate, learnt) between movements of the tongue tip, tongue dorsum and lips. Fig. 1 exemplifies the coordination pattern in /li/ (left) versus /kli/ (right) for one ET patient with stimulation-ON. The figure shows the averaged trajectories including repetitions for consonant and vowel production; the trajectories in the top portion of the figure display the tongue tip closure, and the trajectories in the lower part of the figure show the movement of the tongue dorsum. In /li/, the consonantal and the vocalic gestures show a synchronous

![](image)

Fig. 1: Articulatory coordination patterns in /li/ (left) and /kli/ (right). Boxes display gestural activation interval.
pattern of temporal activation, i.e. initiated at the same time (Fig. 1, left: CV lag around zero). This pattern reflects the expected underlying coupling structure: in CV syllables, C and V are coupled in-phase. Thus, there are no deficits in the realisation of syllables with a low level of complexity, CV, such as /li/, indicating that the simple, innate pattern is still available. However, /kli/ fails to show the expected timing pattern. Due to a competitive coupling structure, there should be an activation delay between the two consonants. This is not the case, since the CC lags are zero, i.e. the consonants are activated at the same time and not sequentially. This indicates that ET patients show timing deficits in realizing complex coordination structures (Fig. 1, right). In order to compensate for these deficits, the gestural activation interval for /l/ is considerably stretched (see Fig. 1: /l/ in /kli/).

**Conclusion:** The overall results reveal stimulation-induced effects on the regulation in speech motor control in ET patients. Under stimulation, we found a detrimental decrease in peak velocities, stiffness and duration of the constriction gestures leading to imprecise articulation, i.e. frication, in the production of stop consonants: movements are slower, longer and less stiff. However, we assume that patients with stimulation-off already show deficits and thus do not adapt the requirements of the fast motor task. They are not able to minimize the effort required for this task (in line with Ziegler & Wessel 1996). Furthermore, we found timing deficits in the phonetic realization of competing coupling relations for complex onsets in the ET patients. While for syllables with high complexity, such as /kli/, a delay would have been expected between the activation of both initial consonantal gestures in the speech of ET patients both C gestures are activated at the same time. We discuss how much timing variability is tolerated in a phonological system before the system becomes unstable and patterns of syllable organisation break down.

**References:**
Fixed ranking over stringency in faithfulness constraints

Overview. In this talk, we identify an empirical generalization about consonant harmony. We argue that it is consistent with theories that have fixed rankings for faithfulness constraints (Prince, 1994), but not with ‘stringent’ constraints (cf de Lacy 2006) or symmetrical Ident (Prince & Smolensky 1993, cf Pater 2004), so providing a new source of evidence for the evaluation of theories of markedness, and of theories of faithfulness constraints.

Dominant harmony. There are three properties that define the outcome of consonant harmony: Dom(inancy), Dir(ectionality), and Privileged Control (PC). Systems may be characterized either by these properties individually, or in combination, yielding a total of 6 possible types of harmonies (1). The three properties are all asymmetric in that they each impose a specific restriction on the harmonizing feature values they select. Our focus is on dominant harmonies, where the asymmetry can be informally described as follows: for a given feature [F], a language will always agree for a specific feature value [mF], but never for the value [uF], where [mF] and [uF] are the marked and the unmarked feature values for the feature F. The generalization applies to all types of dominant harmonies, which make up four of the six possible types, highlighted in (1). (see Bennett, 2013 and Hansson, 2010 for similar generalizations).

<table>
<thead>
<tr>
<th>(1) Six types of directionality</th>
<th>(2) Directionality in dominant languages</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td><strong>Description</strong></td>
</tr>
<tr>
<td>Pure Dom</td>
<td>Target is the marked C</td>
</tr>
<tr>
<td>Pure Dir</td>
<td>Target is the rightmost C</td>
</tr>
<tr>
<td>Dom-Dir</td>
<td>Harmony if rightmost is marked</td>
</tr>
<tr>
<td>Dom-PC</td>
<td>Harmony if marked &amp; in root</td>
</tr>
<tr>
<td>Dir-PC</td>
<td>Harmony if rightmost &amp; in root</td>
</tr>
<tr>
<td>Dom-Dir-PC</td>
<td>Harm. if rightmost, marked &amp; in root</td>
</tr>
</tbody>
</table>

Markedness. To test the markedness generalization, we analyzed 121 cases of consonant harmony. Of these, 51 are evident cases of dominant harmony alternations, and as such, harmony is obtained only if the outcome of the harmony results in a marked feature value (modulo other factors). Following de Lacy (2002), we consider markedness relations to be epiphenomenal, and therefore established by observing typological asymmetries in alternations. The markedness relations observed for consonant harmony are reported in (2), and are mostly compatible with those previously observed in the literature. The values are uncontroversial for voicing, nasality, retroflexion, anteriority, and [k] → [q] ([high] in (2)), but unclear for distributivity.

Discussion. The survey shows that there is an asymmetry in the outcome of consonant harmony, and that the asymmetry is related to markedness. These two observations call for an analysis of the phenomenon that derives the directionality of a dominant harmony from a theory of markedness. In particular, because the marked value is preserved, the generalization specifically relates to the phenomenon of preservation of the marked (de Lacy 2002/2006). In de Lacy (2002/2006), preservation of the marked is due to an asymmetry in Con concerning faithfulness constraints. The theory states that (i) for a binary feature F, there are only the constraints *mF, IDENT-IO(mF) and IDENT-IO(±F): for example *+[voice], IDENT-IO(+[voice]) and IDENT-IO(±[voice]), but not IDENT-IO([-voice]); (ii) the constraint Ident-IO(uF) and *uF cannot exist (Stringency Hypothesis). An alternative hypothesis considered (ibid.) is that the two faithfulness constraints are in a fixed ranking relation (Fixed ranking Hypothesis), with IDENT-IO(mF) ≫ IDENT-IO(uF), where ≫ indicates a fixed ranking dominance relation. There are two more logical hypotheses not discussed in de Lacy (2002), obtained by combining stringency and fixed ranking: one where IDENT-IO(±F) ≫ IDENT-IO(mF), which we call S+F Hypothesis, and another where IDENT-IO(mF) ≫ IDENT-IO(±F), which we call F+S Hypothesis.
Fixed ranking over stringency in faithfulness constraints

In addition to the faithfulness constraints, comparable conditions were also applied to the markedness constraints, which included markedness constraints of the type *F ± mF, *uF, and *mF for both the fixed ranking and the stringent formulations. This distinction is not crucial for the point made in the paper, and so we only refer to the most commonly accepted subset of hypotheses that contain the constraint *mF.

Since the hypotheses investigated are partially independent from the theory of harmony adopted, we used a general constraint Agree, which is violated whenever two segments in the output are different. Since the constraint Agree is agnostic to the directionality of assimilation, the current formulation is compatible with all theories that do not specify the direction of assimilation in the agreement constraint (e.g. most formulation of ABC’s IDENT-CC (Bennett, 2013), or span theory, (McCarthy, 2004)), but requires further stipulations for theories where directionality is encoded in the Agree constraint itself (e.g. Jurgec, 2011).

The candidate sets used to test the hypotheses included candidates with: (i) up to two segments; (ii) output forms of the same length; (iii) the segments being either F or mF. The hypotheses were tested using a computer simulation. To facilitate reading, we report them using [f] to indicate the marked segment [mF] (with respect to anteriority), and [s] for the unmarked segment [uF].

In total, there are five possible input/output forms [s,s], [f...s,s...s], [f...f], which yields 13 candidates for each hypothesis once the input and output forms have been related. A hypothesis is proven to be compatible with the generalization iff it satisfies the following two requirements: (i) the mapping <f...s> → <f...f> (harmony to the marked) is a possible optima, and (ii) if <f...s> → <s...s> is an optimum candidate then <f...f> → <s...s> also is (i.e. the mapping to two unmarked segments must be due to neutralization). As shown in Tableau 1 (below), the stringency hypotheses S and S+F incorrectly predict that assimilation to the unmarked is possible by ranking ID(±ANT) ≫ *[-ANT] and *[-ANT] ≫ ID(-ANT). The fixed ranking hypotheses F and F+S, though, do not predict such optima (Tableau 2), and they are therefore the only hypotheses compatible with the harmony to markedness generalization.

Further issues. There are three issues in the analysis that are worth mentioning: (i), the generalization only applies to alternations, not to static restrictions (e.g. only one glottalized segment per word). These can be analyzed as the result of dissimilation. (ii) Cases where stringency has been used as an argument against fixed ranking must also be considered (e.g. coalescence in Pali, in de Lacy (2002). (iii) In Tiene, the oral causative infix causes the denasalization of the nasals in the root, and thus constitutes a possible exception to the generalization.

SONORITY SEQUENCING IN POLISH: THE COMBINED ROLES OF PRIOR BIAS & EXPERIENCE

Recent findings demonstrate sonority projection effects in English, Mandarin, and Korean: speakers exhibit gradient sonority sequencing preferences among illicit initial clusters, and these preferences mirror the SSP (Berent et al. 2007, 2008; Daland et al. 2011; Ren et al. 2010). While some argue that these results support an innate bias (Berent et al. 2007, 2008; Ren et al. 2010), recent modeling studies question this conclusion, showing that certain computational models can detect SSP preferences from lexical statistics in these languages (Daland et al. 2011, Hayes 2011). In a recent response, Jarosz (2015) finds that Polish presents a particularly good test case to differentiate these competing hypotheses: the same phonotactic models that succeeded in the earlier studies do not predict sonority projection based on the lexical statistics of Polish. This follows primarily from the fact that sonority plateaus make up nearly half of all initial clusters (Table 1). Jarosz also shows that children acquiring Polish nonetheless exhibit sensitivity to the SSP, producing attested onset clusters with larger sonority rises more accurately in spontaneous productions.

Table 1: Frequencies of SSP levels in Polish Initial Clusters from Jarosz (2015)

<table>
<thead>
<tr>
<th>SSP</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>0.1%</td>
</tr>
<tr>
<td>-2</td>
<td>0.2%</td>
</tr>
<tr>
<td>-1</td>
<td>0.1%</td>
</tr>
<tr>
<td>0</td>
<td>45.3%</td>
</tr>
<tr>
<td>1</td>
<td>6.4%</td>
</tr>
<tr>
<td>2</td>
<td>28.0%</td>
</tr>
<tr>
<td>3</td>
<td>19.9%</td>
</tr>
</tbody>
</table>

The present paper expands on these findings by examining the phonotactic knowledge of adult Polish speakers. We report the results of an online acceptability judgment experiment focusing on initial clusters and present the results of computational simulations evaluating the ability of phonotactic models to predict participants’ ratings. Our main findings are that 1) SSP is predictive of adults’ ratings, 2) sonority projection arises in both attested and unattested clusters, and 3) while phonotactic models have significant predictive value, they do not subsume the SSP preference observed in the participants’ ratings.

53 bi-consonantal onset clusters across five levels (-2 to 2) of sonority sequencing profile were chosen to be the heads of experimental words (-3 and 3 were collapsed with -2 and 2, respectively, for reasons of data sparsity). 28 of these are attested initial clusters in Polish, while 25 have comparable sonority profiles but are unattested. These heads were combined with thirty 3-syllable VCVC(C)V(C) nonsense-word tails selected to avoid near phonological neighbors and major phonotactic violations. Heads and tails were combined to create 10 counterbalanced lists, each of which included each head combined with three distinct tails. The resulting 159 test words were mixed with 240 fillers, varying in word length (1 to 4 syllables) and onset length (0 to 3 consonants). The stimuli were presented orthographically one-by-one in randomized order. Participants were instructed to repeat each word to themselves and give a rating of its naturalness as a word of Polish on a scale from 1 (low) to 7 (high). 81 native Polish-speaking adults without speaking or hearing disorders or substantial time spent abroad participated, with the option of payment (28 PLN/$7.25).

Table 2: Average ratings by SSP

<table>
<thead>
<tr>
<th>SSP</th>
<th>Mean (s.e.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-2</td>
<td>2.20 (0.15)</td>
</tr>
<tr>
<td>-1</td>
<td>2.48 (0.17)</td>
</tr>
<tr>
<td>0</td>
<td>3.35 (0.20)</td>
</tr>
<tr>
<td>1</td>
<td>3.48 (0.20)</td>
</tr>
<tr>
<td>2</td>
<td>3.34 (0.20)</td>
</tr>
</tbody>
</table>

Mean ratings (standard error) by SSP are in Table 2. A linear mixed effects model was fitted with rating as the dependent variable, fixed effects of SSP (-2 to 2) and attestedness (unattested vs. attested) and their interaction, and random slopes and intercepts by participant and tail (full random effects structure). This revealed a significant main effect of SSP ($\beta=0.20$, $t=8.80$), indicating participants gave higher ratings to higher sonority rises, a significant main effect of attestedness ($\beta=0.57$, $t=16.18$), indicating higher ratings for attested than unattested clusters, and no interaction between SSP and attestedness ($\beta=0.02$, $t=1.42$), indicating sensitivity to SSP did not differ significantly between attested and unattested.
To model input phonotactics, we used the UCLA Phonotactic Learner (Hayes & Wilson 2008): this was the model most successful at achieving sonority projection in previous work. We trained the model on all initial onsets, and used it to generate (penalty) scores for the clusters in the experimental stimuli. To assess the predictiveness of the model scores relative to SSP, two linear mixed effects models with full random effects structures were compared. One contained fixed effects of the model’s scores (centered and scaled continuous value; $\beta=-0.61, \ t=-14.96$), attestedness ($\beta=0.21, \ t=7.57$), and the interaction between the model’s scores and attestedness ($\beta=0.48, \ t=-11.70$). A superset model additionally included an effect of the SSP ($\beta=0.12, \ t=6.22$). The superset model fit participants’ responses significantly better than the same model without SSP ($\chi^2=263.21, \ p < 0.01$). The UCLA phonotactic model was thus significantly predictive of participants' ratings, and more so for attested than unattested clusters, but this did not fully account for the SSP effect. Figure 1 plots participants' mean ratings for attested and unattested clusters by SSP as a line with standard deviation shown in shaded ribbons and with linearly scaled inverse average UCLA scores as points. The overall shape of the model predictions fits the average trends of ratings for attested clusters nearly exactly, but does not fit the rating trends for unattested clusters. The UCLA phonotactic learner tended to rely on relatively specific constraints reflecting underrepresented combinations of manner and place, some of which reflected aspects of sonority sequencing (e.g. a constraint against clusters with initial non-labial sonorants), but the model on the whole did not project systematic SSP preferences.

Our main findings are that adults’ phonotactic judgments exhibit sensitivity to the SSP for both attested and unattested clusters and that this sensitivity is not entirely predictable from statistical phonotactics. Our findings therefore suggest a role for an SSP bias (possibly innate or derived from phonetic experience) in phonotactic learning. At the same time, participants’ sonority sequencing preferences are not entirely predictable from the SSP: the average ratings for both the attested and unattested clusters fail to increase across the 0-2 SSP range (plateaus/rises). Indeed, a mixed-effects model with full random effects structure fitted just to the clusters with SSP profiles 0-2 finds no significant effect of SSP ($\beta=0.01, \ t=0.36$). As summarized in Table 1, Polish learners experience input with an abundance of sonority plateaus, contradicting the SSP. Considering our results together with those of Jarosz (2015), who found that Polish-acquiring children nonetheless strongly favor rises over plateaus, suggests a complex interplay between prior bias and experience which jointly influence learning of high-level phonological generalizations over time. We hypothesize that such bias shapes early preferences but sufficient exposure may, over time, distort these preferences.

The role of perceived L2 category in cross-language perception and implications for loanword adaptation

**Background:** Some propose that loanword adaptation is at its core a function of native language (L1) perception applied to foreign input (L2) (Silverman 1992, Boersma & Hamann 2001, and Peperkamp, et al. 2008). It has also been noted, however, that L2-L1 correspondences in actual loanwords are far more consistent than expected based on on-line perception by naïve monolinguals and that a perception-based model of loanword adaptation requires an auxiliary mechanism of regularization that reduces variability in L2-L1 correspondence (Peperkamp, et al. 2008, Kang 2010, de Jong & Cho 2012). Regularization may take place outside the perception grammar proper—the norm can be reinforced through orthographic input (Daland, et al. 2016) or sociolinguistic convergence (Lev-Ari & Peperkamp 2014)—but there is also evidence that cross-language perception itself differs as a function of adapters’ L2 proficiency (Kang, et al. 2012, Kwon 2014, Nomura & Ishikawa 2016). These findings suggest that cross-language perception is mediated by adapters’ knowledge of L2 sound structure, rather than a simple function of L1 perception applied to L2 acoustic signals. The current study directly tests the assumption of congruence between L1 perception and L2L1 perception and the role of perceived L2 category in mediating L2L1 perception by conducting a series of perception experiments where L1 and L2 stimuli are controlled for their acoustic properties, a departure from previous studies on cross-language perception that did not control for acoustic differences between L1 and L2.

**Hypotheses:** Specifically, we test two hypotheses, schematically represented in Figure 1. P_{L1} and P_{L2} represent perception functions that map acoustic signals of L1 (Korean) and L2 (English) to respective phonological categories. P_{L2L1} is a cross-language perception function that maps English acoustic input to Korean categories. Eq_{L2L1} maps English phonological categories to equivalent Korean categories (E. voiceless → K. aspirated; E. voiced → K. non-aspirated), established in part through exposure to existing loanwords.

**H1:** P_{L2L1} is the L1 perception function (P_{L1}) applied to L2 acoustic signals.

**H2:** P_{L2L1} is the L2 perception function (P_{L2}), with subsequent equivalent class function (Eq_{L2L1}) that maps English categories to Korean categories—i.e., adapters perceive L2 input as L2 categories and then map them to Korean equivalence classes.

**Experiments:** 65 Seoul Korean listeners (year of birth: 1933–1966) participated in three perception experiments in which they heard stop-initial Korean or English nonce-word stimuli (‘paru’) and responded with the best-fit Korean (p/p’/pʰ) or English (p/b) category. Stimuli were produced by native speakers of each language, then manipulated to vary systematically in VOT (0-120ms) and f0 at vowel onset (83-120 Hz) in order to create a controlled “acoustic space” that was identical in the two languages. Each stimulus was presented twice per task for a total of 480 trials (3 tasks * 8 VOT * 5 f0 * 2 base vowel * 2 rep).

<table>
<thead>
<tr>
<th>Experiment</th>
<th>Stimuli</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>L1</td>
<td>Korean</td>
<td>Korean</td>
</tr>
<tr>
<td>L2</td>
<td>English</td>
<td>English</td>
</tr>
<tr>
<td>L2L1</td>
<td>English</td>
<td>Korean</td>
</tr>
</tbody>
</table>

Eight English listeners without knowledge of Korean also completed the L2 task which provides a target L2 perception against which Korean listeners’ L2 proficiency can be indirectly measured.
Analyses: The response is coded into a binary choice of voiceless/aspirated vs. voiced/non-aspirated. Fortis and lenis responses are collapsed to non-aspirated in Korean as they are both exponents of English voiced stops in loanword adaptation. To calculate the congruence of perception patterns across the tasks, we first calculated the rate of voiceless/aspirated choice (ASP.RATE) for each cell of the f0-by-VOT acoustic space for each task for each speaker. Figure 2 shows the average ASP.RATE values collapsing over all listeners. We then squared the by-cell difference of ASP.RATE across tasks, and calculated the by-speaker means of these squared differences. In particular, by-speaker means of differences between L1 and L2L1 (DIFF.L1) and between L2 and L2L1 (DIFF.L2) measure how divergent L2L1 perception is from L1 and L2 perception respectively for that speaker. For each speaker, we also calculated the difference between ASP.RATE in the L2 task and the average ASP.RATE of the English control speakers (DIFF.TARGET.L2). This measures how divergent the L2 perception pattern is from the actual L2 target and serves as a measure of proficiency, with a lower value indicating higher proficiency.

Results: Figure 3 shows the DIFF.L1 and DIFF.L2 values for each listener. Most listeners are clustered in the bottom left corner, with very little difference between the two tasks. (See the ASP.RATE distribution of listener A in Figure 4 for an example.) However, for those listeners with asymmetries, performance on the cross-language mapping task was more similar to the L2 than the L1 task (e.g. those listeners below the diagonal line). (See the ASP.RATE distribution of listener B in Figure 4 for an example). A paired t-test confirms that DIFF.L1 is larger than DIFF.L2 (t = 2.1786, df = 64, p = 0.03305.) We then examined how well listeners’ L2 perception proficiency (as defined by divergence from the English target, DIFF.TARGET.L2) predicts the degree of relative influence of L2 perception over L1 perception in L2L1 mapping (DIFF.L1-DIFF.L2) and found a trend (p=0.0831) where listeners with higher proficiency (lower Diff.TargetL2) rely more on their L2 than L1 (Diff.L1-Diff.L2 > 0) in their cross-language mapping while listeners with lower proficiency are less likely to do so (See Figure 5).

Conclusion: Our experimental data suggest that L2 knowledge mediates cross-language perception, especially for higher proficiency listeners. The results are significant in showing how cross-language mapping is constrained by the (perceived) phonological categories of the L2 input and that the phonological structure of L2 can play a crucial role (cf. Paradis and LaCharite 1994) even when the underlying mechanism of loanword adaptation is perceptual in nature, thereby reconciling the conflicting predictions of the so-called “phonological” vs. “perceptual” views of loanword adaptation (cf. Kang 2011).
Typological asymmetry in tonal patterns: an implicit pattern learning experiment

In many languages, vowel hiatus is prohibited and resolved by vowel deletion. However, in tonal languages, the deletion of a vowel does not necessarily imply the deletion of its tone. For instance, in Ogori, a Benue-Congo language of Nigeria, the second vowel is always deleted to resolve vowel hiatus at word boundary, but the tone that undergoes deletion is determined by the tone value, regardless of whether it was originally associated with the surviving or with the deleted vowel, as shown in (1).

(1) Ogori tonal pattern (Chumbow 1982)

<table>
<thead>
<tr>
<th>Noun</th>
<th>Adjective</th>
<th>NP</th>
<th>Gloss</th>
<th>Tone Pattern</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ọtélè</td>
<td>ọkèka</td>
<td>ọtélàkèka</td>
<td>‘big pot’</td>
<td>H#L → H</td>
</tr>
<tr>
<td>b. igilà</td>
<td>óbòrò</td>
<td>igilóbòrò</td>
<td>‘good yam’</td>
<td>L#H → H</td>
</tr>
</tbody>
</table>

Since High tone (H) is always retained, it is said to have dominance over Low tone (L) in the case of tone retention pattern, which is observed across various languages (Maddieson 1972). The fact that H is always retained can be explained by de Lacy's claim that “marked elements are subject to greater preservation than less marked ones (2002, p. 196).” This asymmetry in typology may due to difficulties in perception or production, or some innate learning bias in learning certain patterns. This study reports an artificial grammar learning experiment that examined the learnability of the following two tonal patterns: a natural pattern that is common cross-linguistically (H#L → H and L#H → H), and an unnatural pattern that seems to be rare across languages (H#L → L and L#H → L).

The experiment was conducted with 64 English speakers, and 42 Mandarin Chinese speakers who are familiar with tones but have no knowledge regarding this tone retention pattern. The participants first performed an ABX tone discrimination task on H and L level tones. Then they were trained to learn nonsense words with VCV structure, each associated with a picture of either an animal or a fruit, e.g. [ewe] ‘monkey’ with the tonal pattern [H.L] or [owu] ‘banana’ with [H.H]. During the training session, participants listened to the sound of the animal and the fruit along with the pictures, which combined and formed a possessive noun phrase, e.g. [ewowu] ‘monkey’s banana’. Participants were divided into two groups; one group was exposed to the natural pattern where H is retained while the other was exposed to the unnatural pattern where L is retained. Participants were instructed to pay attention to the tones, and they listened to 20 trials of possessive NP formation. However, no explicit rules were given during the training session.

Later in the testing session, participants carried out a two-alternative-forced-choice task which presented an animal and a fruit, followed by two possessive NPs: one with the natural pattern, and one with the unnatural pattern. The possessive NPs either had the same tonal pattern as the stimuli in the training session (Similar NPs), or they had new tonal pattern that were not shown in the training session (New NPs). The purpose of Similar NPs was to test the learnability of the tonal patterns and the purpose of New NPs was to see participants’ ability of generalizing learned knowledge to novel forms they were not exposed to before.

The results show that all participants performed at ceiling in distinguishing different level tones. For the Similar NPs, the average accuracy of English speakers who learned the natural pattern is significantly higher than those who learned the unnatural pattern (natural = 66%,
unnatural = 61%, F(1198,1) = 4.16, p < 0.05). Moreover, English speakers who learned the natural pattern also scored higher on New NPs (natural = 55%, unnatural = 46%, F(478, 1) = 4.43, p < 0.05). The difference of the accuracy rates on Similar NPs indicates that English-speaking participants had more difficulty learning the unnatural pattern. The accuracy on New NPs further shows that participants in the natural condition were more likely to generalize the learned pattern to novel forms.

As for the Mandarin Chinese speakers, no significant difference was found on the average accuracy of Similar NPs (natural = 64%, unnatural = 59%). However, those who learned the natural pattern had higher average accuracy on New NPs (natural = 61%, unnatural = 45%, F(334, 1) = 8.9, p < 0.01). This result of Similar NPs shows that the natural and unnatural tonal patterns were equally learnable for Mandarin Chinese speakers. However, the difference in their accuracy rate on New NPs shows that participants who learned the natural pattern were more likely to generalize the knowledge to novel forms they were not exposed to during the training session. On the contrary, participants who learned the unnatural pattern performed poorly.

This study investigates both the learnability of phonological patterns concerning tone, and the ability of extending phonological patterns to novel forms. The results of the Mandarin Chinese speakers support the view of analytic bias (Moreton 2008) that cognitive predispositions may facilitate the learning of tone retention patterns with preference for H tone over L tone because the learners were more likely to extend natural tone patterns to novel forms.

References
Speech production planning affects variability in connected speech

Introduction  Connected speech processes have played a major role in shaping theories about phonological organization, and how phonology interacts with other components of the grammar (Selkirk, 1974; Kiparsky, 1982; Kaisse, 1985; Nespor and Vogel, 1986, among others). External sandhi is subject to locality conditions, and it is more variable compared to processes applying word-externally. We suggest that an important part of understanding these two properties of external sandhi is the locality of speech production planning.

Presenting evidence from English flapping and French liaison, we argue that the effect of lexical frequency on variability can be understood as a consequence of the narrow window of phonological encoding during speech production planning. This proposal complements both abstract, symbolic and gestural overlap-based accounts of phonological alternations. By connecting the study of phonological alternations with the study of factors influencing speech production planning, we can derive novel predictions about patterns of variability in external sandhi, and better understand the data that drive the development of phonological theories.

Background  According to influential models of speech production (Levelt, Roelofs and Meyer, 1999; Dell and O’Seaghdha, 1992), planning of connected speech proceeds hierarchically and incrementally. Units like syllables and prosodic words are planned before detailed segmental information, and larger units are planned further in advance than smaller ones (Sternberg, Knoll and Monsell, 1988; Wheeldon and Lahiri, 2002; Ferreira and Swets, 2002).

The literature on speech planning shows that the size of planning “chunks” for phonological encoding are relatively small (Wheeldon and Lahiri, 2002), and so may not always encompass two adjacent words. Our proposal is that the locality as well as the probability of cross-word phonological interactions are a direct consequence of the locality of production planning. Certain types of phonological information about upcoming words will only be available within a small window and will only be planned in time to affect the planning of a previous word with a certain probability. The speech production process can be influenced by many factors, including syntactic and semantic processing, which can have consequences downstream for phonological encoding. This leads to linguistic output in which phonological factors appear to be shaped by non-phonological information. We propose this relationship is indirect, a consequence of the incremental nature of production planning. We refer to this idea as the production planning hypothesis (PPH).

This proposal leads to a number of novel, testable predictions about phonological variation. Broadly, any factor that affects the likelihood two words being encoded within the same planning unit will affect the application of external sandhi processes.

Case study: lexical frequency  Many studies have shown that high lexical frequency facilitates word form retrieval (Oldfield and Wingfield, 1965; Jescheniak and Levelt, 1994). Accordingly, the PPH predicts that lexical frequency should influence external sandhi in a very specific way: the higher the frequency of word following the target word, the more likely the process should be to apply, since the words are more likely to be encoded within the same planning window. This prediction was tested for flapping using data from the Buckeye Corpus of Conversational Speech, and we found that indeed there is a statistically significant increase in the likelihood of flapping as the frequency of the word following the target increases, even controlling for duration and word length. Under the view that flapping is a reductive process
due to gestural overlap with adjacent vowels (e.g. Fukaya, 2005), this finding fits in well with the broader research on probabilistic effects on reduction (Bybee and Schiebman, 1999; Bell et al 2003; Jurafsky, Bell, Gregory and Raymond, 2001). But unlike, for example, the Probabilistic Reduction Hypothesis of Bell et al (2003), the predictions of PPH extend also to non-reductive sandhi processes, predicting similar effects of lexical frequency in both cases.

We tested this prediction for liaison in French, where a latent word-final consonant appears only if the following word is vowel-initial and closely bound to the consonant-final word. Data was extracted from the Phonologie du français contemporain (PFC) corpus, and we examined the effect of following word frequency on the likelihood of liaison in two syntactically-controlled environments: a plural noun followed by an adjective, and an adjective followed by a noun. Results show that in both of these cases, there is a clear positive effect of following word frequency, shown in Figure 1.

**Figure 1:** Relationship between likelihood of liaison between (a) a plural noun followed by an adjective and (b) an adjective followed by a noun, by frequency of the second word in the pair.

**Discussion**

This case study on the effect of lexical frequency on flapping and liaison shows that the predictions of the PPH extend to both reductive and non-reductive sandhi processes. The PPH is compatible with syntax/prosodic accounts of external sandhi locality, and with gestural overlap accounts of variability, but our case studies suggest that the effect of the following word’s frequency is not reducible to either of these proposals. Critically, the appearance of the same frequency effect in the non-reductive case of liaison is only predicted by the PPH. Investigating the relationship between online speech production planning and phonological processing/computation offers a new perspective on phonological patterns, in particular on variability and its place in building phonological theories.

**References**

Phonological trends in Seoul Korean Compound tensification

In a Korean compound composed of two nouns, \( W_A \) and \( W_B \), if the initial onset of \( W_B \) is a lax obstruent, it often undergoes tensification, as in /tol + tam/ [tol.t*am] ‘stone wall’. This tensification process does not occur in every compound. In /tol + kye.tan/ [tol.kye.tan] ‘stone steps’, the initial onset of \( W_B /k/ \) remains lax.

Treatment of “exceptions” differs in generative phonology and the recent phonological research. In generative phonology, rules apply categorically. Many of previous studies attempted to define the application condition of the tensification rule, but exceptional cases were found no matter how rules were defined. Therefore, this tensification phenomenon was considered “unpredictable” under the rule-based framework. However, the recent phonology accepts that the distribution of the exceptions themselves is phonologically patterned (Zuraw 2000). In other words, “exceptional” cases might not be a mere exception and might have phonological reasons to be a variant. Therefore, not a single factor, but rather the interaction of various factors, both phonological and non-phonological ones, decides the occurrence of tensification as a whole. Among these factors, the present study focuses on phonological ones. Specifically, I will examine what phonological factors and how significantly these factors contribute to the overall applicability of tensification.

Zuraw (2011), the first systematic study on the distribution of Seoul Korean compound tensification, argued that both phonological and non-phonological factors attribute to the overall probability of the tensification. As inspired by Ito’s (2014) survey study on Yanbian Korean, I performed a similar survey on twenty-one Seoul Korean speakers employing 304 compound words. In the survey results, I identified if the trends caused by each factor are significant. The trends found to be significant are shown in (1).

(1) Trends in Seoul Korean compound tensification

a. Tensification is more likely with high frequency items.

b. Tensification is more likely when \( W_A \) ends with an obstruent, followed by a nasal, a liquid and a vowel, in descending order.

c. Tensification is more likely when \( W_A \) ends with a liquid and \( W_B \) also begins with a coronal consonant.

d. Tensification is less likely when \( W_B \) contains a laryngeally marked consonant.

I also attempted to develop a formal analysis of this phenomenon, in a frame of Optimality Theory (OT). Characterizing the variable pattern of the phenomenon, Maxent OT (Hayes & Wilson 2008) was employed. Constraints responsible for the occurrence of tensification are \textsc{RealizeMorpheme} (“Morphemes are phonologically realized”) and \textsc{Ident}(tense) (“Correspondent segments in the input and output are identical for the feature [tense]”).

Various trends found in the existing words were also formalized into the separate OT constraints. For (1a), following Ito (2014), a constraint \textsc{Tense/LowFrequency} (*T/LF, “No tensification for low frequency items”) was adopted. For (1b), regarding the highest tensification rate with \( W_A \) obstruent final compounds, it was speculated that post-obstruent tensification, obligatory within a single accentual phrase in Korean (Jun 1993), still plays a significant role at the juncture of a compound. Therefore, a constraint *obs-lax (“No lax obstruent after an obstruent in an accentual phrase”) was established. According to Ito (2014), lenition might militate against the application of tensification. And the different tensification rates after a vowel and a sonorant might result from the different preferences for lenition. Kirchner (1998) suggested that the impetus for lenition varies depending on the flanking segment: lenition is the most likely when a vowel precedes a target consonant, less likely
when a liquid does, and the least likely when a nasal does. This hierarchy accords with the result of my survey where the tensification rate of the W_A vowel final compounds was significantly lower than that of the W_A liquid final ones, which in turn was lower than that of the W_A nasal final ones. Capturing the different impetus for lenition, or blockage of tensification, among the three sonorous W_A coda types, a constraint for each context was established: *TENSE/VOWEL ("After a vowel, no tensification"), *TENSE/LIQUID ("After a liquid, no tensification"), *TENSE/NASAL ("After a nasal, no tensification").

In Korean native monomorphemic words, a coronal consonant right after a liquid coda is always tense. Regarding the trend (1c), it was assumed that the coronal consonants’ greater impetus for tensification after a liquid might mirror this pattern in a monomorpheme. Martin (2011) proved that a morpheme-internal constraint diffuses its weaker effect across morpheme boundaries and termed it “leakage” in the sense that a phonotactic generalization somewhat leaks from the tautomorphic domain to the heteromorphemic ones. Capturing this leakage effect at the compound juncture, a constraint *L(+)C (“No sequence of a liquid and a lax coronal”) was adopted.

As pointed out in Ito (2014), the trend in (1d) is attributed to laryngeal co-occurrence restrictions. The presence of a laryngeally marked consonant, tense ([+constricted glottis]) or aspirated ([+spread glottis]), blocks tensification. Unlike in Ito (2014) in which the presence of a laryngeally marked consonant in both W_A and W_B considerably lowered the tensification rate, in my study, the presence in W_B only showed this effect. The laryngeal co-occurrence restriction holds only within a stem, at least in Seoul Korean compound tensification. Thus OCP(stem) (“No co-occurrence of laryngeally marked consonants in a stem”) was adopted.

Using Maxent Grammar Tool (Hayes 2009), I took the survey results as the training data and tried to find the specific weights of those constraints, shown in (2).

(2) Constraint weight obtained
OCP(stem) (1.676), *obs-lax (1.533), REALIZEMORPHEME (1.227),
*TENSE/LIQUID (1.102), *TENSE/VOWEL (0.983), *L(+)C (0.785),
*T/LF (0.429), IDENT(tense) (0.142), *TENSE/NASAL (0.0000006)

This weighted set of the constraints reflects the crucial effects observed in the existing lexicon. I also confirmed that the distribution of the data reproduced by this grammar highly accorded with that of the input data (R^2=0.88). Therefore, it can be concluded that the proposed analysis can explain the various trends observed in the phenomenon.

References
Marked structures in case of failure in feature specification of special moras in Japanese:

Evidence from loanwords, a reversing language game, and blending

Proposal: This paper investigates how special moras in Japanese (long vowels, geminates, coda nasals) are realized when place features of these segments fail to be specified in the way that they normally are. Based on data derived from loanwords, a reversing language game called Sakasa Kotoba, and blending, I propose that special moras in marked environments are realized through repair processes that result in one of three marked structures as below.

1a. Structures that are over-generalization of regular structures found in the core lexicon
   b. Irregular structures that are restricted to loanwords
   c. Game-specific structures

I illustrate that even in marked environments, repair processes make outcome structures as unmarked as possible by employing over-application of regular assimilation process (1a), or by realizing with The Emergence of the Unmarked (1b).

The proposed analyses contribute to the phonological study of Japanese (i) by describing peripheral phonological processes in Japanese, (ii) by providing evidence about the nature of moraic representation in Japanese, and (iii) by describing Sakasa Kotoba, a language game that has been hitherto paid little attention in the literature (e.g., Smith 1980).

Special moras: In addition to (C)V moras as in sakura ‘cherry’ or ao ‘blue’, Japanese has what are traditionally referred to as special moras (e.g. Vance 1987), as in (2).

a. Long vowel (R): siito /siRto/ 'sheet'
   kaado /kaRdo/ 'card'

b. Coda nasals (N): santu /saNtu/ 'Santa (Claus)'
   kaŋki /kaNki/ 'ventilation'

c. Geminates (Q): okappa /okaQpa/ 'bobbed hair'
   kitsu /kiQts/ 'stamp'

The place of articulation of special moras is determined by their environment: R is a copy of the preceding vowel; N and Q undergo place assimilation to following segments. However, a coda nasal N can occur in word-final position as in (3), in which N is realized as a uvular nasal. I assume, based on the behavior of N in (3), uvular is an unmarked place feature specification.

The game rule, total moraic reversal, suffers no exception at all. That is, the application of the game sometimes produces a marked phonological configuration that is not commonly observed in core lexicon.

Special moras in special occasions: Some phonological processes force these special moras to appear at positions where they are not normally permitted by Japanese phonotactics and where the place feature of special moras are not specified in the typical ways (as in 2). First, loanwords often do not obey rules/constraints that core lexicon (Yamato Japanese, Sino Japanese) are subject to. Second, I demonstrate that Sakasa Kotoba (outlined below) produces a marked structure. Third, I do the same in blending, a phonological or morphological truncation process as in (4). These irregular processes result in creating three types of irregular structures as in (1).

4) wandaa foogeru /waNdaR foRgeru/ --> waŋgeru /waNgeru/ 'Wandervogel'

Sakasa Kotoba: A word in Sakasa Kotoba is derived through reversing moras, as seen in the forms in (5) and (6). The data in (5) contain only CV or V moras, and the examples in (6) contain special moras R, N, and Q. These data illustrate that a mora functions as a prosodic unit and special moras behave in the same way as (C)V moras in terms of the reversal.

5) Non-game Sakasa-kotoba Gloss
   (C)V only
   sakura rakusa 'cherry'

6a. LongVowel (R): toreedo /toreRdo/ dooreto /doRreto/ 'trade'
   b. Coda nasal (N): daŋkai /daNkai/ ikanda /iNaNda/ 'stage'
   c. Geminate (Q): batto /baQto/ tobba /toQba/ 'bat'

The game rule, total moraic reversal, suffers no exception at all. That is, the application of the game sometimes produces a marked phonological configuration that is not commonly observed in core lexicon.
Marked structure 1: Loanwords give us examples of the structure in (1a), that is, overgeneralization of regular structures. Namely, while gemination only occurs in voiceless obstruents in core lexicon, the gemination is applied to voiced obstruents (beddo in 7a), and to approximants (arraa in 7b).

(7)a. betto /beQto/ ~ beddo /beQdo/ 'bed'  
(7)b. arraa /aQraR/ ~ aʔraa /aQraR/ 'Allah'

Similarly, Sakasa Kotoba provides examples of the first type of marked structures; gemination can occur to voiced obstruents (6c) or approximants (8). Blending also allows the same overgeneralization process for voiced obstruents (9a), or for approximants (9b).

(8) rakka --> karra /kaQra/ 'fall'

(9)a. katto moderu --> kaddoru /kaQdoru/ 'cut model'  
(9)b. rokku feraa --> roorraa /roQraR/

Marked structure 2: Loanwords moreover employ structures unavailable in core lexicon. For instance, gemination of sonorants can be resorted to another repair process that results in aʔraa in (7b). In this case, the first half of the “geminate” is realized as a glottal stop, which I assume surface representation of a placeless consonant, i.e., the unmarked place specification.

A coda nasal N also shows a highly marked structure that is not observed in core lexicon; while N is restricted to word-medial or word-final positions, loanwords allow N to appear at the word-initial position as in (10). In this position, N is realized either through place assimilation in the same way as a word-medial nasal (as in 2b, but in a position that is not allowed in core lexicon), or as a uvular nasal, i.e., the unmarked place specification (as in 3).

(10) Word-initial moraic nasal: ndzamena ~ Ndzamena 'N'Djamena (foreign proper noun)'

In this position, N is realized either through place assimilation in the same way as a word-medial nasal (as in 2b, but in a position that is not allowed in core lexicon), or as a uvular nasal, i.e., the unmarked place specification (as in 3).

In Sakasa Kotoba, “geminated” approximants can be replaced with a glottal stop (11) as well as doubling /ɾ/ (as in 8). The game also allows a coda nasal N to appear at word-initial position, wherein N is realized through either repair process in (10), i.e., regular place assimilation (ηkika in 12) or unmarked specification (Nkika in 12).

(11) rakka --> kaʔra /kaQra/ 'fall'

(12) kikaN --> ηkika ~ Nkika /Nkika/ 'trachea'

As well, blending allows “geminated” approximants to be replaced with a glottal stop (13) as well as doubling approximants (as in 9b).

(13)a. rokku feraa --> roʔraa /roQraR/ 'Rockefeller'

Thus, the irregular process produces a marked structure that is not found in core lexicon, but the repair strategies can be characterized as an instance of resorting to the unmarked place specifications (i.e., a uvular nasal or a glottal stop).

Marked structure 3: The game and blending moreover create too a marked structure that special moras are realized with a game-specific structure. Consider the following:

(14) Non-game forms Game forms Gloss
(a) Sakasa Kotoba kaa /kaR/ aka /Rka/ 'car'
(b) Sakasa Kotoba siN /siRN/ NNsi ~ nnsi /NNSi/ 'scene'
(c) Blending santa kuroosu /SaNta kuroRsu/ san-nsu 'Santa Claus'

When the second half of a long vowel R comes to the word-final position as in (14a), it copies the following vowel beyond the intervening consonant. The examples in (14b, c) are also realized by a game-specific process. Namely, R prolongs a coda nasal. These are found only in the games.

Summary: Thus, we demonstrated that failure in place feature specification for special moras are resolved with repair strategies, resulting in the marked structures in (1). Even in the marked environments (loanwords, games), outcome structures are meant to be as unmarked as possible: first, over-generalization of regular rules; second, unmarked place specification.
The Ganging-up of OCP-labial Effect on Japanese Rendaku

Introduction Harmonic Grammar (HG) is a constraint-based theory in which each constraint is numerically weighted (e.g., Legendre et al. 2006; Pater 2009; Potts et al. 2010). In HG, a harmony score \( H \) for each candidate is calculated in terms of \( H = \Sigma s_k w_k \); The candidate’s violation on each constraint \( (s_k) \) is multiplied by the weight \( (w_k) \). The aim of this paper is to argue that there exists OCP-labial effect on Japanese rendaku, and to offer an HG analysis to account for a ganging-up effect.

Japanese rendaku is a morphophonological phenomenon in which a morpheme-initial voiceless obstruent becomes voiced when it is the non-initial member of a compound (e.g., McCawley 1968; Vance 1987). When rendaku applies, /h/ usually becomes labial /b/ (e.g., hako ‘box’ + hune ‘ship’ → hakobune ‘ark’; fude ‘pencil’ + hako ‘box’ → fudebako ‘pencil case’; sandan ‘three steps’ + hara ‘stomach’ → sandanbara ‘potbelly’). However, the rendaku application of /h/ is blocked if the following consonant is labial /m/ (Kawahara et al. 2006; Kawahara 2015) (e.g., suna ‘sand’ + hama ‘beach’ → sunahama ‘sand beach’/*sunabama; kutsu ‘shoe’ + himo ‘lace’ → kutsuhimo ‘shoelace’/*kutsubimo; mai ‘dancing’ + hime ‘princess’ → maihime ‘dancing princess’/*maibime). One contributing factor to this rendaku blocking is a violation of OCP-labial constraint: if /h/ became labial /b/; it would yield a sequence of homorganic consonants /b…m/ (labial…labial). Below, this paper reports an experiment which examines whether the blocking effect on rendaku applies productively to nonce words.

Experiment The experiment used trimoraic nonce words \([hV_1C_2V_2ra]\) \((V_1 = \{a, i, u\}; V_2 = [a] \) unless \( C_2 \) is [\( \Phi \)]. There were three experimental groups: each contained a labial consonant \([m, \Phi, w]\) on the second-initial consonant (e.g., [hamara]; [ha\( \Phi \)ura]; [hawara]) (In Japanese, [\( \Phi \)] occurs when /h/ is followed by /u/). [h…h…r] (e.g., [hahara]) was used as a control group which does not contain any labial consonants.

Sixty-one native speakers of Japanese participated in this study. In the test, they were told that the words were used in Old Japanese, and were given two forms (rendaku- and non-rendaku forms) for each nonce word. They were then asked to choose which of the forms is more natural than the other if tested words are attached to the word nise ‘fake’ (e.g., nise + hamara → nisehamara or nisebhamara). The order of the nonce words was the same for each participant.

Results For analysis, 183 items (61 subjects × 3 vowels each) were analyzed. Figure 1 shows the results of the experiment. There were statistically significant differences of rendaku proportion between \([b…h…r]\) (0.70) and each experimental group \([b…m…r] = 0.34; [b…\( \Phi \)…r] = 0.59; \[b…w…r] = 0.51\). In addition, there were also statistically significant differences between \([b…m…r]\) and \([b…\( \Phi \)…r]\) (0.34 vs. 0.59), and between \([b…m…r]\) and

\[b…h…r] vs. \([b…m…r]\) \((\chi^2(1) = 47.676, p < .0001)\)

\[b…h…r] vs. \([b…\( \Phi \)…r]\) \((\chi^2(1) = 12.499, p < .001)\)
These results suggest the following points: (i) the OCP-labial effect can be generalized in Japanese rendaku; and (ii) [m] exhibits a stronger OCP-labial effect than [Φ, w].

**Analysis** This paper suggests that the results of the experiment come from two constraints of OCP-labial: OCP (labial) and OCP (labial, -continuant). Note that, while the former is violated when [b] is followed by [m, Φ, w], the latter is violated only when [b] is followed by [m]. Following the past Optimality-theoretic analysis of Japanese rendaku (e.g., Itô & Mester 2003), the present HG analysis employs REALIZE MORPHEME (RM), which requires rendaku, and IDENT (voice). In addition to these constraints, this paper also uses IDENT (Place), with which the two OCP-labial constraints show gang effects. In the present analysis, constraints assign negative scores to candidates, and thus the candidate that has the value closest to zero will be optimal.

The result that the OCP-labial effect can be generalized in rendaku is explained as follows. For the [h…Φ…r]/[b…Φ…r] case, if /h/ undergoes rendaku, then it violates IDENT (voice) and IDENT (Place), and, in addition, the resulting consecutive labials violate the OCP (labial). This is what we call a ‘gang effect’: the OCP (labial) (w = 1) and IDENT (Place) (w = 1) gang up with IDENT (voice) (w = 1.5) to overcome RM with higher weight (w = 3) (see Tableaux). For the [h…m…r]/[b…m…r] case, the OCP (labial, -continuant) also participates in the gang effect.

<table>
<thead>
<tr>
<th>HG Tableaux</th>
<th>REALIZE MORPHEME</th>
<th>IDENT (voice)</th>
<th>IDENT (Place)</th>
<th>OCP (lab, -cont)</th>
<th>OCP (lab)</th>
<th>H</th>
</tr>
</thead>
<tbody>
<tr>
<td>/+ h…Φ…r/</td>
<td>w = 3</td>
<td>w = 1.5</td>
<td>w = 1</td>
<td>w = 1</td>
<td>w = 1</td>
<td></td>
</tr>
<tr>
<td>→ … h…Φ…r</td>
<td>-1(No RM)</td>
<td>-1(h → b)</td>
<td>-1(h → b)</td>
<td>-1(b…Φ)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>→ … b…m…r</td>
<td>-1(No RM)</td>
<td>-1(h → b)</td>
<td>-1(h → b)</td>
<td>-1(b…m)</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>/+ h…m…r/</td>
<td>w = 1</td>
<td>w = 1</td>
<td>w = 1</td>
<td>w = 1</td>
<td>w = 1</td>
<td></td>
</tr>
</tbody>
</table>

The present HG analysis also accounts for the result that [m] showed a stronger blocking effect on rendaku application than [Φ, w]. This paper assumes that, the lower a candidate’s H is across candidate sets, the more unlikely it is to be considered acceptable. (Provided that the optimal candidate of each candidate set has the same violation profile). As displayed in Tableaux, both of the non-rendaku forms [h…Φ…r] and [h…m…r] violate only RM, and thus H of each is -3. For the non-optimal candidate of each candidate set, H of [b…m…r] (= -4.5) is lower than that of [b…Φ…r] (= -3.5), which predicts the result of the experiment that /h/ is more unlikely to undergo rendaku when followed by [m] than [Φ].

**Conclusions:** The present wug-study suggests that the OCP-labial effect can be generalized in Japanese rendaku. This paper concludes that Japanese rendaku is involved with the ganging-up effect of two OCP-labial constraints and IDENT (Place). It also shows the possibility that strength of a blocking effect can be predicted from H across candidate sets.
ARMENIAN PLURAL ALLOMORPHY DOES NOT COUNT SYLLABLES

The selection of modern Armenian plural allomorphs has been previously interpreted as a case of syllable-counting allomorphy (Vaux 1998, 2003; Vaux et al. 2013; accepted by, e.g., Inkelas 2014: 286) and explicitly used to falsify Kager’s (1996) argument that putative cases of syllable-counting allomorphy are to be properly interpreted as output-oriented phenomena.

The selection of Modern Armenian plural allomorphs (/-ɛɾ/ ~ /-nɛɾ/) is analyzed as a phonologically conditioned allomorphy in terms of parsing optimization. The selection results from the interaction between the surface prosodic structure of the entire phonological word into which the plural morpheme adjoins and the phonological shape of the allomorphs themselves in the framework of *Optimality Theory* (Prince & Smolensky 2004; McCarthy & Prince 1995).

Telegraphically, the left (or affixal) edge of the plural morpheme (/\-Pl/ → [-nɛɾ] ) is required to be aligned to the right edge of a PROSODIC WORD (PW) category in the structure of the *Prosodic Hierarchy* (Selkirk 1978; 1986: 384; 2004: 466). When the plural morpheme satisfies this alignment specification, it is contained in a recursive Pw structure (in the sense of Itô & Mester 2007, 2009) and automatically parsed as a self-contained syllable. The selection of the allomorph /-nɛɾ/ is in this configuration motivated by its ability to provide an onset cf. (1a-b). However, in order to avoid parsing the stem into a degenerate (i.e. monosyllabic) foot, cf. the sub-optimal configuration in (1c), the syllable which hosts the plural morpheme is parsed in the same Pw as the stem. This configuration favors the allomorph /-ɛɾ/, since the selection of this allomorph reduces the number of segments in the coda of the preceding syllable and subsequently results in a less marked syllabic structure, cf. (1d-e).
In support of the arguments originally expressed in Kager (ibid.), the analysis provides additional evidence for the relevance of metrical feet in morphological phenomena and for a constraint-based model of the morphology-phonology interface.

The analysis utilizes and provides support for the Weak Bracketing approach of Hyde (2001, 2002, 2008, 2014), which argues for improperly bracketed (or ‘over-lapping’) feet. This approach is originally employed to avoid a set of pathological predictions that arise under Weak Layering and Proper Bracketing (Itô & Mester 1992).

Mayak and the typology of labial harmony

Both typological (Kaun 1995, 2004) and experimental studies (Finley 2008, 2012) have argued that labial harmony is motivated by perceptual weakness. The definition of weakness, as presented in Kaun (1995), is defined in vowel-intrinsic terms, without reference to a vowel’s harmonic counterpart. In this paper I present data from Mayak (Andersen 1999) that is incompatible with Kaun’s atomistic definition of weakness. However, if perceptual weakness is construed in terms of similarity between harmonic counterparts, Mayak is not exceptional, but falls out from a preference for minimally salient surface alternations (Steriade 2001).

Arguing that labial harmony extends the temporal span of a weak [round] contrast, Kaun (2004) formulates the following four generalizations into constraints.

(1) a. The trigger must be non-high- ALIGN-L/R ([RD]/[-HI])
   b. The trigger must be front- ALIGN-L/R ([RD]/[-BK])
   c. The target must be high- *ROLO, which militates against all non-high round vowels
   d. Cross-height harmony is dispreferred- GESTURALUNIFORMITY[RD]

Kaun’s analysis predicts that triggers must be non-high or front, (1a,b), but in Mayak only [u] triggers harmony (2a,b). Second, her analysis predicts that targets must be high, (1c), but targets are non-high in Mayak (2a-e). Thirdly, her analysis predicts that cross-height harmony entails same-height harmony, (1d), and furthermore, cross-height harmony asymmetrically targets high vowels, due to (1c,d), as in Turkish (see also Steriade 1981). However, cross-height harmony in Mayak preferentially targets non-high vowels. Mayak thus undermines much of Kaun’s analysis.

Mayak has the following inventory: /i i e a ø u u/. Additionally, the vowels [e] and [o] are surface [+ATR] allophones of /e ø/. The language exhibits multidirectional ATR and optional regressive labial harmony. As [o] does not occur non-initially, the apparent trigger preference is epiphenomenal. Nevertheless, labial harmony in Mayak is anomalous under Kaun’s analysis because cross-height harmony preferentially targets non-high vowels, (2a,b,e).

(2) a. tɔk-uði ~ tok-uð-i ‘wash.AP-PST-SUF’
   c. ?ið-u (*?uð-u) ‘shape with an axe-PST’
   d. miɣ-ok (*moɣ-ok) ‘spider-PL’
   e. wil-ɔl (*wol-ɔl) ‘guest-SG’
   f. wilɣ-ɔn (*wolɣ-ɔn) ‘rib-SG’
   g. mað-ɔnɔn (*mæð-ɔnɔn) ‘drink-1P.EX’

However, if Kaun’s argument that harmony is perceptually motivated is maintained but perceptual weakness is redefined in Dispersion theoretic (Liljenbergs & Lindblom 1972; Lindblom 1986; Flemming 2002) terms, the analysis is straightforward. This paper uses Flemming’s vowel space (2002:30), shown below in (3), with two modifications. First, Euclidean distances are calculated between vowels, and second, the vowel space is warped (Schwartz et al. 1997) to weight F1 contrasts over F2, reflecting perceptual sensitivity to F1 (Flanagan 1955; Lindblom 1975).

Since [o] may not occur as a trigger, I argue that all round vowels may trigger harmony, but only [A]-[o] may alternate via harmony. In this way, Mayak limits the set of potential undergoers to the least dispersed ATR-harmonic pair, [A]-[o], shown in (3) below, evidence for minimally perceptually salient alternations, which is formalized via *M A P constraints (Zuraw 2007).
In (4), the potential targets of harmony are delimited by *MAP (Δ>1.4), preventing [i] ~ [ʊ], but allowing the less salient alternation, [ʌ] ~ [o], defined according to the weighted Euclidean distances in (3). Reformulating perceptual weakness as perceptual distances successfully accounts for harmony in Mayak. Moreover, the Dispersional analysis presented herein has been shown to accurately predict trigger/target preferences from phonetic data in a number of Altaic languages (Author, submitted). The revised typology, shown below, consists of the following four generalizations, their respective constraints, and example languages. Kaun’s alignment constraints are conditional on certain feature combinations, e.g. ALIGN-L/R[(RD)/[-HI]], which compels harmony only if the trigger is non-high. In contrast, the constraints below are conditional upon perceptual distances, Δ, as well as vowel duration, τ.

<table>
<thead>
<tr>
<th>Generalization</th>
<th>Constraint</th>
<th>Example Languages</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. The least dispersed vowel(s) must trigger harmony.</td>
<td>ALIGN-L/R (Δ &gt; X) (RD)</td>
<td>Khalkha, Shuluun Höh, Solon</td>
</tr>
<tr>
<td>2. The least dispersed vowel(s) must surface via harmony.</td>
<td>*MAP[RD] (Δ &gt; X) (RD)</td>
<td>Khalkha, Shuluun Höh, Solon, Mayak</td>
</tr>
<tr>
<td>3. The shortest vowel(s) must trigger harmony.</td>
<td>ALIGN-L/R (RD)/τ &lt; X</td>
<td>Kachin Khakass, Kazakh</td>
</tr>
<tr>
<td>4. The shortest vowel(s) must surface via harmony.</td>
<td>IDENT-I0 [RD/τ &gt; X]</td>
<td>Kachin Khakass, Crimean Tatar</td>
</tr>
</tbody>
</table>

This analysis argues that weakness depends on language-specific harmonic pairings rather than vowel-intrinsic properties defined without reference to harmonic pairings. Operationalizing perceptual weakness in these terms offers a reconception of labial harmony that is able to account for the data presented in Kaun (1995, 2004) while also successfully modeling seemingly exceptional data from Mayak.

SELECTED REFERENCES:
Cyclic spell-out of phrasal morphophonology: the case of Seenku possessive tone

This talk explores the interaction of phrasal morphophonological alternations and cyclic spell-out \[1\][2] by drawing on primary data from Seenku, a Northwestern Mande language of Burkina Faso. Seenku displays the same complex series of grammatically conditioned tonal alternations in two environments, between a direct object and a verb in its irrealis form and between an inalienable possessor and the possessed noun. For simplicity, I focus here on possessive tone. The talk makes two primary claims: first, that these construction-specific tonal alternations require cyclic spell-out to predict the correct result, and second, that the spelled out phonological form from one cycle must not only be visible to subsequent cycles but may also be altered to meet subsequent morphophonological demands. This last conclusion contradicts recent claims in the literature \[3][4\] that material that has been spelled out and received phonological form is no longer accessible in later cycles of the grammar.

Seenku is a four-tone language, and the four tones e(xtra)L, L, H, and e(xtra)H can be accounted for using a system of two binary tones along the lines of \[5\]. Of these four tones, L is lexically rare, attested in only a small handful of numerals and adverbs. However, it is very common on plural nouns, grammatically created from the affixation of a [+raised] plural feature to lexically eL-toned stems, e.g. bèè ‘pig’ \(\rightarrow\) bèè ‘pigs’. Further, there is a systematic gap in level H-toned nouns and verbs, a gap which is filled by a large number of HeL contour tones. I analyze these contours as the result of an eL epenthesis process to satisfy a category-specific tonotactic constraint against H in final position. This analysis is corroborated by the fact that HeL singular nouns correspond to eH plurals, suggesting that [+raised] affixation affects the H-toned root before eL epenthesis, e.g. bì ‘goat’ \(\rightarrow\) bì ‘goats’.

By and large, adjacent words do not have any effect on each others’ tone, barring regular processes like downstep. Inalienable possession, on the other hand, displays a series of tonal changes on the possessed noun triggered by the possessor. The resulting tonal form depends on the possessor’s final tone and morphosyntactic form. If the possessor is a simple noun, its final tone spreads onto the possessed noun, neutralizing lexical contrasts.

\[
\begin{array}{c|ccc}
\text{Possessed noun} & \text{eL} & \text{H} & \text{eH} \\
\hline
\text{eL} & \text{eL} & \text{eH} & \text{eH} \\
\text{H} & \text{eH} & \text{eL} & \text{eL} \\
\end{array}
\]

As the table shows, eH-toned pronouns follow the same pattern of spreading (mì nì ‘our father’, mì nà ‘our mother’), eL-toned pronouns trigger a lowering process (eH \(\rightarrow\) H \(\rightarrow\) eL, eL \(\rightarrow\) eL), and H-toned pronouns cause a flip of eL to eH and eH to eL, while lowering H to eL.

Looking at the examples in (2), we see that the possessor must have its final surface form before the tone of the possessed noun is calculated. For instance, it is the L tone on ‘pigs’ resulting from the affixation of plural [+raised] that spreads onto the possessed noun. Similarly,
it is the eL tone epenthesized to the end of the H-toned stem ‘goat’ that spreads onto the possessed noun, rather than the H tone itself. These ordering effects fall out naturally from a grammatical architecture with cyclic spell-out, in which syntax is built up and sent to Morphology, PF and LF in chunks known as phases. The possessor, itself a DP, is spelled out before the DP in which it is embedded, and hence it receives its morphophonological form first. Crucially, the computed phonological form must then be reinserted into the syntax “as a giant lexical compound” [1], lacking internal syntactic structure but imbued with PF and LF interpretation, as schematized in the following diagram:

![Diagram of spell-out domain and syntax](image)

The reinsertion of spelled out material means that when the possessed noun’s DP is sent to spell-out and reaches Morphology, the correct tonal form of the possessed noun can be computed based on the possessive DP’s final tone. These tonal phenomena provide evidence for phonological effects of cyclic spell-out above the word level, claimed to be absent [6]. But more striking is that the previously spelled out possessor can actually have its phonological form altered during the cycle spelling out the possessed noun’s DP. As mentioned above, the plural is formed by suffixing a feature [+raised] to the final tone of the noun. When that tone is the result of spreading from the possessor, [+raised] alters not only the tone of the possessed noun (the noun morphologically marked as plural) but also the tone of the possessor: \( bēe \ tsiē \) \([+\text{raised}]\) \( \rightarrow \ bēe ≠̌ tsiē \) ‘pig’s feet’, where ‘foot\text{PL}’ takes the feature [+raised], but ‘foot’ has received eL by spreading from the possessor; thus, docking this feature affects both words.

Data such as these directly contradict recent literature (e.g. [3][4]) arguing that material that has undergone spell-out should no longer be phonologically accessible or alterable in subsequent cycles, an extension of the syntactic Phase Impenetrability Condition [2]. This talk thus adds to the growing body of literature (e.g. [7][8]) arguing that spelled out material, at least at the phrasal level, can be altered.

Grammatical factors in Tommo So tone-tune mapping

When words are set to music in tone languages, the singer must decide how to map tone sequences onto musical sequences, an aspect of text-setting that we refer to as tone-tune mapping. Three types of alignment can be distinguished (Kirby & Ladd 2016): Mapping is parallel if the tone contour matches the musical contour (e.g. a rising tone LH set to a rise in the music), contrary if the tone contour opposes the music (e.g. LH on a musical fall), and otherwise oblique (e.g. LH on flat music). We examine text-setting in Tommo So, a Dogon language of Mali (McPherson 2013), drawing on a newly transcribed corpus of 174 musical lines (2,223 bigrams), as exemplified below.

Several novel findings about tone-tune mapping are presented and analyzed, in some cases revealing new parallels between text-setting and metrics. First, tone sequences comprise two distinct groups in Tommo So, namely, rising (LH and 0H, where 0 is unspecified) vs. non-rising (all other sequences). In other words, flat tones are grouped with falling tones and against rising tones for text-setting purposes (Mantel-Haenszel $M^2(4) = 86, p < .0001$). The chart on the left below shows how each possible tone sequence is mapped onto musical tones. The dendrogram on the right illustrates the clustering of sequences, by far the most significant classifier being rising (left cluster) vs. non-rising (right cluster).

Second, in Tommo So, unlike in many other languages studied for which this issue has been addressed (e.g. Cantonese, Ho 2006; Vietnamese, Kirby & Ladd 2016), oblique mappings are not (even weakly) avoided; only contrary mappings are. Constraints penalizing oblique mappings were weighted zero in the maxent models below. The non-avoidance of oblique mappings is also apparent in the chart above, in which the white space between the “stalagmites” and “stalactites” represents oblique settings.

Third, we test for effects of musical step size, finding that the degree to which a contrary mapping is avoided scales with the size of the musical step. For instance, contrary mappings are avoided more for two-step changes than one-step changes (Fisher’s $p = .03$). Fourth,
unlike most previous studies, we distinguish between rote and improvised verse, finding that mapping tends to be stricter in the former \((p < .0001)\), though both compositional types exhibit the same active constraints, underscoring their productivity.

The final two principles that we discuss here concern interfaces with the grammar, neither of which has been documented previously for text-setting to our knowledge. First, mapping is stricter within words than across them. This mirrors results in metrics (e.g. Kiparsky 1975; Hayes 1989; Hayes et al. 2012). The second interface principle is that mapping is stricter for lexical tone than grammatical tone (the latter being tone imposed by a grammatical overlay; cf. McPherson 2014). Bigrams in which both syllables carry lexical tone are significantly better aligned than bigrams carrying grammatical tone, with mixed lexical-grammatical bigrams being intermediate.

We model all of these effects in a maxent framework. The system is organized around *Contrary*, which penalizes opposing tone-tune mappings, as defined above. This constraint is also akin to bigram stress-meter mapping constraints employed for the English iambic pentameter by Hayes et al. (2012: 701), except that in the present context stress is replaced by tone and metrical iamb/trochee by musical rise/fall.

Of particular analytical interest is the fact that this core constraint is modulated by several potentially overlapping factors; for example, mapping is stricter within words, stricter for lexical tone, etc. We compare two analytical approaches to such modulations. The first is stringent constraints (cf. e.g. Prince 1999, de Lacy 2004): Alongside generic *Contrary, which evaluates all bigrams, *Contrary_{Lex} and *Contrary_{Word} evaluate subsets of bigrams. This approach is compared to a scalar multiplier approach (cf. McPherson and Hayes 2016; also Kimper 2011, Zymet to appear), by which mapping constraints receive multipliers based on the lexical and word-internal status of the locus of violation. While these two approaches may be indistinguishable for a single scale, they make different predictions about the interaction of multiple scales, in whether penalty increases are additive or multiplicative (cf. Zuraw 2012, Shih 2015).

In sum, this talk presents the system of tonal text-setting in Tommo So and demonstrates that the factors affecting it and the constraints required to model it closely mirror those of metrics, suggesting that tonal text-setting is not as exotic and removed from metrical grammar as it is often assumed to be.

Canadian French high-vowel laxing: A corpus study using automated discrimination

Introduction. High vowels in Canadian French undergo several processes with respect to their realisation as tense or lax (e.g. Dumas 1976, Walker 1984, Poliquin 2006, Dalton 2012). In final syllables closed by a consonant other /v z ʒ r/, high vowels are categorically realised as lax, while in final open syllables and in final syllables closed by a voiced fricative the high vowel is tense (example (a)). As shown in example (b), closed-syllable laxing is optional in non-final syllables. If closed-syllable laxing can occur in the base, but the word is derived and therefore the high vowel is in an open syllable, the high vowel surfaces as tense (example (c)). This generates opacity for an additional process called laxing harmony (example (d)), by which a high vowel in the first syllable or in a syllable left of a syllable where laxing occurred can optionally be realised as lax if the final syllable has laxing. When you add a suffix like –al, the second syllable surfaces as tense, but laxing harmony may still be present (example (e)).

The quantitative data for laxing harmony predominantly come from Poliquin (2006), who mainly collected acceptability ratings in perception. We examine non-final laxing in corpus data to test the effects of syllable structure, of final syllable laxing, and of the base showing laxing in isolation in speech. Our results suggest that these do play a role, but that laxing can also occur in non-final syllables with no evident trigger.

Examples:
(b) Initial-syllable laxing: *vulgaire* /vyl̩ɡɛʁ/ ‘vulgar’ [vyl̩ɡɛʁ] ~ [vyl̩ɡɛʁ]
(d) Laxing harmony: *musique* /myzik/ [my.zik] ~ [my.zik]
(e) Opaque interaction: *musical* /myzikæl/ ‘musical’ [my.zi.kal] ~ [my.zi.kal]

Methods. The acoustic distinction between tense and lax high vowels is multiparametric with the categories overlapping in acoustic dimensions (e.g. Poliquin 2006, Dalton 2012). As such, we trained a forced aligner (citation redacted) on realisations of tense and lax high vowels in final syllables, where laxing is categorical and predictable, and used the forced aligner to perform an automatic classification of high vowels as the tense or lax variant in other contexts. The data consist of over 41000 tokens of high vowels in non-final syllables and were then analysed using mixed-effects logistic regression.

Results. As shown in figure 1, closed syllables significantly favour the lax variant ($\beta=0.38$, $p=0.0002$). This factor plays an especially large role if the high vowel is in a closed base-final syllable and, in isolation, that base would show laxing due to being a closed final syllable ($\beta=1.41$, $p=0.0051$). This is consistent with syllable structure – a categorical predictor in final syllables – playing a role non-finally as well. The effect of syllable structure is particularly strong in initial syllables, as evidenced by a significant interaction ($\beta=0.50$, $p=0.0220$).

As illustrated in figure 2, we do not find confirmation that laxing in non-final syllables can be solely associated with the base-final syllable being able to lax. We do, however, observe that laxing in the final syllable is associated with a greater probability of a non-final high vowel laxing ($\beta=1.76$, $p<0.0001$). If the final syllable shows laxing and the base-final syllable could lax in isolation, then the probability for a high vowel to lax appears to increase further but it
doesn’t do so significantly – there’s a significant main effect of whether the following vowel is a lax high vowel that is mainly responsible for this additional increase ($\beta=0.37$, $p<0.0066$).

**Discussion.** Our results are consistent with predictions that laxing is sensitive to the presence of laxing in the final syllable and to the syllable structure of the syllable itself. However, we find that the laxed variant can surface without any apparent trigger, meaning that the syllable was open and that there was no laxing possible in the base and that the word did not end in a high lax vowel. We also suggest that this methodology, which is still little-known and which can be used for other types of distinctions (e.g. burst detection as in Schuppler et al. 2014), offers an exceptional way to categorise data when doing so manually is problematic due to having a large sample size, the variants being similar for the available acoustic cues or the difference between variants being difficult to perceive in the desired context.

![Figure 1](image1.png)  ![Figure 2](image2.png)

**Figure 1:** The frequency of laxing based on the type of base, base-finality and syllable structure.  

**Figure 2:** The frequency of laxing based on the type of harmony that could apply.

**References**
Three degrees of vowel length in Nuer

Western Nilotic languages such as Shilluk and Dinka are among the few languages of the world that have been reported to have three contrastive degrees of vowel length (Remijsen & Gilley 2008, Odden 2011).

Here we examine newly collected Nuer data to show that this Western Nilotic language also distinguishes three degrees of vowel length. For example, kót “transport.Sg.Nom” has a short vowel, kó:t “shield.Sg.Nom” has a long vowel, and kò::t “shield.Sg.Gen” has an overlong vowel. However, we also show that Nuer vowels are lexically specified for only two degrees of vowel length – short and long, and that the existence of three degrees of vowel length is a result of application of a morphological rule of lengthening that is itself a relic of a compensatory lengthening following loss of old Nilotic suffixes.

Even though Nuer has some suffixal morphology, most of the functional load in the nominal inflection is carried by the stem. To signal case and number the stem is modified in various ways: the stem vowel may be lowered (diphthongized), raised, change phonation; the tonal melody may be modified; the final consonant of the stem may be mutated; and, most pertinently, the stem vowel may change its quantity. Which forms in a paradigm are affected by these stem-internal changes and which of the above-mentioned processes are employed in generation of specific nominal forms is largely unpredictable and has to be memorized for each lexical item individually. In regards to the modification of the vowel quantity, it is common for the stem vowel of the Gen Sg and Nom Pl to be longer than that of Nom Sg: či̤ɛ̤́l “elbow.Sg.Nom”, či̤ɛ̤́l: “elbow.Sg.Gen/Loc”, či̤:l “elbow.Pl.Nom”. However, it is also possible to have the reverse situation where the stem vowel of the Nom Pl or Gen Sg (or both) is the shorter one: cjé:r “star.Sg.Nom”, cjēr “star.Sg.Gen”, cjēr “star.Pl.Nom”.

We propose that the stem vowel with the shortest duration in a given paradigm represents the underlying length of the stem vowel in the particular lexical item, and that there is a rule of lengthening that is part of the inventory of Nuer morphological rules which typically lengthens the underlying vowel by one unit of duration. There are no lexical items with an underlying overlong vowel (despite some surface counterexamples). Depending on a noun, the rule may apply in derivation of any of the forms that constitute the nominal paradigm in Nuer, including the Nom Sg.

Some paradigms show double application of the lengthening rule, especially those where the Nom Pl form is the one containing the shortest vowel in a paradigm (a class of nouns termed “basic plurals” in the Nilotic literature). In such paradigms the vowel of the Nom Sg is derived by the lengthening of the stem vowel of the Nom Pl by one degree, and then the Gen. Sg is derived by further lengthening the stem vowel of the Nom Sg by another unit of duration: ki̤r “river.Pl.Nom”, ḳi:r “river.Sg.Nom”, ḳi::r “river.Sg.Gen”,

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An additional source of overlong vowels comes from short vowels that lengthen straight to overlong instead of long before certain stem-final consonants. In other words, in some phonological environments the rule of lengthening applies to lengthen short vowels by two units of duration. For example, a short /a̤/ lengthens to an overlong /a̤/ before liquids: cəí ‘Nile Perch.Nom.Sg’ and cəːː ‘Nile perch.Nom.Pl’.

Evidence for the rule of lengthening as opposed to the rule of shortening comes from distribution of continuant allophones of dorsal stops. The velar stop /k/ and the palatal stop /c/ have allophones [ɣ] and [j] in stem-final position. The stops [k] and [c] appear after short vowels, while [ɣ] and [j] appear after overlong vowels. Mid stem vowels are followed by [k] and [c] only if there are no short vowels in the paradigm, and by [ɣ] and [j] if there are short vowels in the paradigm. The distribution of the stops vs continuants stem-finally in paradigms such as “pestle” (Nom Sg lɛ̂ːk, Nom Pl lɛːːɣ; Gen Sg lɛːːːɣ) can only be explained if we posit that the underlying stem-final consonant is a stop which is lenited after lengthened vowels, rather than positing an underlying stem-final fricative with a shortening-triggered strengthening of a stem-final consonant.

Related languages such as Mayak (Northern Burun) provide evidence for the origins of the three-way vowel length distinction in Nuer. This language has two degrees of vowel length, and it preserves suffixes that were lost in Nuer. Conditioned by the loss of the suffixes, short vowels lengthened to long, while long vowels lengthened to a newly developed degree of length (the Nuer “overlong”) due to compensatory lengthening. For example, the Mayak forms goːk ‘dog.Sg’ and gʊː ‘dog.Pl’ correspond to Nuer jʊːk and jʊːːɣ, demonstrating the effects of the loss of the plural marker. Likewise, the correspondence between Mayak ɁeːːɁ ‘faeces.Sg’ and ɁeːːɁ ‘faeces.Pl’ on one hand and Nuer cɛːːɁ ‘faeces.Sg’ and cɛː ‘faeces.Pl’ on the other demonstrates the effects of the loss of the singulative marker.

We hope that the present study contributes to the typology of vowel length in the world languages. Our findings confirm the typological markedness of the three-way contrast in vowel length. We show that stem vowels in Nuer are lexically specified for two degrees of length only. A morphological process of vowel lengthening is responsible for the emergence of the third vowel length grade and is concomitant with changes in the realization of stem-final consonants.

References
LEARNING PARAMETRIC STRESS WITHOUT DOMAIN-SPECIFIC MECHANISMS

Parametric theories of stress (e.g., Dresher & Kaye 1990, henceforth DK) model typology using a small set of choices (parameters) specified in UG. One often cited motivation for the parametric approach (Chomsky 1981) is its presumed advantage for the language-learning child, whose task is reduced to setting the values for these pre-specified parameters. Despite this apparent learning advantage, parameter setting is a difficult problem, since parameters are interdependent, and determining the target grammar requires inferences to be made across many word forms (DK). Existing parametric stress learners address these challenges by positing domain-specific learning mechanisms, such as setting parameters in a pre-specified order, and/or giving parameters substantive cues (pre-specified phonological configurations that trigger a certain parameter value; see DK). Moreover, Pearl (2011) argues that the general-purpose statistical learner for parameters developed by Yang (2002), the Naive Parameter Learner (NPL), requires such domain-specific mechanisms to learn English stress.

In this paper we introduce a general-purpose, incremental, statistical model for learning parameters, relying on Expectation Driven Learning (EDL; Jarosz 2015). We show that EDL performs well on a representative subset of the languages in DK’s parametric system. We also test the NPL and show that it does not succeed on the same learning problem. Our results weaken the case for domain-specific learning mechanisms, supporting a more modest UG.

The NPL maintains a stochastic grammar: each parameter value (e.g., the value ‘Left-headed/Trochee’ for the ‘Foot headedness’ parameter) is associated with a probability. At each iteration, one randomly chosen data point is processed, and a single sampled value is stochastically and independently selected for each parameter. If the sampled values correctly predict the stress pattern of that word form, each sampled value’s probability is updated to be closer to 1; if not, each sampled value’s probability is steered closer to 0. Formally, for a learning rate $\lambda$, and for each sampled parameter value, its updated probability $p_{\text{new}}$ is determined by the following update rule: $p_{\text{new}} = (1 - \lambda) \times p_{\text{old}} + \lambda \times p_{\text{est}}$, where $p_{\text{old}}$ is that value’s probability in the current stochastic grammar, and $p_{\text{est}}$ is 1 if the stress pattern matches and 0 otherwise. The new probability for the parameter’s opposing value is $1 - p_{\text{new}}$.

EDL also processes each word one-by-one and updates each parameter’s probability by the same update rule as NPL. However, in EDL $p_{\text{est}}$ is a continuous value between 0 and 1 that reflects each parameter value’s compatibility with the current datum. Formally, $p_{\text{est}}$ is the conditional probability of a parameter value $v$ given the grammar $g$ and the current datum $d$: $P(v \mid d, g)$. By Bayes’ rule, this is proportional to $P(d \mid v, g) \times P(v \mid g)$. $P(v \mid g)$ is simply the probability of the parameter value in the current grammar, and $P(d \mid v, g)$ can be estimated by ‘testing’ each parameter value on the current datum. This involves temporarily fixing that parameter value in the stochastic grammar and letting the resulting grammar generate stress patterns to estimate that parameter value’s likelihood of success on that datum. While the computation of $p_{\text{est}}$ is more involved for EDL, these calculations are nonetheless computationally efficient—they are linear in the number of parameters.

To illustrate the effectiveness of this more nuanced update procedure, we tested the model on a representative sample of the languages defined by DK’s 10 binary parameters (minus the defooting parameter), consisting of 23 languages that explored all combinations of quantity-sensitivity, foot headedness, foot boundedness, extrametricality (none, left, or right), and ‘obligatory branching’ (a parameter used to distinguish between same-edge and opposite-edge unbounded systems; see DK). Other parameters were held constant: CVC syllables were always heavy, stress was always iterative, and primary stress was always leftmost. In order to retain only one of each pair of languages that are ‘mirror images’ of one another (i.e., their stress patterns are identical when viewed in reverse; DK’s parameter set is symmetrical, so that such languages have identical dependencies between parameters), only L-to-R footing was used, and unbounded quantity-insensitive (QI) iambic systems were removed from
consideration, since they ‘mirror’ unbounded QI trochaic systems. The learners do not know these restrictions and have to learn these parameter values just like any others. The learning data for each language consisted of all 3 to 6-syllable pseudowords that can be constructed out of the syllables [ta], [taa], and [tan], with stress assigned by one of the grammars above.

(1) gives example languages and illustrates some learning challenges. Languages a. and b. have identical stress patterns in even-numbered syllable words. The difference in stress in odd-numbered syllable words reflects a difference in two parameters: extrametricality (LXM = left extrametricality, RXM = right ex.m., -XM = no ex.m.) and foot form. At the same time, languages b. and c. as well as a. and c. only differ in one parameter each, but their stress patterns differ dramatically. Successful learning requires disentangling these various effects.

We tested each learner 10 times on each language. For both models, we set initial values of all parameters to 0.5, fixed $\lambda$ to 0.1, and limited learning to a maximum 1,000,000 iterations. For EDL, the sample size at each iteration was set to 50 (this determines how many times each parameter value is stochastically ‘tested’). We defined successful convergence as follows: for every word in the data, 99 out of 100 samples from the grammar generate a correct stress pattern for that word. Convergence was checked every 100 iterations.

The NPL only learned 1 of the 23 languages reliably: a QI language with initial main stress and no secondary stress. For this language, the NPL converged within 89,370 iterations on average (range: 16,300 – 204,600). For all the others, it never successfully converged. Overall, this amounts to an average success rate of 4.3%.

EDL, on the other hand, learned all but one (1a) of the languages in the typology on all runs, and (1a) was still learned 10% of the time. This amounts to an overall average success rate of 96%. Among these successful runs, EDL required only 200 iterations on average to converge (range: 100–400). Languages (1c,d) were the fastest to be learned, always converging within 100 iterations, and even (1a) was learned within 200 iterations when it succeeded. While most languages have some word forms for which there are multiple analyses, (1a) is particularly ambiguous: its even-numbered syllable words look like (1b), and its odd-numbered syllable words look just like (1d), and both of these lookalikes use iambics while (1a) requires trochees.

To our knowledge, our findings are the first to report a high success rate for a general-purpose statistical learner for parametric stress, and also the first systematic efforts to test the NPL on a typology of QI and QS languages. Our results indicate that the more nuanced update procedure of the EDL enables the learner to disentangle the ambiguous and interdependent effects of the parameters where NPL fails. The general failure of NPL on a typology of regular stress demonstrated above weakens Pearl’s case for the necessity of substantive enhancements to UG (see also DK). At the same time, the general success of EDL on a representative typology of regular stress in DK’s framework suggests that a general-purpose statistical learning approach for parametric stress may be sufficient after all.

Contrastive reduction of lax vowels in response to minimal pair competition

Experimental and observational work suggests that phonetic cues to phonemic category identity are enhanced in response to lexical competition (e.g., Baese-Berk & Goldrick 2009, Fox et al. 2015, Hall et al. in prep). However, evidence also suggests that phonetic cues can be reduced in response to competition from lexical minimal pairs with more extreme phonetic values (e.g., reduction of voice onset time in initial voiced stops with a voiceless stop minimal pair competitor; Schertz 2013, Wedel et al. in prep). These results suggest a kind of contrastive hyperarticulation that increases the perceptual distance between target and competitor and can manifest as either enhancement or reduction. However, the majority of past work has focused on (i) laboratory communication tasks in which the lexical competitor is present in the immediate context and (ii) investigations of the effect of competition on the primary cue distinguishing target and competitor (e.g., voice onset time of initial stops or formant values of vowels). This paper expands on prior work by investigating the effect of lexical minimal pair competition on a secondary cue to segment identity (vowel duration) in a corpus of spontaneous English.

We investigated the effect of minimal pair competition between the tense/lax vowel pairs /i~/ɪ/ and /e~/ɛ/ on the realization of vowel duration for 31 of the 40 speakers in the Buckeye Corpus of Conversational Speech (Pitt et al. 2007). For each monosyllabic content word with one of these vowels, we replaced the vowel in the phonemic form of that word’s lemma with it’s tense/lax counterpart. If the resulting form was also a lemma of English, we coded the tense/lax minimal pair existence factor as TRUE for that word; otherwise, we coded it as FALSE. We analyzed the data using linear mixed effects models with a large set of predictor variables that affect word or segment durations (cf. Bell et al. 2009, a.o.). Analysis was conducted in R (R Core Team 2016) using the lme4 package (Bates et al. 2015).

![Fig. 1. Boxplots of the durations (in ms) of both tense (/i,e/ left panel) and lax (/i,ɛ/ right panel) vowels as a function of tense/lax minimal pair competitor existence.](image-url)
We found that lax vowels were predictably shorter if the lexical minimal pair defined by their tense vowel counterpart exists in the English lexicon, as compared to when this competitor does not exist (log-likelihood ratio test: \( \chi^2(1) = 4.7, p < 0.05 \)). We found no significant effect of tense/lax minimal pair competition on the realization of the tense vowels.

Our results mirror those of Schertz (2013), who found that speakers exaggerated the duration contrast between /i~ɪ/ minimal pairs when clarifying misheard speech. In addition, these results reinforce the notion that a multiplicity of phonetic cues signal phoneme identity. Vowel identity is primarily cued by F1/F2, and recent corpus evidence shows that F1/F2 Euclidean distance is greater between vowels that form a lexical minimal pair (Wedel et al. in prep). Here we found evidence that a different cue, duration, is affected by lexical competition. This is consistent with experimental evidence that speakers can manipulate multiple cues in response to minimal pair competition (Seyfarth et al. 2016), and that listeners are sensitive to subtle manipulations of duration (McMurray et al. 2002). These results suggest that speakers can hyperarticulate phonetic cues in order to maximize perceptual distance between competing lexical items. The lexical status of competitors is important, largely due to the role of words as meaning-bearing units of language. This is consistent with the idea that phonology is a tool for the successful transmission of meaningful messages, or “message-based phonology” (Hall et al. in prep). According to such an approach, both reduction and enhancement result from a trade-off between reliable message transfer and minimal articulatory effort, and compounding effects of this type can affect long-term sound change (Hall et al. in prep and references therein).

References:
Intermediate Markedness in Phonological Acquisition

Intermediate stages. In the phonological acquisition literature, it has been observed that children sometimes acquire marked structures of the target language in a two-step fashion: they go through a stage in which they produce the marked structure only in some privileged position(s) within the word, before producing that structure in the full range of positions found in the target language. A simple example comes from Rose (2000), who observes a stage in the acquisition of Québec French in which complex onsets are faithfully produced only in stressed syllables. Complex onsets in unstressed syllables are not allowed.

(1) a. Théo:

<table>
<thead>
<tr>
<th>Target</th>
<th>Child</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>/gʁo/</td>
<td>’gʁo’</td>
<td>‘big’</td>
</tr>
<tr>
<td>/tʁe/</td>
<td>’kʁε’</td>
<td>‘train’</td>
</tr>
<tr>
<td>/ɡʁyjo/</td>
<td>[k̚e jo]</td>
<td>‘oatmeal’</td>
</tr>
<tr>
<td>/tʃu’ve/</td>
<td>[k̚e ]</td>
<td>‘found’</td>
</tr>
</tbody>
</table>

b. Clara:

<table>
<thead>
<tr>
<th>Target</th>
<th>Child</th>
<th>Gloss</th>
</tr>
</thead>
<tbody>
<tr>
<td>/bi’bʁa/</td>
<td>’pa’ ’kʁa’</td>
<td>‘baby bottle’</td>
</tr>
<tr>
<td>/sɪ tʁo’jɛ/</td>
<td>’θo’ ’tʁukjɛ’</td>
<td>‘pumpkin’</td>
</tr>
<tr>
<td>/fu ’go/</td>
<td>[bu ’ko]</td>
<td>‘fridge’</td>
</tr>
<tr>
<td>/tʃu’ve/</td>
<td>[tɔ ’ve]</td>
<td>‘found’</td>
</tr>
</tbody>
</table>

The puzzle. It is commonly assumed that the intermediate stages observed are due to the general ranking schema in (2) (Tessier, 2009). The ranking of constraints for Québec French under this schema are also provided.

(2)

<table>
<thead>
<tr>
<th>Positional Faithfulness</th>
<th>Markedness</th>
<th>General Faithfulness</th>
</tr>
</thead>
<tbody>
<tr>
<td>MAX/’ɛ</td>
<td>*COMPLEX</td>
<td>MAX</td>
</tr>
</tbody>
</table>

Assuming that the learner begins with all Markedness constraints ranked above all Faithfulness constraints, gradual OT learners such as the Gradual Learning Algorithm (GLA) (Boersma, 1997; Magri, 2012) fail to predict that children will ever have the ranking in (2). Since a positional Faithfulness constraint will always receive a subset of the violations of its more general counterpart, it will always be promoted at a slower rate by the GLA. As such, it will not outrank a Markedness constraint in advance of its general counterpart, and the ranking in (2) will not be achieved (Jesney and Tessier, 2008; Tessier, 2009). This failure to predict an intermediate stage has been used to argue that gradual OT learners either must be modified (Tessier, 2009) or abandoned in favour of using algorithms based on HG (Jesney and Tessier, 2008).

Using positional Markedness. The claim that other gradual learners should be preferred due to their ability to predict intermediate stages is entirely dependent upon the specific constraints used to characterize these stages. If the grammar has recourse to positional Markedness constraints, the intermediate stages can also be characterized by the schema in (3), with the ranking of constraints for Québec French also provided.

(3)

<table>
<thead>
<tr>
<th>Positional Markedness</th>
<th>Faithfulness</th>
<th>General Markedness</th>
</tr>
</thead>
<tbody>
<tr>
<td>*COMPLEX/’ɛ</td>
<td>MAX</td>
<td>*COMPLEX</td>
</tr>
</tbody>
</table>

This characterization will allow gradual OT learners to successfully arrive at an intermediate stage for the same reason that the characterization in (2) does not. Since a positional Markedness constraint always receives a subset of the violations of its more general counterpart, it is demoted at a slower rate by the GLA, and will not be outranked by a Faithfulness
constraint before the more general Markedness constraint. No additional assumptions about
the initial state of the grammar need to be made, and no modifications need to be made to
the GLA, either.

**Consequences for positional Faithfulness.** Use of positional Markedness constraints
proves to be beneficial when modelling intermediate stages with the GLA, so it is tempt-
ing to attempt to eliminate positional Faithfulness constraints from CON altogether. This
is not plausible, since not all positional Faithfulness constraints have useful Markedness
counterparts. For instance, a Markedness counterpart of an Anchor constraint such as
Anchor-σ-R would have to ban syllables that were not adjacent to the right edge of the
word. However, this constraint by its very nature of being a Markedness constraint would
be unable to penalize candidates where the rightmost input syllable was not retained, as
any syllable that is rightmost in the output form will satisfy this constraint. At least some
positional Faithfulness constraints must therefore be retained.

While reference to positional Faithfulness is sometimes necessary, positional Faithful-
ness constraints do not need to be highly ranked in children’s intermediate grammars in
order to select the attested output forms. This becomes apparent when examining another
intermediate stage in the acquisition of English unstressed syllables. This stage has been
previously analyzed as requiring a high-ranking Anchor-σ-R constraint (Kehoe, 2000). In
this intermediate stage, English-learning children preserve all stressed syllables but preserve
only the right-edge unstressed syllables. While this has been analyzed by Kehoe (2000) as
being due to the ranking in (4a), it may also be analyzed with Anchor-σ-R low-ranked, as
demonstrated in (4b).

(4)  a. Align-σ-L, Anchor-σ-R ≫ *σ ≫ Max

<table>
<thead>
<tr>
<th>/ænəməl/</th>
<th>Align-σ-L : *σ</th>
<th>Max : Anchor-σ-R</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. ˈænɔmə</td>
<td>**</td>
<td>*</td>
</tr>
<tr>
<td>b. ˈænə</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>c. ˈæmə</td>
<td>*</td>
<td>***</td>
</tr>
</tbody>
</table>

Analyzing the grammar as in (4b) ensures that the GLA is able to correctly predict chil-
dren’s intermediate stage grammars while still being able to reference positional Faithfulness
constraints, without arriving at the constraint ranking in (2).

**Alternate approaches.** While the approach above demonstrates that analysis of inter-
mediate stages is by no means impossible with gradual OT learners such as the GLA, it is only
one of many solutions compatible with the GLA. One requires modification of the assump-
tions about the initial state grammar, such that positional Faithfulness constraints begin by
being ranked as a group between the general Faithfulness constraints and the Markedness
constraints (Tessier, 2009). Another makes use of the PMap (Steriade, 2002) by allowing
constraints such as Max/σ to be in a fixed ranking with other Max constraints. If Max/σ
must be ranked high in the hierarchy of Max constraints, any Markedness constraint that
is demoted must pass below Max/σ before any other Max constraints, thus arriving at the
grammar in (2). While the GLA does not currently allow fixed rankings of constraints to be
maintained, this is a feature that will ideally be implemented, and offers yet another way to
ensure that it will be capable of modelling intermediate stage phenomena.
A formal analysis of Correspondence Theory

The goal of this paper is to investigate the computational complexity of Correspondence Theory, as put forth by McCarthy and Prince (1995), which explicitly recognizes the correspondence between underlying and surface elements. We have three distinct results. First, we show that the GEN function, assuming Correspondence Theory, is not definable using Monadic Second Order logic (MSO). On the other hand, we show that the set of output candidates for a given input is in fact definable in First-Order (FO) logic, given a relational representation. Lastly, we find that typical underlying representation (UR) to surface representation (SR) mappings can be directly described with FO logic without recourse to optimization. Our approach is similar in spirit to Potts and Pullum (2002), which uses logic to formalize OT constraints. The major difference is that we employ language-specific inviolable constraints, cf. Jardine (2016).

Correspondence Theory is widely used in OT analyses (Kager, 1999). It relies on GEN, which maps input forms to candidates, considered as input-output pairs (Prince and Smolensky, 2004). Earlier computational analyses of GEN (Frank and Satta, 1998; Riggle, 2004) understood it as a regular relation. MSO-definability of functions are not the same as regular relations (Engelfriet and Hoogeboom, 2001), therefore this study supplements previous research.

One way of defining complexity is through a logical hierarchy. For instance, MSO logic is more complex than FO logic, which is more complex than propositional logic (Rogers and Pullum, 2011). MSO-definability has been argued to be an important quality for phonological patterns (Heinz, forthcoming). In any MSO definable function, the size of the output must be bounded by some positive integer value times the size of the input (Engelfriet and Hoogeboom, 2001). Since GEN’s output is not bounded, it cannot be an MSO-definable function.

However, the set of candidates produced by GEN for a specific input \( w \) is in fact FO-definable, if we represent the UR-SR correspondence in a relational structure, with constraints (1b–1d). The underlying form and the surface form are represented in two tiers in a graph, and each node is labeled for the sound it represents and also for being part of the UR (\( u \)) or the SR (\( s \)). Constraint (1b) specifies that edges labeled \( \prec \) can only connect nodes in the same tier. Constraint (1c) requires that edges labeled \( c \) force the correspondence to be between the underlying and surface tiers. Constraint (1d) spells out the specific input \( w \), which is /kætz/ in this example. The correct mapping is shown in (1a), which is one of the infinitely many possible candidates for /kætz/. If we consider the set of all possible structures which do not violate constraints (1b–1d), then this is exactly the candidate set produced by GEN for the input /kætz/. Note that (1b-1d) are FO definable.

Our third result shows that if we eliminate Constraint (1d) we can model all potential correspondences between URs and SRs directly, provided we add language-specific inviolable constraints.
on these correspondence structures. This model can describe a variety of canonical phonological processes, including Tibetan consonant deletion (Halle and Clements, 1983), nasal assimilation (Onn, 1980), and Hungarian [j] epenthesis in vowel hiatus (Siptar, 2005), (shown in (2)). To get the correct SR \text{[fiu:] as in (2a)}, we need to ban graphs like (2b) where underlying vowel hiatus is not fixed, as well as those that use any repair strategy which does not insert [j]. (2c) defines structures where a vowel is followed by another vowel. We use this definition to write our constraint in (2d), which is violated in (2b), but not in (2a). Other constraints, not shown here, rule out all other correspondence structures which have /fiu:/ underlyingly.

(2) a. \begin{align*}
    f_u &\rightarrow i_u &\rightarrow u'_u &\rightarrow c \\
    f_i &\rightarrow i_u &\rightarrow u'_u &\rightarrow c \\
    f_s &\rightarrow i_s &\rightarrow j_s &\rightarrow u'_s
\end{align*}

b. \begin{align*}
    f_u &\rightarrow i_u &\rightarrow u'_u &\rightarrow c \\
    f_i &\rightarrow i_s &\rightarrow u'_s &\rightarrow c \\
    f_s &\rightarrow i_s &\rightarrow j_s &\rightarrow u'_s
\end{align*}

c. \(v_x v(x) \equiv \exists y [\text{edge}_c(x, y) \land \text{vowel}(x) \land \text{vowel}(y)]\)

d. \(\neg(\exists x, y) [v_x v(x) \land v_y v(y) \land \text{edge}_c(x, y)]\)

In this paper we have shown that the formal properties of Correspondence Theory depend on the particulars. The complexity of the GEN function itself is not MSO-definable, while each output candidate set is. However, we also show that GEN is not required to encode individual UR-SR mappings, as these can be defined with various FO constraints. As we will discuss, many of these resemble standard OT faithfulness constraints. Using Correspondence Theory this way can account for a wide variety of phonological processes, without resorting to optimization. Whether these mappings can be defined in a more restrictive logic is a subject for future research.

References

Are suffixed words different? Evidence from a modified lexical decision task

Overview. Do listeners process suffixed versus prefixed words differently? We address this question with a lexical decision task that has been crucially modified to eliminate competition between primes and targets, a factor that confounded previous studies. Preliminary results suggest that lexical activation is weaker for suffixed roots (such \textit{kin in kin-ship}) than for matched prefixed roots (\textit{group in re-group}). If confirmed, these findings could explain why phonological alternations affecting roots are more common for suffixed words than for prefixed ones.

Background. The literature on spoken word recognition contains many suggestions – but few direct demonstrations – that listeners process suffixed words differently than prefixed words. In English, for example, prefixed words primed other prefixed words with the same root (\textit{un-fasten primed re-fasten}), just as predicted by any theory in which listeners decompose words into component morphemes (e.g., Taft & Forster, 1975). Contrary to predictions, however, suffixed words did not behave similarly (\textit{confess-ion} did not prime \textit{confess-or}) (Marslen-Wilson, Tyler, Waksler, & Older, 1994). Subsequent studies have reported comparable findings for French (Meunier & Segui, 2002) and Polish (Reid & Marslen-Wilson, 2000). This result has typically been attributed to inhibition between competing word candidates during the lexical decision task, but recent work with an alternative task suggests a different cause: listeners may actually perceive suffixed roots less clearly than prefixed roots (Pycha, 2015). Conceivably, then, slow reaction times (RTs) to words like \textit{confess-or} could be due not to competition from \textit{confess-ion}, but to the suffixed status of \textit{confess-or} itself. Our goal is to revisit this issue using a lexical decision task that has been crucially modified to eliminate confounding competition between words. The new paradigm allows us to ask: does speech input activate lexical representations for roots less strongly when they occur in a suffixed context, compared to a prefixed one?

Method. Using immediate auditory repetition priming (Emmorey, 1989), we presented primes that combined a clear-speech root plus degraded-speech affix (such as \textit{kin-xx}, where \textit{xx} refers to degraded speech), and measured RTs to subsequent targets that were entirely clear (\textit{kin-ship}). Degradation used low-pass filtering (< 500 Hz), such that affixes sounded like speech but were nevertheless incomprehensible. Roots remained clear. Thus, the prime \textit{kin-xx} sounds like a complete suffixed word, yet it is entirely compatible with the target \textit{kin-ship} and should not compete with it for activation. This technique allowed us to isolate the morpheme of interest (e.g., the root \textit{kin}) while minimizing unwanted interference that occurs between primes and targets when they are both complete affixed words (\textit{confess-ion} and \textit{confess-or}). The crucial comparison was between prefixed (\textit{re-group}) versus suffixed (\textit{kin-ship}) targets, which were matched for frequency, familiarity, probability of phonotactic transition across morpheme boundary, and type-parsing ratio of the affix (Hay & Baayen, 2002). As a control, we included pseudo-prefixixed (\textit{resort}) and pseudo-suffixed (\textit{worship}) targets.

<table>
<thead>
<tr>
<th>Word type</th>
<th>Real affixes</th>
<th>Pseudo affixes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefixed</td>
<td>\textit{xx-group} → \textit{re-group}</td>
<td>\textit{xx-sort} → \textit{resort}</td>
</tr>
<tr>
<td>Suffixed</td>
<td>\textit{kin-xx} → \textit{kin-ship}</td>
<td>\textit{wor-xx} → \textit{worship}</td>
</tr>
</tbody>
</table>

The experiment also included trials with unrelated primes (\textit{star-xx → king-dom}) and with non-word targets (\textit{well-xx → zeydess}). On each trial, participants heard a prime, a 1000 ms ISI, then a target. Their task was to indicate, as quickly and accurately as possible, whether the target was a real word of English or not. They used a button-box to respond “No” with their non-dominant hand or “Yes” with their dominant hand. The order of trials was randomized for each participant.
Results. The RT to a target such as *kin-ship* reflects two components: the activation that *kin*-xx shares with *kin-ship*, and the overall activation of *kin-ship*. By subtracting a baseline RT to *kin-ship* after an unrelated control prime (e.g. *lord-xx*), we calculate a difference, \( \Delta \), that isolates the activation that *kin*-xx shares with *kin-ship*, which is a reasonable approximation of the activation level for the suffixed root *kin*-alone. In this way, we can evaluate our hypothesis that comparable speech input should activate e.g. suffixed *kin-* less strongly than prefixed -*group*.

Pilot results (n=5) provide preliminary support for this hypothesis. The table below shows mean RTs, in ms, for correct responses to real word targets (accuracy was high, 98.6%).

<table>
<thead>
<tr>
<th>Pseudo affixes</th>
<th>Target</th>
<th>Related</th>
<th>Unrelated</th>
<th>( \Delta )</th>
<th>Target</th>
<th>Related</th>
<th>Unrelated</th>
<th>( \Delta )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefix</td>
<td>re-group</td>
<td>788.00</td>
<td>1024.65</td>
<td>-236.65</td>
<td>resort</td>
<td>771.76</td>
<td>1017.78</td>
<td>-246.02</td>
</tr>
<tr>
<td>Suffix</td>
<td><em>kin-ship</em></td>
<td>873.00</td>
<td>1006.20</td>
<td>-133.20</td>
<td>worship</td>
<td>780.00</td>
<td>999.33</td>
<td>-219.33</td>
</tr>
</tbody>
</table>

While *xx-group* reduces RTs to *re-group* by a large amount (-236.65 ms), *kin-xx* reduces RTs to *kin-ship* by a much smaller amount (-133.20 ms), suggesting weak activation for suffixed roots. Pseudo-affixed words also show this trend, but the difference is smaller, suggesting that the effect arises specifically from morphological constituency. Final results will be analyzed in a linear mixed-effects model with affix position (prefix vs. suffix) and status (real vs. pseudo) as predictor variables, participant and item as random variables, and RT as the outcome variable.

The results of the study will have implications for theories of phonology, because many phonological alternations change the underlying segments of suffixed roots (as in English *leaf[f], leaf[v]-es*), but not prefixed ones (*off-[p]eat for off-beat, *sub-[b]ar for sub-par*) (Hyman, 2008). This asymmetry occurs across many language families and alternation types, suggesting the need for a general explanation. Because strong activation allows listeners to “overlook” variability in the speech input (e.g., in *off-beat*, to overlook [bɪt] and perceive [bɪt]) (Samuel, 1996), differences in the activation of root representations, if found, could offer such an explanation: conceivably, variability resists phonologization just in those contexts where listeners overlook it.

References
Gradient harmonicity in compounds

Many phonological phenomena are known to be domain-specific but parsing into domains, the distinction between morphologically complex and simplex forms is often problematic. Nevertheless, segmentation is traditionally considered to be categorical and consistent with respect to specific morphemes. By contrast, some recent approaches claim that (i) morphological complexity is gradient so that even different forms that share the same component morpheme may differ in complexity and (ii) a frequency-dependent measure of complexity is appropriate for capturing these differences. In this paper we argue that the latter approach can explain the unexpected harmonic behaviour some compounds and monomorphemic words in Hungarian and put forward a modified measure of complexity.

Front/Back vowel harmony in Hungarian is stem-controlled, i.e. the last non-neutral vowel (F, B) in the stem triggers harmony whose target is a non-neutral vowel in a harmonically alternating suffix: [[[...F][F]], [[[...B][B]], see the examples in (1a). Some neutral vowels (N) are fully transparent ([[...FN][F]], [[[...BN][B]] if N=i, i., e:) others are variably transparent ([[...B] ːː ɛ], [[[...B%F]], see (1b). Antiharmony occurs in the system: some all-neutral stems take front suffixes [[N+], others take back suffixes [[N][B]], see (1c). The domain of harmony is traditionally assumed to be the prosodic word where the constituents of compounds, prefixes and some non-neutral suffixes form their own separate harmonic domains. Since the domain of harmony thus depends on morphological structure, it is possible to identify contexts where differences in morphological structure result in differences in suffix harmony. For instance, when monomorphemic, the harmonic context BN_ requires a back suffix or variable B%F suffixation, see (1b). The same phonological context conditions different harmonic suffix behaviour when [B][N] is a compound whose second member is a stem that is not antiharmonic. In this case, the suffix allomorph predicted on the basis of the traditional domain condition on harmony is front: [[[B][N][F]], which is what is attested. Similarly, the harmonic context FN_ requires a front suffix allomorph when morphologically simplex but a back suffix allomorph when [F][N] is a compound whose second member is an antiharmonic stem [[[F][N][A]%B]; compare forms in (1b) and (1d):

(1) a. [[F][F]] fyl-næk ‘ear-DAT’
   [[B][B]] høl-næk ‘fish-DAT’
   b. [[[BN][B]] aliz-næk ‘Alice-DAT’
   [[[FN][F]] røvid-næk ‘short-DAT’
   c. [[[N][N][F]] i:z-næk ‘taste-DAT’
   [[[N][N][B]] hi:d-næk ‘bridge-DAT’
   d. [[[B][N][F]] høl-i:z-næk ‘fish-taste-DAT’
   [[[F][N][B]] kø.:hi:d-næk ‘stone-bridge-DAT’
   [[[B%F]] fø:sør-næk/-næk ‘guy-DAT’
   [[[B][F]] fø:sør-næk/-næk ‘guy-DAT’

Given what we have seen above, it is unexpected that some complex words that are like those we have discussed in vocalic makeup and morphological structure show variation in suffix harmony rather than the categorical behaviour predicted by the domain condition, e.g. hon-ve:d-næk%-næk ‘soldier=homeland+defence-DAT’. See further examples in (2):

(2)  a. [[[BN][B]] vs. [[[B][N][A]]%F] hø:j(-)ve:t-næk/-næk ‘Easter=meat+take-DAT’,
    [[[B][N][B]] vs. [[[N][N][A]%B] fe:r(-)fi-næk/-næk ‘man=?+son-DAT’
    [[[B%F]] vs. [[[B][F]] jo:j(-)sør-næk/-næk ‘medicine=medical+remedy-DAT’

Traditionally, this is explained by claiming that the division of domains in these words (originally compounds) has been “obscured”, they have ceased to be complex, i.e. [BN] and not [B][N]. This explanation fails since the obscured compounds are predicted to behave like monomorphemic stems (i.e. categorically). It is also untenable to think that variation here is due to the fact that these words are morphologically complex for some speakers but simplex for others: the variation reported here is intraspeaker variation (vaccillation). Assuming that one and the same speaker has more than one representation for such a word, a morphologically parsed...
one and an unparsed one, leads to an implausible view of lexical access especially since vacillation is not random and there is usually a preference for one or the other variant.

We claim that this variation is not due to a choice between a categorically parsed vs. unparsed representation, but to the gradience of morphological structure (parsability), which is determined by the frequency of the complex form compared to that of its constituents. Hay (e.g. Hay 2001, Hay & Baayen 2005) proposes a measure of parsability in derived words based on the relative frequency of the base in isolation compared to the derived form:

\[(3) \text{Parsability of the derived (suffixed) form } AB \text{ (Hay 2001)} \]
\[
p = \frac{\text{freq}(A)}{\text{freq}(AB)} \quad (0 \leq p < +\infty)
\]

Since we are dealing with compound-like structures with potentially more than one base we modify Hay’s measure in two ways: (i) the parsability of a compound is the arithmetic mean of that of its constituents and (ii) the parsability of a constituent is given by the ratio between the frequency of the constituent in isolation and in compounds and the frequency of the compound:

\[(4) \text{Modified parsability (left, right and bilateral) of the compound } AB \]
\[
p_L = \sum_X \frac{\text{freq}(AX)}{\text{freq}(AB)} \quad p_R = \sum_X \frac{\text{freq}(XB)}{\text{freq}(AB)} \quad p = (p_L + p_R)/2 \quad (1 \leq p < +\infty)
\]

As opposed (3), the minimum of modified parsability is 1 (when the constituents do not occur independently of the compound). In order to get a more plausible measure we take the reciprocal of these values, which we define as the unseparability (unity) of the compound: in this case the unseparability value of the compound is within the interval [0,1]:

\[(5) \text{Left, right and bilateral unseparability of the compound } AB \]
\[
u_L = 1/p_L \quad u_R = 1/p_R \quad u = 1/p \quad \text{therefore} \quad u = H(u_L,u_R) \quad (0 < u \leq 1)
\]

Thus, the unseparability of a compound is the harmonic mean (H) of that of its components. It is a linguistically desirable property of the harmonic mean that the low unseparability (i.e. high parsability) of one of the constituents makes the unseparability of the compound low independently of the unseparability of the other constituent. This is in accord with the relatively low unseparability (ie. high parsability) of cranberry-type compounds one of whose constituents is bound and/or extremely rare (cran-), but the other one (berry) is frequent.

We will show that the proposed measure of unseparability makes correct predictions about and motivates the behaviour of the problematic type of compounds. Categorical behaviour occurs when (i) \(u\) is (close to) 1: single-domain behaviour; or (ii) \(u\) is close to 0: multiple-domain behaviour. Unseparability is maximal (=1) when the hypothesized constituents never occur elsewhere but in the “compound” examined. It is close to minimal (0) if the compound is rare and its constituents are highly frequent. Variation occurs between a bottom and a top threshold (Hay & Baayen 2005) in unseparability. hon(-)ve:d, hu:ʃ(-)ve:t, fe:r(-)fi etc. fall within this range: they are relatively frequent while their constituents are rare in other compounds or in isolation, hence the vacillation in harmonic suffixation. This approach can also be extended to explain a gang effect, the fuzzy compound-like, unexpectedly variable harmonic behaviour of monomorphemic ...BN words (mʌjʌnəz ‘mayonnaise’, indʌnəz ‘Indonesian’, melənəz ‘Melanesian’ etc.) whose meaningless final sequence is recurrent and therefore lowers unseparability.

References
Rhythmic repair of morphological accent assigned outside of a metrical window

Metrical windows refer to a designated number of moras/syllables at a domain-edge within which primary metrical prominence is restricted, prototypically the final two or three syllables of a word (Gordon 2002; Caballero 2011; Kager 2012; and literature on ‘stress windows’ as well). A well-known example is Latin, where primary stress appears on “the penult or antepenult, whichever of the two is heavier (e.g. /ho.nes.tus/; /do.mes.ti.kus/)”, but not further away (Kager 2012:1458). In languages demonstrating lexically and morphologically conditioned accent, Kager (2012) shows that if such accent is assigned to a position within a metrical window, accent and primary prominence align (i.e. acoustic stress is realized on this accented position). If however accent is assigned outside of this window, they do not align, and primary prominence is instead realized on a default position within the window. I refer to this as Default Repair.

This paper presents a novel type of metrical window repair not previously diagnosed in the literature. In this second type, when morphological accent is assigned outside of the window, the position of primary prominence is not a default but rather is a position which is rhythmically dependent on the window-external accent, e.g. uniformly being two syllables away. I call this Rhythmic Repair. The table below schematizes these two repairs using an initial trisyllabic window. This shows that under default repair the position of primary prominence is uniformly on the initial position (variable across languages), while under rhythmic repair it appears on the second or third syllable depending on the position of morphological accent.

<table>
<thead>
<tr>
<th>Repair types</th>
<th>Default</th>
<th>Rhythmic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Input</td>
<td>#σσσσσσ</td>
<td>#σσσσσσ</td>
</tr>
<tr>
<td>Output</td>
<td>#σσσσσσ</td>
<td>#σσσσσσ</td>
</tr>
</tbody>
</table>

I illustrate rhythmic repair with data from Ese’eja (Takanan: Bolivia). This paper shows that a confluence of typologically marked features – three different types of morphologically conditioned accent patterns (dominant/recessive/rightmost) and morphologically conditioned iambs/trochees – results in an unusual initial trisyllabic metrical window, itself a rarely documented window (Kager 2012 contra Gordon 2002).

The prosody of Ese’eja. The prosodic system of Ese’eja necessitates distinguishing Primary Prominence from Phonological Accent. Primary prominence refers to obligatory word level stress, whose main acoustic correlate is pitch. This prominence can fall on the 1st, 2nd, or 3rd syllable of a word, but not the 4th. The position of primary prominence within this window emerges from phonological accent. Accent in Ese’eja can be understood as an abstract phonological designation on certain syllables, which in the majority of cases is morphologically conditioned. I illustrate the interaction of accent and prominence below with verbs.

All Ese’eja verb roots are bound, and verbal words display a high degree of polysynthesis. Verbal accent varies according to a number of variables. Transitive roots have accent on their final syllable, whereas intransitive roots have no such accent. When roots combine with the 3rd person agreement marker –ka, accent is assigned to the left edge of the stem and erases transitive accent, classified as Dominant Accent (Kiparsky 1973). Within the derivation, verbal words are further inflected by a tense/mood suffix, which assigns accent to the penult or ultima of the stem. Suffixes form two accent patterns. In one, tense/mood accent assignment is blocked if an accent is already present, termed Recessive Accent. In another, tense/mood accent is not blocked by input accent, but only the rightmost accent is preserved, termed Rightmost Accent.

In many words, the accented syllable falls within the initial trisyllabic window and results in primary prominence realized on the accented syllable. However, this does not happen if
morphological accent is assigned outside of the initial metrical window [1a]. It also does not happen under specific morphological conditions even though the accented syllable falls within the window [1b]. In both cases, prominence appears two syllables to the left of the accent.

[1] Morphological accent Surface position of primary prominence


b. /i.shè.ˈtá-he/ [i.shè.ˈtá.he] *[i.shè.ˈtá.he]

The issue. Kager (2012) decomposes metrical windows into constraints enforcing *Weakly Layered Feet* (ternary feet involving a two syllable ‘head’ plus an adjunct syllable), in conjunction with constraints of foot alignment (e.g. ALIGN-WORD-L) and foot head alignment (e.g. ALIGN-HD-R). Crucially these are ranked above FAITH-ACCENT. The result is that input accents can receive primary prominence only when they appear in a domain-aligned foot; otherwise a default position receives primary prominence. This analysis does not predict the data in ex. [1] above. This is because (1) the constraints enforcing default primary prominence position make no reference to input accent, and (2) FAITH-ACCENT constraints should enforce alignment of accent and prominence whenever accent falls within the domain-aligned foot.

Analysis. To account for these data I argue that after morphological accent is assigned, iterative footing takes place, accounting for the differences in Ese’eja metrical windows compared to those in Kager (2012). Iterative footing is enforced through a highly ranked PARSE-SYL constraint, dividing syllables into strong/weak pairs emanating from morphological accent. One group of suffixes has a cophonology enforcing trochees (*RType=T >> RType=I*) [2a], whereas another group’s enforces iambs [2b-c]. Primary prominence emerges from a highly ranked LEFTMOST constraint enforcing the head foot be leftmost within the prosodic word.

[2] Morphological accent Affix type Iterative footing Primary prominence Falls on

a. i.shè.ˈtá-he Trochaic (i.shè).ˈtá.he (i.shè).ˈtá.he 1st σ
b. i.shè.ˈtá-me Iambic i.(she.ˈtá).me i.(she.ˈtá).me 3rd σ
c. i.shè.ˈtá-ká-me Iambic (i.shè).ˈtá.ká.me (i.shè).ˈtá.ká.me 2nd σ

Adopting iterative feet therefore accounts for the dependency of primary prominence on window-external accent shown in [1a] above, and also the ‘unnecessary’ misalignment of accent and prominence shown in [1b]. Acoustically, secondary alternating prominence may sometimes appear – always emanating from primary prominence – supporting the existence of rhythm.

Conclusion. This analysis presents a novel type of initial trisyllabic window, and demonstrates the need to reference both morphological/lexical accent and the role of rhythm is decomposing metrical windows. Further, it is theoretically important in two ways. First, it demonstrates a typologically rare mixed iambic/trochaic system violating the *Metrical Cohesion Principle* (previously documented in this region - Gonzalez forthcoming). Second, under this analysis iterative footing must be established prior to primary prominence delegation, demonstrating it as a Count System and not supporting the Primary Accent First model of prosody (v.d. Hulst 1996).

Stress-modulated quantitative meter

Among meters regulating properties of syllables, two types are traditionally distinguished, namely, accentual (regulating stress placement, as in English) and quantitative (regulating weight, as in Sanskrit). (Tonal sequencing may also exhibit metrical properties; Hayes 1988 et seq.) Also attested, at least in certain contexts of some meters, is a hybrid of these two types, in which strong positions require both stress and weight, while weak positions eschew both (e.g. Latin hexameter cadences; Allen 1973).

This paper treats an understudied metrical type that is not covered by the aforementioned taxonomy, here termed STRESS-MODULATED QUANTITATIVE METER (SMQM). In such a meter, weight is regulated, but more strictly for stressed than unstressed syllables. To my knowledge, the only previously described case of SMQM is the Finnish Kalevala meter.

Two new findings are presented. First, SMQM is attested beyond Finno-Ugric, in Dravidian. Traditional descriptions of the relevant Tamil meters obscure the importance of stress, which is brought out here. Second, previous analyses of the Kalevala meter claim that only primary-stressed syllables are regulated. The situation is more nuanced: In both Finnish and Tamil, stressed syllables are indeed the most stringently regulated, but unstressed syllables also show a significant tendency to align with the meter quantitatively, secondary stress (in Finnish) being intermediate. Calling the meters STRESS-MODULATED emphasizes this gradience: Strictness scales with stress level.

Consider a meter frequently encountered in a medieval Tamil epic, Kambar’s telling of the Rāmāyaṇa. To a first approximation, the meter can be said to have the form below. – represents a position that must be filled by a heavy (C₀V₀C₁ or C₀V:C₀, where V: ∉ {āi, āu}), ◦ by a light, and × by a syllable of any weight.

\[
\begin{array}{cccc}
| - | - & - & - \\
| \infty | \infty & \infty & \infty \\
\end{array}
\]

As traditional descriptions of Tamil meter suggest, exceptions to – and ◦ are frequent (Hart & Heifetz 1988, Ryan 2011). Three illustrative lines follow, with exceptions underlined.

a. ˈt̪alalaiːvar | ˈannavarkḷeː | ˈcaraŋ | ˈnāŋkaːleː;
b. ˈpuːŋ ˈt̪aŋ | ˈcekkān | puːniːtanaːlːjeː | ˈporu;
c. ˈeːtu | ˈcej tk̪a | ˈt̪aṁ | 'emtk̪a | iljampinan̄

Examining the distribution of exceptions, I find the vast majority to come from unstressed syllables. Stress was likely uniformly initial (ibid., Christdas 1988, Krishnamurti 2002, Keane 2001, 2003). The chart below reflects 628 scanned lines. A strong position (–) is heavy 100% of the time if filled by a stressed syllable; vs. 86% otherwise (p < .0001). A weak (◦) is heavy 5% of the time under stress, vs. 13% otherwise (p < .0001). Thus, stressed syllables are regulated nearly categorically, while unstressed syllables are more flexible (but still not ignored by the meter, as Monte Carlo baselines confirm). Moreover, Tamil meter is clearly not “accentual” in the usual sense. Stressed syllables are spread across strong and weak positions at approximately chance rates, as exx. (a–c) above reinforce.
The situation is qualitatively the same for the Kalevala meter (Lönnrot 1849). Three levels of stress can be distinguished, namely, primary (word-initial, as in Tamil), secondary (Anttila 2010), and none. According to traditional descriptions (Sadениemi 1951, Kiparsky 1968, Leino 1986, 1994), the meter regulates only primary stressed syllables for quantity. As the chart below reinforces, quantity sensitivity in fact scales with stress level. As with Tamil, however, unstressed syllables are not wholly ignored. A Monte Carlo method supports that the overrepresentation of unstressed heavies in strong positions is unlikely to be due to chance nor merely reflexive of the distribution of stressed syllables, which are more constrained.

These systems are analyzed in maxent HG by extending the mapping constraints of Hanson & Kiparsky (1994: 308), viz., (paraphrasing) "<strong, light, stressed>, <weak, heavy, stressed>, to a stringency hierarchy (cf. de Lacy 2004) for stress level: (1) primary, (2) primary or secondary, (3) all. It is also proposed (following a suggestion by Sadениemi 1953 for Finnish) that languages tend to employ SMQM when they meet two conditions, namely, initial stress and distinctive quantity primarily confined to word-initial position.

Phonologically Driven Allomorph Selection and Variation in the Sanskrit Perfect

The division of labor between the phonology, the morphology, and the lexicon in the treatment of allomorphy is a perennial problem. One current approach (seen in, e.g., Wolf 2015) suggests that allomorphy may be purely phonological, where the phonology is transparent and productive, or result from the insertion of distinct lexical entries to best satisfy phonological constraints. This paper argues that a paper argues that an under-investigated type of allomorphy in the Sanskrit reduplicated perfect (see Whitney 1889[1960]: 279–96 and examples in (1)) offers further evidence not only for lexical insertion in the phonological component, but for the productivity of inflectional morphology in furnishing those lexical entries. In addition, the presence of both type and token variation in the data of Sanskrit perfect allomorphs requires the use of a phonological model that can generate variable outputs (e.g., Maximum Entropy).

(1) Example Sanskrit Perfects to /tərd-/ ‘bore’ and /ʃtər-/ ‘strew’
   a. /tərd-/: 1.SG [tə-tərd-ə], 3.PL [tə-tərd-úr]
   b. /ʃtər-/: 1.SG. [tə-ʃtər-ə], 3.PL [tə-ʃtər-úr]

Most treatments of reduplication in the Sanskrit perfect (Steriade 1988, Fleischhacker 2005, Zukoff 2015) devote considerable attention to examples of the type in (1)b, which show copy of the second consonant from the left edge (C₁), where the root begins with an [s] + stop cluster. Steriade and Fleischhacker see (1)b. as a preference for the copy of lower-sorority onsets, while Zukoff instead invokes the Poorly-Cued Repetition Principle (PCR, defined in (2)), both being markedness effects that outranked a preference for left-edge anchoring of the reduplicant and base (ANCHOR-L-BR).

(2) The Poorly Cued Repetition Principle (PCR):
   A CVC sequence containing identical consonants (CₐVCₐ) is dispreferred, due to repetition blindness; it is especially dispreferred if one or both of the consonants do not bear phonetic cues which are important for the perception of its presence (in contrast to zero) in the speech signal. Relevant phonetic cues may include consonant-to-sonorant transitions, intensity rise, burst, and frication noise, relative to adjacent segments.

These treatments, however, do not attempt to model a subtype of perfects built to roots of the shape /CₑCₐC₋/, in which the plural stem takes the form [Cₑ:C₋], without transparent reduplication, rather than an expected stem of the shape [CₑCᵥCᵥC₋]. Descriptively speaking, the /a/ of the root appears to be substituted by [e:] in some inflectional forms of the perfect. Examples of this subtype of perfects, which I will refer to as the Cₑ:C₋ type, are given (3); see Sandell 2015: ch. 8 for further examples.

(3) Example Sanskrit Perfects to /pəc-/ ‘cook’ and /səp-/ ‘care for,
   a. /pəc-/: 1.SG [pə-pəc-ə], 3.PL [pəc-úr]
   b. /səp-/: 1.SG [sə-səp-ə], 3.PL [səp-úr]

Building upon the suggestion that Sanskrit perfects with Cₑ:C₋ allomorphs also instantiate an effect of the PCR (Zukoff 2015)), and the proposal that Cₑ:C₋ allomorphs largely emerge where the sequence [CᵥCᵥ] is phonotactically dispreferred in Sanskrit (Sandell 2015: ch. 8)), this paper advances the following arguments:

1. The selection of Cₑ:C₋ forms as winning candidates reflects phonologically conditioned lexical selection, rather than phonological repair alone, because the [e:] is not phonologically derivable.
2. The existence of both type and token variation in the perfects of /C,aCz-/ roots between C,e:Cz-forms and reduplicated C,aCaCz-forms requires a gradient interpretation of Zukoff’s PCR, which interacts with gradient phonotactic constraints (following Hayes and Wilson 2008).

As for point 1., The [e:] of the C,e:Cz-pattern is not attributable to a compensatory lengthening of /a/ by deletion of the /C, / of the base, principally because prosodically motivated processes of lengthening of /a/ in Sanskrit produce a surface [aː], not [eː] (see Insler 1997 for one such case). Furthermore, C,e:Cz-allomorphs are productively generated through a morphological process: new C,e:Cz-forms emerge in the history of Sanskrit, competing with or replacing older perfect stems of the form C,aCz. For instance, to the root /man-/ ‘think’, earlier Sanskrit exclusively attests a reduplicated stem [məːmː], while later Sanskrit exclusively shows a stem [məːnː].

As for point 2., C,e:Cz-forms emerge as winners just in case the combined penalties from PCR violations and phonotactic violations outweigh the penalty of failing to select the lexical entry /RED/. This interaction of a gradient PCR and gradient phonotactics is captured most straightforwardly through the use of weighted constraints, which are implemented using a Maximum Entropy grammar (Goldwater and Johnson 2003). This model successfully generates subtle type variation, where roots with relatively similar segments show different behavior (e.g., /pəːn-/ ‘admire’ has a perfect stem [pəːpənː], while /pɜːl-/ ‘burst’ has a perfect stem [pɜːlː], and token variation, where the same root may have both reduplicated and C,e:Cz-stems (e.g., Pāṇini reports that /jəːr-/ ‘grow old’ may have either the stem [jəːrː] or [jəːrː]). Violations of a gradient PCR are assessed using a scale based on the presence or absence phonetic cues in a particular CC sequence (cf. the definition in (2)); phonotactic violations are assessed using the results of phonotactic learning trained on a corpus of Sanskrit using the software of Hayes and Wilson 2008.

The results from this analysis of Sanskrit perfects thus provide further evidence for the selection of lexically listed or morphologically generated allomorphs in the phonological component of the grammar (e.g., Wolf 2015), and speak in favor of quantitative models of the phonology that can neatly model phonological variation at multiple levels.

References


Binarity and focus in prosodic phrasing: New evidence from Taiwan Mandarin

Introduction: This paper makes novel claims and presents new evidence for the binarity of prosodic phrases, alignment of focused elements, and their interaction. Several authors have argued that there are binarity restrictions at the level of the prosodic phrase (e.g. Prince 1980, Ito & Mester 1992, Selkirk 2000). In this paper, I provide new support for this claim from Taiwan Mandarin (TM). I argue that prosodic phrases must be decomposed into Minor Phrases (MiPs) and Major Phrases (MAPs) (Selkirk et al. 2004), and that both levels can have minimal and maximal binarity restrictions. Crucially, MAPs must be binary. Moreover, I argue – extending Féry (2013) – that focused elements can require both left and right edge alignment of a constituent (in TM, a MiP). Finally, I show that requirements on binarity and focus can interact in striking ways – a binarity restriction on MAPs prevents alignment of the right edge of focused elements in specific environments.

Methodology: Numeral strings were used to examine TM’s phrasing pattern. The five word string /wuL wuL wuL wuL wuL/ ‘55555’ and the six word string /wuL wuL wuL wuL wuL wuL/ ‘555555’ were used to test the default phrasing patterns. Each word was replaced by /tɛjouL/ ‘9’ to test the focal phrasing patterns (‘95555’, ‘59555’, etc.). Two frame sentences were used: [tʃɛmHL xwɑHL xuɑHL maL ʂɿH L __] ‘The telephone number is __’, and [puHL, puMH ʂɿHL __, ʂɿHL __] ‘No, it's not __. It's __’. The default string was placed in the first and second slots, and the focal string in the third. The stimuli and frame sentences ensured that a contrastive focus was elicited. Tone sandhi applies when two underlying low tones are adjacent: i.e. /L L → [MH L], iteratively. Two female and three male native speakers of TM participated in the experiment (ages 21-34). There were six recording sessions, yielding a total of 99 tokens per speaker. 44 fillers with other numbers were also included to divert speakers’ attention from the tone sandhi. Two native speakers of TM performed an auditory analysis of tone: a tone was coded as either L or MH and included in analysis only when both listeners agreed on its classification; there was 99% agreement. The results concerning five syllables are not discussed in this abstract due to space limitations.

Default phrasing: For the six word string, all subjects produced two MAPs of three Prosodic Words (o) each, with the first two in a MiP and the last in another one: [[(o.o)][o]] [[(o.o)][o]] (a o is coextensive with a σ in TM; { } mark MAP boundaries; [ ] mark MiP boundaries) (There were three clear diagnostics for phrase boundaries: (a) a pause indicated a MAP boundary; (b) a glottal stop/glottalization marked a MiP boundary; and (c) tone sandhi occurred within a MAP). Similar to arguments for unmarked binarity at other prosodic structure levels (e.g. Ito & Mester 1992, 2006, 2009; Bennett et al. 2016), I propose that MAPs are obligatorily binary branching in TM, necessarily including two MiPs. MiPs are less restricted: they can be either unary or binary branching, containing one or two Prosodic Words each. This asymmetry is captured by constraints which restrict the size of MAPs and MiPs: MAPMIN (Incur a violation for each MAP that contains fewer than two MiPs), MAPMAX (Incur a violation for each MAP that contains more than two MiPs), and versions for MiPs – MiPMIN and MiPMAX (cf. Selkirk 2000, Elias-Ulloa 2006, Ito & Mester 2007). By ranking MAPMAX and MAPMIN over MiPMIN, a MAP which contains three MiPs (see 1b) or one MiP (see 1c) is eliminated.
Ranking MiPMax over MiPMIn excludes a MiP with more than two Prosodic Words (see 1d). The prosodic structures {{{o}[o][o]}} and *{{o}[o][o][o]}} incur equal violations of MiPMIn since both have one monosyllabic MiP (see 1a and 1c). The ungrammatical candidate *{{o}[o][o][o]}} fatally violates the constraint ALIGN-R(MiP, MAP) (align the right edge of every MiP with the right edge of a MAP) twice because the right edge of the first MiP is two Prosodic Words away from the right edge of the MAP, whereas {{{o}[o][o]}} violates ALIGN-R(MiP, MAP) once. The winner is (1a).

(1) 6 word string ( { } mark MAP edges; [ ] mark MiP edges)

<table>
<thead>
<tr>
<th></th>
<th>MAPMAX: MiPMIN</th>
<th>MiPMax</th>
<th>MiPMIN</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>{{{o}[o][o]}}</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>b.</td>
<td>{{{o}[o][o][o]}}</td>
<td>*</td>
<td>****</td>
</tr>
<tr>
<td>c.</td>
<td>{{{o}[o][o][o][o]}}</td>
<td>***</td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>{{{o}[o][o][o][o]}}</td>
<td>***</td>
<td>***</td>
</tr>
<tr>
<td>e.</td>
<td>{{{o}[o][o][o][o]}}</td>
<td>***</td>
<td>***</td>
</tr>
</tbody>
</table>

Focal phrasing: The focal phrasing patterns are given in (2). All the subjects produced the focal phrasing patterns for the six word string. The generalization is that the focused element forms a MiP on its own, except when doing so would force the MiP to two Prosodic Words (see 2b and 2c). Essentially, focus forces the arrangement of MiPs to deviate from the default pattern so that MAPs can still maintain their binarity. After Féry (2013), I propose that focal phrasing in TM is governed by constraints aligning the edges of the focused element with the edges of a MiP: ALIGN-L(F, MiP) and ALIGN-R(F, MiP).

(2) 6 word string with contrastive focus (Default: {{{o}[o][o][o]}} ‘555555’)

<table>
<thead>
<tr>
<th></th>
<th>MAPMAX: MiPMIN: MiPMax: ALIGN-L(F, MiP)</th>
<th>ALIGN-R(F, MiP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>{{{o}[o][o][o]}} ‘955555’</td>
<td>*</td>
</tr>
<tr>
<td>b.</td>
<td>{{{o}[o][o][o][o]}} ‘595555’</td>
<td>*</td>
</tr>
<tr>
<td>c.</td>
<td>{{{o}[o][o][o][o][o]}} ‘559555’</td>
<td>*</td>
</tr>
<tr>
<td>d.</td>
<td>{{{o}[o][o][o][o][o][o]}} ‘555559’</td>
<td>*</td>
</tr>
</tbody>
</table>

Extending Féry (2013), I argue that both constraints must be active in the language to compel deviation from the default phrasing, as in {{{o}[o][o][o]}} ‘555555’). However, ALIGN-L(F, MiP) must outrank ALIGN-R(F, MiP) because in some situations perfect MiP-to-focus alignment is not possible (namely when MAPs would otherwise be ternary or unary): i.e. in {{{o}[o][o][o]}} ‘555555’), not *{{o}[o][o][o][o]}} (see 3c) or *{{o}[o][o][o][o][o]}} (see 3d). We can see in this situation that the need for maximal and minimal binarity in MAPs outweighs the need to align the right edge of the focused element with a MiP. These points are summarized in (3); a full ranking will be presented in the talk.

(3) 6 words with focus on the second syllable: MAP-binarity beats right-alignment of Focus and MiP

<table>
<thead>
<tr>
<th></th>
<th>MAPMAX: MiPMIN: ALIGN-L(F, MiP)</th>
<th>ALIGN-R(F, MiP)</th>
<th>ALIGN-R(MiP, MAP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>{{{o}[o][o][o][o][o]}} '595555'</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>b.</td>
<td>{{{o}[o][o][o][o][o][o]}} '599555'</td>
<td>*</td>
<td>**</td>
</tr>
<tr>
<td>c.</td>
<td>{{{o}[o][o][o][o][o][o][o][o]}} '595555'</td>
<td>*</td>
<td>***</td>
</tr>
<tr>
<td>d.</td>
<td>{{{o}[o][o][o][o][o][o][o][o][o][o]}} '595555'</td>
<td>*</td>
<td>**</td>
</tr>
</tbody>
</table>

Theoretical implications: This paper shows that there are binarity restrictions at the MAP and MiP levels, and focus can require alignment of both left and right boundaries, filling in a typological gap in Féry (2013). It further shows that one edge-alignment can be prioritized over the other, and that binarity and focus restrictions can interact in striking ways, illuminating the nature of both kinds of conditions on prosodic phrasing.
Harmony Triggering as a Contrastive Property of Segments

In some languages, segments bearing a potential harmonizing feature trigger harmony while other segments bearing that feature do not. In Classical Manchu (Tungusic; Vago 1973, Zhang 1996), some high vowels trigger tongue root harmony (1a-b) while others do not (1c-d). (The low vowel alternates between ATR [a] and RTR [a].)

1. ilhi-ŋa ‘next in order’
2. kumu-ŋa ‘noisy’
3. ciha-ŋa ‘eager’
4. tusa-ŋa ‘useful’

Similar patterns are found in other harmony systems, including those of Hungarian and Rejang, and are often treated as cases of exceptionality in harmony. This paper proposes that these patterns are best handled by an analysis in which a segment’s status as a harmony trigger is encoded as part of its sub-segmental representation. This is made possible by adopting dynamic units of representation, such as gestures (as in Articulatory Phonology, Brown & Goldstein 1986). Under this view, a segment is composed of one or more gestures, whose status as a harmony trigger is represented by a parameter for prolonged duration. A common alternative, indexation of a morpheme to a spreading constraint, makes several undesirable predictions, both over- and under-generating patterns of exceptional (non-)triggering of harmony.

Proposal. This paper proposes that the idiosyncratic ability of some segments to trigger harmony is an encoded property of those segments. When a segment in an output form bears this property, it will trigger harmony. This is best implemented in the gestural framework proposed by Smith (2016), in which harmony is the result of gestural units that prolong their active duration and overlap the gestures of other segments in a word, causing them to undergo harmony. The following figure shows a harmony-triggering tongue root advancement gesture (2a), which does not self-deactivate when its target state is reached, as well as a typical, non-triggering gesture (2b). (Width of the boxes indicates the duration of each gesture; the gradually climbing line within each box represents the attainment of tongue root advancement.)

A segment will trigger harmony if one of its gestures surfaces as non-self-deactivating. This occurs when a markedness constraint, NONSELFDEACTIVATE, requires a gesture of a certain type to always surface as non-self-deactivating. In other instances, faithfulness constraints preserve a gesture’s underlying deactivation parameter. This is summarized in (3).

Harmony: NONSELFDEACTIVATE $\gg$ SELFDEACTIVATE, IDENT(deactivation)
Contrastive Triggering: IDENT(deactivation) $\gg$ SELFDEACTIVATE, NONSELFDEACTIVATE
No Harmony: SELFDEACTIVATE $\gg$ NONSELFDEACTIVATE, IDENT(deactivation)

When IDENT(deactivation) is high-ranked, the grammar will allow both self-deactivating and non-self-deactivating gestures to surface, causing some segments to trigger harmony while others do not. This is the case for Classical Manchu tongue root harmony and many other harmony systems that display apparent exceptionality in patterns of triggering. The high vowels in forms (1a-b) include non-self-deactivating, harmony-triggering tongue root gestures, while those in forms (1c-d) include self-deactivating, non-triggering tongue root gestures.
This approach to representing harmony is unique in that it does not rely on a harmony imperative constraint. Instead, harmony is driven by the phonological units themselves, with constraints used only to shape phonological inventories to either include or exclude harmony-trigging segments. Because of this, the gestural approach to exceptionality in harmony does not suffer from the issues that beset featural analyses that rely on harmony-driving constraints.

**Issues with indexation.** One way of analyzing patterns of exceptionality in harmony is via morpheme indexation (Pater 2000) to a harmony driver, such as **Spread** (Padgett 1995). However, this approach both over- and under-generates patterns of harmony triggering.

**Overgeneration.** As it is typically defined, **Spread(F)** is violated by any segment in a harmony domain that is not associated with a feature F. In the indexation approach to exceptionality in harmony, patterns in which some morphemes display harmony while others do not are analyzed by indexing triggering morphemes to a version of **Spread** that outranks **Ident**.

(4) Ranking for exceptional triggering of harmony for indexed morphemes only:

$$\text{Spread}(F) \gg \text{Ident}(F) \gg \text{Spread}(F)$$

However, there is no principled way of restricting **Spread-indexation** only to morphemes that contain a trigger segment. Issues arise when a disharmonic (non-indexed) morpheme that includes a segment bearing a feature F is concatenated with a morpheme that bears indexation with **Spread(F)_i**, as in (5). The segment $X_1$ has triggered harmony in order to satisfy **Spread(F)_i**, despite the fact that $X_1$ does not occur in the morpheme bearing the indexation. While this hypothetical language usually has no within-morpheme harmony (due to the ranking **Ident(F) >> Spread(F)**), within-morpheme harmony has occurred in order for the feature F to spread to the indexed morpheme, thereby satisfying high-ranked **Spread(F)**. Such a pattern is unattested according to Finley (2010), who states that the presence of an affix that is an exceptional target of harmony never induces harmony in an otherwise disharmonic stem.

**Under-generation.** In addition, an analysis in which morphemes are indexed to harmony-driving constraints cannot account for harmony systems in which both a triggering and non-triggering segment occur in the same morpheme. So long as a morpheme bears an indexation to a harmony-driving constraint, all segments bearing a harmonizing feature will trigger harmony. This prediction is contradicted by languages such as Rejang, in which forms such as [mĩnæ] ‘come here’ contain two nasal consonants, one that triggers nasal harmony, [m], and one that does not, [n] (Coady & McGinn 1982). The gestural analysis of harmony encounters no such difficulty as both harmony-triggering and non-triggering types of gestures may surface in the same morpheme and do not affect one another’s ability or inability to self-deactivate.

**References**

Emergent idiosyncracy in English comparatives

Introduction: Although speakers have knowledge of phonological trends across the words of their lexicons (Ernestus and Baayen 2003, Hayes et al 2009, et seq.), in many cases individual items behave idiosyncratically (Zuraw 2016). We present the results of a computational model which uses UR constraints (Pater et al. 2012) to represent lexical idiosyncracy. We demonstrate that across generations, the behavior of individual lexical items can diverge. We specifically examine the case of the English comparative, which can be realized with -er (happier) or more (more happy). Although the choice between -er or more is influenced by phonological factors, it is ultimately idiosyncratic to particular adjectives. Crucially, our model requires storage of more forms in addition to storage of -er forms. This expansive view of what’s stored in the lexicon builds on work in different phonological domains, such as French liaison (Bybee 2000), and English binomials (Mollin 2012), both of which argue for the storage of multi-word sequences.

Lexical idiosyncrasy in the English comparative: The choice between more and -er is governed by both phonological and syntactic factors (Hilpert, 2008). Monosyllabic words prefer -er (taller > more tall), while 3+ syllable words prefer more (more unimpeachable > unimpeachable). The adjective’s final segment (Kytö & Romaine 1997, Lindquist 2000), and stress (Leech & Culpeper 1997) are also predictive.

<table>
<thead>
<tr>
<th>Adj.</th>
<th>P(-er)</th>
<th>Total (more + -er)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lonely</td>
<td>0.75</td>
<td>163</td>
</tr>
<tr>
<td>deadly</td>
<td>0.42</td>
<td>355</td>
</tr>
<tr>
<td>timely</td>
<td>0.11</td>
<td>167</td>
</tr>
<tr>
<td>worldly</td>
<td>0.05</td>
<td>95</td>
</tr>
<tr>
<td>likely</td>
<td>&lt;0.01</td>
<td>21,899</td>
</tr>
</tbody>
</table>

However, even when these phonological factors are held constant, adjectives vary greatly in their rate of appearance with more vs. -er. The table shows five adjectives, all initially stressed and ending in [li], whose rates of taking -er vary from < 1% to 75%. Counts come from COCA (Davies 2008–).

Historical development: Kytö and Romaine (2000) show that, over time, individual adjectives have become more strongly idiosyncratic. In late Middle English, most adjectives used -er about 30% of the time. Since then, -ous final adjectives have drifted towards more (now at 0% -er) and -li/-y final adjectives have drifted towards -er (now at about 80% -er). Although -ly final adjectives now generally prefer -er, exceptions remain, such as likely above. The goal of our model is to capture this arbitrary drift towards either -er or more.

Frequency effects: The results of this drift can be seen in the synchronic grammar, in which high-frequency adjectives prefer more or -er nearly categorically. For low frequency adjectives, the rate of -er is closer to 50%. This is shown in the left-hand figure below, from Boyd (2007), which plots comparatives from the British National Corpus. We argue that this effect of frequency is a result of speakers’ ability to explicitly store the comparative form(s) of an adjective. As a speaker is exposed to more instances of a given comparative, that comparative will be stored more strongly in the speaker’s lexicon. The speaker will be less likely to forget it, and more likely to use it rather than compose the comparative anew.

Model description: Storage of comparatives in the lexicon is modeled with UR constraints of the form: PRETTY + COMPARATIVE → /pøiri/ (Boersma 2000, Pater et al. 2012)
This constraint assigns a violation whenever the word pretty in the comparative is realized with more rather than with -er. UR constraints are situated within a MaxEnt grammar (Goldwater & Johnson 2003), which also contains two phonological constraints— one preferring more and one preferring -er— which stand in for the complex array of phonological variables discussed above. UR constraints are induced, and sometimes forgotten, during learning. Learning proceeds gradually, sampling one word at a time based on lexical frequency. If the learner makes an error on a word, it uses the delta rule (Rumelhart & McClelland 1986) to update existing constraints, and also creates a new UR constraint if necessary. Weights of UR constraints decay over the course of learning, so that ones that are never updated eventually disappear. UR constraints affiliated with lower frequency lexical items are more fragile, since opportunities to update on those lexical items are rare.

The starting data was a toy dataset of 100 lexical items, varying in frequency according to a zipfian distribution. The first generation saw data in which every word had a 50% chance of appearing with -er. Each generation trained for 10,000 updates, with a learning rate of 0.1 and a decay rate for UR constraints of 0.0001 (the weight of a UR constraint that is not updated for 5 updates would decay by 0.0005). UR constraints, when induced, had a starting weight of 1. Each generation trained on the end-state of the previous generation’s learning, and the model ran for 20 generations. The right-hand graph below shows the results of the final generation.

Since UR constraints of high-frequency lexical items are updated often, small mismatches between the input and the result of learning at each generation magnify into very pronounced differences between individual high-frequency lexical items. Lower-frequency lexical items remain undecided, since their UR constraints tend to decay away.

**Conclusion:** We model two aspects of lexical idiosyncrasy in English comparatives: its historical development, and its interaction with frequency. Crucial to the success of our model is the use of UR constraints to ‘store’ both -er and more forms of the comparative. Because of this storage ability, lexical idiosyncracy emerges across multiple generations of learning.
Segmental blocking in dissimilation: an argument for co-occurrence constraints

Until recently, most contemporary work has assumed that dissimilation is motivated by segmental or featural co-occurrence (OCP) constraints (e.g. Alderete 1997, Suzuki 1998): a process that maps /l...l/ to [...r] (for example) would be explained by positing a ban on co-occurring [l]s. The framework of Agreement by Correspondence (ABC: Rose & Walker 2004; Hansson 2010, a.o.), however, offers a novel way of analyzing dissimilatory processes: they avoid an otherwise required correspondence relation (Walker 2001:542; Bennett 2015). As demonstrated by Bennett (2015), correspondence-based approaches to dissimilation make predictions that diverge from those of OCP-based analyses. One difference concerns the typology of segmental blocking effects (Bennett 2015), a term used to describe cases in which a dissimilatory process is blocked by some segments, but not others. For example, dissimilation might apply across some intervening segment Z (X...Z...X → X...Z...Y), but not across some other segment Y (X...Y...X → X...Y...X).

This paper (i) summarizes the typology of segmental blocking effects, (ii) shows that an OCP-based analysis predicts all and only the attested effects, and (iii) shows that current correspondence-based theories of dissimilation (Bennett 2013, 2015) overgenerate: while they are (with modifications) able to generate all observed blocking patterns, many of the additional predicted patterns are not observed. I conclude that the typology of segmental blocking effects provides a reason to favor OCP-based analyses of dissimilation over the correspondence-based alternatives.

(i) Typology. Bennett’s (2013, 2015) large survey of long-distance dissimilatory processes uncovered three that clearly exhibit segmental blocking effects: liquid dissimilation in Latin, Georgian, and Yidiny. (Several less clear cases, presented in Bennett’s 2015 appendix, will also be discussed.)

Latin & Georgian. In Latin, the suffix /–alis/ can be realized as [–āris] if the stem it attaches to contains an /l/ (1b), cf. (1a); data from Perseus Digital Library. But when /t/ intervenes between the trigger (stem) and target (suffixal) /l/, liquid dissimilation is blocked (1c). /t/ only blocks when it intervenes: as shown in (1d), a non-intervening /r/ does not block dissimilation. (The claim that non-coronals also block (Cser 2010; Bennett 2013, 2015) is not supported by the data: a full statistical analysis shows that this effect is confounded with other factors (also Zymet 2014).)

| 1a. | nāv+ālis → nāvālis (...l → ...l) | ‘of ships, ship’, nautical, naval’ |
| 1b. | famu+ālis → famulāris (l...l → l...r) | ‘of servants, belonging to slaves’ |
| 1c. | plūr+ālis → plūrālis (l...r...l → l...r...l) | ‘belonging. . . to more than one. . . ’ |
| 1d. | rēgul+ālis → rēgulāris (r...l...l → r...l...l) | ‘of or relating to a bar’ |

Georgian liquid dissimilation (Fallon 1993) is the mirror image of the Latin pattern. A number of /t/-containing suffixes (e.g. /–uri/, as in [svan-uri] ‘Svan’) are realized with an [l] when attached to a stem containing an /l/ (/german+uri/ → [german-uli] ‘German’). Dissimilation is blocked when an /l/ intervenes between the target and trigger /l/s /last’ral+uri/ → [ast’ral-uri] ‘astral, of the stars’), but not when an /l/ precedes the trigger (/bulgar+uri/ → [bulgar-uli] ‘Bulgarian’).

Yidiny. In Yidiny (Dixon 1977:98ff), /l...l/ across a morpheme boundary surfaces as /r...l/ (magi+i+ŋal → magi-riŋal ‘went climbing up with’, cf. magi+i+l ‘climbed up’). If the heteromorphemic /l...l/ sequence is preceded by an /t/, dissimilation fails (buwa+i+ŋal → buwa-ːliŋal). Yidiny is thus unlike Latin and Georgian in that a non-intervening segment can block dissimilation.

(ii) OCP-based analysis. The patterns in (i) can be analyzed as the result of two interacting co-occurrence constraints, one penalizing co-occurring [l]s ([L]...[L], or [+lateral]...[+lateral]) and the other co-occurring [r]s ([R]...[R], or *[−lateral]...*[−lateral]). (See Kenstowicz 1994, Steriade 1995.)
To derive the Latin and Georgian patterns, I assume that *L...L and *R...R stand for families of constraints that ban the co-occurrence of [l]s and [r]s at different distances, with constraints that ban the more local violations universally dominating constraints that ban the less local violations: *L...L is shorthand for *L0L *L1L *L2L (etc.), and *R...R is shorthand for *R0R *R1R *R2R (etc.). (This proposal is identical in spirit to Suzuki’s Proximity Hierarchy; the use of syllables is a notational variant inspired by Zymet 2014.) The fact that only intervening consonants block liquid dissimilation in these systems shows us that less-local violations of *R...R and *L...L are always preferred to more local violations, so it must be the case that *L0L *R0R *L1L *R1R *L2L *R2R (etc.), as illustrated for Latin régulāris and plūrālis below. (Georgian forms are not included below, but the analysis accounts for the data presented in (i).)

<table>
<thead>
<tr>
<th>régulālis</th>
<th>*Rσ0R</th>
<th>*Lσ0L</th>
<th>*Rσ1R</th>
<th>*Lσ1L</th>
<th>*Rσ2R</th>
<th>*Lσ2L</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. régulāris</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>b. régulālis</td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>plūrālis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c. plūrālis</td>
<td>*!</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>d. plūrālis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

To derive the Yidiny pattern, I assume that *RσxR *LσyL, where x and y stand for any number: having multiple [r]s within a single word in Yidiny is worse than having multiple [l]s. Thus while *LσyL can motivate dissimilation in the general case ([l...l] → [r...l]), higher-ranked *RσxR blocks dissimilation when an [r] is present ([r...l...l] → [r...l...l], *[r...r...l], *[r...l...r]).

The OCP-based analysis predicts that the typology of segmental blocking in dissimilation should be limited to only those effects that can be analyzed as the result of competing co-occurrence constraints. For example, the analysis correctly predicts that there should be no pattern in which [m] blocks [r] dissimilation (so /r...r/ → [r...l], but /r...m...r/ → [r...r...r]) as the unattested outcome (*[r...m...l]) is not dispreferred by any available constraint. I present new data showing that words with 2+ [r]s or 2+ [l]s are underattested in the lexica of Georgian and Yidiny (see Cser 2010 on further co-occurrence restrictions on [r] and [l] in Latin); this further supports the claim that competing co-occurrence constraints are responsible for segmental blocking in dissimilation.

(iii) Correspondence. The set of segmental blocking effects predicted by correspondence-based theories does not closely resemble the typology in (i). This divergence suggests that the OCP-based approach, not the correspondence-based approach, is an appropriate analysis of blocking effects.

Undergeneration. Current correspondence-based theories of dissimilation (e.g. Bennett 2015) cannot analyze the Latin/Georgian pattern, where only intervening liquids block. I show that this pattern can be derived if a given CORR constraint stands for a distance-sensitive family of CORR constraints, with members that prefer more local correspondence dominating those that promote less local correspondence (also Zymet 2015). With this modification, CORR constraints perform the same function as the constraints in (ii): the most local illicit correspondence relation is avoided.

Overgeneration. Correspondence-based theories also generate a class of patterns that cannot be analyzed by the OCP-based account, i.e. those in which the blocking behavior of some consonant cannot plausibly be attributed to a co-occurrence constraint. For example, Bennett (2015) shows that the pattern discussed in (ii), where [m] blocks [r] dissimilation, can be derived: in short, if [m] is permitted to correspond with the two [r]s, then under certain conditions dissimilation can be avoided. But as is evident from (i–ii), segmental blocking that is not attributable to a co-occurrence constraint is unattested. The correct theory of dissimilation should therefore avoid predicting it.
Characterizing and learning unbounded stress patterns with a restricted logic and enriched strings

We examine the characterization and learning of grammars defined by logical expressions which are the Conjunction of Negative and Positive Literals (CNPL) with unbounded stress patterns. Expressions that are the Conjunction of Negative Literals (CNL) only ban ill-formed sub-structures (Rogers and Pullum, 2011). Since the stress patterns require stress, CNL expressions are not sufficiently expressive to describe unbounded stress patterns (Heinz, 2014). We show that they can be described with CNPL logic and that such expressions (including ones for unbounded stress patterns) are learnable from positive data. Formal languages described by CNPL logic have not yet been carefully investigated, and our motivation for studying them is that certain phonological sub-structures seem to be required, rather than banned. This is precisely what the conjoining of positive literals contributes.

If stress always falls a fixed distance from the right or left word edge, the pattern is said to be bounded. Unbounded stress patterns are those that are not bounded. In one unbounded pattern, stress falls on the leftmost heavy syllable or on the rightmost syllable if there is no heavy syllable. This is called LHOR (Leftmost Heavy, Otherwise Right) (Hayes, 1995).

Heinz (2014) shows that these simple unbounded patterns are not describable by CNL expressions. They are describable with propositional logic with the alphabet \( \Sigma = \{H, L, \hat{H}, \hat{L}\} \) where the literals are interpreted as subsequences. Informally, string \( u \) is a subsequence of string \( v \) if \( u \) can be ‘revealed’ by erasing zero or more letters of \( v \) (so order is preserved). For example, \( \hat{H}H \) is a subsequence of \( L\hat{H}L\hat{L}HL \) but \( H\hat{H} \) is not. Table 1 shows the permissible and forbidden subsequences of length 2 for LHOR.

<table>
<thead>
<tr>
<th>Permissible</th>
<th>Forbidden</th>
</tr>
</thead>
<tbody>
<tr>
<td>LL HH LL HL</td>
<td>LH ŁH ŁL LL</td>
</tr>
<tr>
<td>LH HH LH HL</td>
<td>HŁ HŁ HL HŁ</td>
</tr>
</tbody>
</table>

Table 1: Permissible and forbidden subsequences of length 2 for LHOR

Propositional logic is more expressive than CNL because it allows conjunction and disjunction of both negative and positive literals. However, there are two arguments against a computational theory of stress which assumes full propositional logic. First, the expressivity of the theory may significantly overgenerate the attested typology. Second, the greater expressivity may increase the time and/or data complexity needed to learn these stress patterns. CNPL offers an alternative that circumvents both problems.

In traditional string models each position in the string has a single property, indicating which symbol in the alphabet \( \{H, L, \hat{H}, \hat{L}\} \) it represents. We consider an enriched model with the set of properties \( \Sigma = \{\text{light, heavy, stress}\} \), allowing positions to have more than one property. For example, in the model of the word \( LL\hat{H}L \), the third position has the properties heavy and stress. This model faithfully captures the linguistic truism that stress is an additional aspect of syllables. Figure 1 summarizes the types of domain elements our model generates. The symbol we use in-text for shorthand is shown below each structure.

To illustrate our approach, we now construct a new expression that also describes LHOR exactly. Every word must have at least one syllable (regardless of quality) and one stressed...
syllable. These positive literals are \( \sigma \) and \( \dot{\sigma} \), which represent sub-structures shown in Figure 1. Crucially, these sub-structures are underspecified; a stressed heavy and a stressed light both contain \( \dot{\sigma} \) as a sub-structure.

A stressed light is only permissible if it is the final syllable, so one of the banned sub-structures is a stressed light followed by any other syllable: \( \dot{\sigma}L \). Again, this sub-structure is underspecified, matching four of the forbidden subsequences in Table 1: \( \dot{\sigma}H, \dot{\sigma}L, \dot{\sigma}L \), and \( \dot{\sigma}\dot{\sigma} \). Additionally, a word cannot have a heavy syllable followed by any stressed syllable: \( H\dot{\sigma} \) is banned. This effectively bans the remaining four forbidden subsequences from Table 1: \( HH, HH, HL, \) and \( HL \). Thus the LHOR pattern is described by a CNPL as in (1).

\[
\phi_{\text{LHOR}} = \sigma \land \dot{\sigma} \land \neg\dot{\sigma}L \land \neg H\dot{\sigma}
\] (1)

Expressions of negative literals \( (\neg\dot{\sigma}L \land \neg H\dot{\sigma}) \) and positive literals \( (\sigma \land \dot{\sigma}) \) can be translated into the sets of permissible and required sub-structures, and vice versa. The learning algorithm does just that. It identifies the target CNPL expression by simultaneously building two sets: one for permissible sub-structures \( (G_{\text{per}}) \) (as in Heinz 2010) and another for required sub-structures \( (G_{\text{req}}) \). \( G_{\text{per}} \) develops a grammar of permissible sub-structures by first presupposing the null grammar \( (G = \emptyset) \). It then identifies the sub-structures of size \( k \) or smaller of the first datum and adds these to the grammar. It then takes the union of this with the set of permissible \( k \)-sub-structures of the following datum and so on. On the other hand, \( G_{\text{req}} \) takes the intersection of the sets of \( k \)-sub-structures of each datum, thereby identifying those sub-structures required of all strings. In the paper, we present a step-by-step demonstration of the learning algorithm.

We showed how CNPL expressions with enriched models of strings can characterize simple unbounded stress patterns. In contrast to Heinz (2014), this allows the fact that stress is required to be learned instead of given \( a \) \( \text{priori} \). The learning algorithm presented successfully identifies CNPL expressions from positive data by building sets of permissible sub-structures and required sub-structures. Additionally, the word model helps reduce the time and data complexity of learning.

The correlation between rendaku and accent in Japanese surnames: A foot-based account

Outline: Rendaku in surnames is inversely correlated with accent: names with rendaku tend to be unaccented and those without rendaku accented. I propose that the correlation arises from a conflict between constraints on foot structures. Compound surnames are treated like single stems and can contain only one foot, which results in antepenultimate accent. Rendaku, on the other hand, must be realized between two feet, which derives unaccentedness (Ito & Mester 2016).

Background: Japanese surnames with a compound structure may undergo rendaku, which voices the initial obstruent of the second element (e.g. /yama+ta/ → yama-da). Previous studies (Sugito 1965, Ohta 2013, Zamma 2005) report an inverse correlation between rendaku and accent in surnames with common second elements such as /ta/ ‘paddy’ and /kawa/ ‘river’. Although rendaku application is not entirely predictable, a name is often unaccented if it undergoes rendaku (e.g. sawa-da, miya-gawa; no accent mark indicates no accent), otherwise it is mostly accented (e.g. mőri-ta, kurő-kawa). No study has proposed a formal analysis of the patterns or an explanation of why the correlation is found in proper names such as surnames and island names (Tanaka 2005) but not in regular compounds (except in some particular verbal constructions; Yamaguchi 2011).

Analysis: I propose an account based on metrical feet. Compound surnames do not follow the usual compound accent rule which places accent near the boundary of the two elements: e.g. mőri-ta, *mörï-ta. I argue that, although a compound surname is composed of two stems, the whole compound is also treated as one single stem, since it is semantically one single name. I further posit that, just like stem nouns, three-syllable compound names receive antepenultimate accent with a bimoraic trochaic foot and a final extrametrical syllable (Ito & Mester 1992/2003) as in “(mőri)-ta”. In order to formally implement the idea, I propose a constraint STEMFOOT, which prohibits a stem from containing multiple stems having their own feet. The constraint is violated by a compound name with exhaustive footing as in “(mőri)-(ta)” since a stem (namely, the whole compound) contains two independent stems with their own feet. (Note that the constraint is usually satisfied by any normal stem that is composed of a single stem.) A high ranking of this constraint ensures that a compound surname has a stem-like foot structure as in “(mőri)-ta”.

It looks as though accented compound names of four syllables have accent near the morpheme boundary, following the normal compound accent rule: e.g. kurő-kawa. However, instead of positioning feet aligned with the boundary as is usually suggested for regular compounds (Kubo-zono 1995, 1997; Tanaka 2001), I propose that a four-syllable accented surname has a single foot that spans across the boundary between the two elements as in “ku(rő-ka)wa”. Notice that “(kurő)-(kawa)” with exhaustive footing would contain two stems with their own feet, violating STEMFOOT. Again, compound surnames receive antepenultimate accent (which happens to be at the edge of a morpheme in the case of four-syllable names) with extrametricality, just like accented regular stems.

Why, then, do names become unaccented when they undergo rendaku? First, I propose a constraint which requires rendaku voicing to be realized only between two full-fledged stems with their own feet. Following Ito & Mester (2003), I assume that rendaku is a realization of a feature-sized morpheme [+v] which links two stems in compound formation. The proposed constraint requires that each of the combined stems be minimally a foot in order for such a linking morpheme to be realized (see Rosen 2003 for a similar idea). I will refer to this constraint as LINKFOOTEDSTEMS. If the constraint is ranked high in the grammar, rendaku can be realized in surnames of three or four syllables only when they are exhaustively footed as in “(yama)-(da)” and “(miya)-(gawa)”.

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I claim that this exhaustive footing required for a realization of the linking morpheme is the cause of unaccentedness in surnames with rendaku. Ito & Mester (2016) (henceforth IM16) propose that unaccented words in Japanese are derived to resolve the tension between the constraints NONFINALITY(Ft’), which bans a head foot from occurring at the right edge of a prosodic word, and RIGHTMOST, which requires a head foot to be the rightmost foot. Under their analysis, a word which consists of four light syllables is exhaustively footed into two feet as in “(σσ)(σσ)”. Note that placing accent in either foot would violate one of the above constraints. If the two constraints outrank WORDACCENT, which requires a prosodic word to have a prominence peak, the conflict is resolved by rendering the word unaccented. Adopting the constraint ranking “NONFIN(Ft’), RIGHTMOST ≫ WDACC” proposed by IM16, I argue that surnames with rendaku get unaccented due to exhaustive footing enforced by another high-ranked constraint LINKFOOTEDSTEMS.

The proposed analysis thus explains why rendaku and accent do not cooccur. High-ranked STEMFOOT makes compound surnames have a single trochaic foot with a final extrametrical syllable, which results in antepenultimate accent: e.g. “(mōri)-ta”, “ku(rō-ka)wa”. Also high-ranked LINKFOOTEDSTEMS prohibits rendaku from being realized in such surnames with a single foot as in *“(mōri)-da”, **“ku(rō-qa)wa”. This suggests that STEMFOOT and LINKFtSTEMS outrank REALIZEMORPHHEME, which requires the linking morpheme to appear on the surface.

Certain surnames do undergo rendaku, however. Although rendaku in surnames can be triggered by phonological factors such as Identity Avoidance (Tanaka 2016), some of the variation is entirely based on lexical idiosyncracy. Here, I simply assume that there are subgrammars of Japanese with slightly different constraint rankings along the lines of IM16. A subgrammar with the ranking LINKFtSTEMS, REALIZEM ≫ STEMFOOT enforces rendaku application at the cost of creating two footed stems within a name (i.e. a violation of STEMFt) as in “(yama)-(da)” and “(miya)-(gawa)”, and the exhaustive footing in turn causes unaccentedness as discussed above.

The rendaku-accent correlation should not arise in regular compounds since each element of a compound is usually required to form a foot by high-ranked LEXICALFOOT (IM16). Regular compounds thus always satisfy LINKFOOTEDSTEMS, and rendaku application and footing do not affect each other. Compound surnames, on the other hand, are treated as single stems and need to have a stem-like foot structure due to the ranking STEMFt ≫ LEXFt, except when the surname is prone to rendaku. In other words, the inverse correlation between rendaku and accent is the tension between the realization of a linking morpheme, which requires exhaustive footing, and the stem-like parsing of a compound, which bans such a foot configuration specifically in names.

The generalization of the correlation has some exceptions (Zamma 2005). Certain surnames can show rendaku and be accented (e.g. hāra-da) or show no rendaku and be unaccented (e.g. mura-ta). The analysis can also capture such less common patterns with some minimal constraint rerankings. A subgrammar in which REALIZEM outranks STEMFt, and NONFIN and WdACC outrank RIGHTMOST (IM16), “(hāra)-(da)” with rendaku and antepenultimate accent will be the optimal candidate. Similarly, if IDENT(voice), which bans a voicing change, outranks REALIZEM, and LEXFt outranks STEMFt, “(mura)-(ta)” without rendaku or accent will be the winner.

Conclusion: I have proposed a formal account of the rendaku-accent correlation in surnames. The correlation arises from the conflict between two forces: a compound surname must be prosodically parsed as a single stem, but rendaku must apply in a compound, which also requires a specific prosodic shape. The analysis reveals the structural reasons for the correlation and answers the question of why the patterns are found only in a specific area of the lexicon, namely, proper names.
**Phonological development and children’s variable acceptability judgments of onset clusters**

**Background** How does phonological perception develop in childhood? Infant studies have demonstrated that children acquire language-specific discriminations skills for phonemes and phonotactics before their first birthday (e.g. Werker and Tees, 1984; Jusczyk et al, 1993), and behavioral evidence suggests that toddlers can perceive the difference between the target form of familiar words and subtle mispronunciations (e.g. Swingley, 2009; Berko and Brown, 1960). At the same age, however, young children’s production is much more simplified and restricted, and many researchers assume two mental representations of phonological knowledge – one grammar for perception and another for production (for example, Menn and Matthei, 1992).

While children’s perception usually appears to develop much faster toward the adult target than production, it is not perfect (e.g. Macken, 1980). Moreover, developing adult-like perception also requires some flexibility – to be used e.g. when decoding non-native accents, a skill which begins developing around ages 4-7 (e.g. Nathan et al, 1998, Bent, 2014). Rather little is actually known about how flexible or restrictive children’s perception grammars are (cf. McAllister Byun, 2015) For example: do they produce adult-like acceptability judgments?

**Experiments** To study the development of childhood perception we focus here on English onset clusters, whose trajectories in production have already received extensive scrutiny. This literature shows that kids’ earliest cluster productions are typically reduced, via consonant deletion or fusion (e.g. Smith, 1973; Gnanadesikan, 2004); later they may produce epenthesis as well as other segmental modifications before reaching adult-like mastery. Along the way, English [s]-initial and especially [s]-stop clusters may often pattern differently from other onset clusters (e.g. Pater & Barlow, 2003; Goad & Rose, 2004).

The present work reports production and perception data from seven monolingual children ages four to seven (mean age: 5;6). In the first task each child produced 22 words with word-initial clusters, elicited with cartoon pictures. Half of the words began with an sC cluster, while the rest were other fricative, stop and nasal-initial clusters (1). In the second task, children played a perception game: on each trial, two aliens (Boo and Tee) who were learning English both labeled the same cartoon pictures, and the child’s task was to indicate “who said it best”. On every trial one of the aliens produced the cluster correctly, and the other produced it either with one consonant deleted or with an [ɪ] epenthesized before or after C1. Clusters were represented in two different words, each seen twice during the game, and the items were counterbalanced across multiple lists so that children heard all four possible repairs for each cluster (see 2):

<table>
<thead>
<tr>
<th>(1)</th>
<th>s+stop</th>
<th>s+nasal</th>
<th>s+approx.</th>
<th>f+approx.</th>
<th>stop+approx</th>
<th>C+glide</th>
</tr>
</thead>
<tbody>
<tr>
<td>spoon</td>
<td>smoke</td>
<td>slide</td>
<td>frog</td>
<td>plate</td>
<td>piano</td>
<td></td>
</tr>
<tr>
<td>spaceship</td>
<td>smiling</td>
<td>sleeping</td>
<td>freezer</td>
<td>planet</td>
<td>music</td>
<td></td>
</tr>
<tr>
<td>skis</td>
<td>snake</td>
<td>swing</td>
<td>flip</td>
<td>clock</td>
<td></td>
<td></td>
</tr>
<tr>
<td>skateboard</td>
<td>snowman</td>
<td>swimming</td>
<td>flower</td>
<td>closet</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2a)</th>
<th>2b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>List1</td>
<td>Boo</td>
</tr>
<tr>
<td>flip</td>
<td>[ɪ][f]-lip</td>
</tr>
<tr>
<td>List2</td>
<td>flip</td>
</tr>
</tbody>
</table>

**Results** Our central finding is that though these children were all very proficient in production – no deletion or epentheses was used, and nearly every cluster were segmentally accurate – their
performance on the perception game varied widely. Children’s overall average accuracy in choosing the correct alien’s production was 74% (see 3), with a trend for improved performance at older ages. They overwhelmingly picked the correct cluster when it was paired with (2b) deletion (120/132 correct trials) although one child (6F) rejected deletion only 15/22 times. However, children were much more tolerant of epenthesis: only 66/133 such trials were correct, and all six participants insisted on many (2a) trials that both aliens had produced the target word equally well. The number of accurate epenthesis trials ranged from 17/22 to only 3/22 (see 4):

(3) % perception accuracy (44 trials per child) (4) Raw accuracy on deletion vs. epenthesis

**Discussion** Why are young children apparently so tolerant of non-target epenthesis into familiar onset clusters – even when explicitly paired with a target-like pronunciation? Do these results reflect anything about their phonological knowledge? Several facts suggest they do. First: the sole child who chose reduced clusters showed a positional effect, in that six of her seven accepted reductions involved C2 deletion (e.g. *flower~flower*, not *flower~lower*). Another positional effect can be seen across all 67 epenthesis errors: sC clusters were nearly twice as likely to be accepted with initial epenthesis (24 errors like *is-lide*) rather than medial epenthesis (13 errors like *si-lide*), mirroring previous L2 evidence (e.g. Broselow, 1983) whereas other cluster epentheses were equally split (14 initial errors vs. 16 medial errors). Additionally: ongoing acoustic analysis of children’s cluster production has yet to reveal any predictor of their acceptability judgments. For example: the two children who accepted the most deletion (6F) vs. the most epenthesis (4M) produced no differences in mean segment duration in their clusters.

Our overall results indicate that perceptual cluster judgments from four to seven year olds are phonologically-governed, in keeping with known preferences (e.g. Fleischhacker 2001; Farris-Trimble, 2008), but that they also demonstrate wide inter-listener variation. Further work is necessary to determine how perception continues to develop in the later stages of acquisition, and to integrate these results with existing theories of perception and production grammars.


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1 6M got 32/33 correct before becoming irritated with the task.
A Dispersion-Theoretic account of Taiwanese CV phonotactics

This study aims to provide an account of Taiwanese CV phonotactics, with a focus on the co-occurrence restrictions of voiced stops and nasal vowels. In Taiwanese, vocalic nasality is phonemic and is contrastive in almost all contexts (e.g., pi̍h55 ‘sad’ vs. pì̍h55 ‘side’). However, nasal onsets are only followed by nasal vowels (i.e., mā̍h55 ‘mom’ vs. *ma). Other languages with phonemic nasal vowels, such as French and Portuguese, do not have such restrictions (e.g., in French, /bɛ/ ‘berry’ vs. /bɛ̃/ ‘bread’ and /ma/ ‘my’ vs. /mə̃/ ‘(he) lies’; from Delvaux et al., 2008).

I propose an analysis based on Flemming’s (2008) Dispersion-Theoretic framework, in which the phonological grammar is broken down into Phonemic Selection, Phonetic Realization, and Evaluation of Surface Contrasts (ESC). Phonetic Realization is the locus of the difference between Taiwanese and French, where the former requires a larger velic opening gesture than the latter. The stipulation about the difference in the velic opening gesture is supported by some phonetic studies: nasal vowels in Taiwanese have almost full nasal duration, while French and Portuguese nasal vowels often have delayed nasalization (Chang et al., 2011; Delvaux et al., 2008; Parkinson, 1983). Full nasality in Taiwanese potentially renders voiced oral stops less distinctive from nasals stops, thus forms like [b̃a] are ruled out in ESC. Also, in Phonetic Realization, Taiwanese prioritizes the protection of oral vowel against nasality, while French prioritizes the maintenance of nasal contrast in consonants.

The size of the velic opening gesture is modeled by the constraint VELICOPEN. In Taiwanese, this gesture is required to be larger than in French (VELICOPEN++). In articulatory configuration, it means that velic opening starts as soon as the stop closure gesture ends. In languages like French, the gesture is shorter (VELICOPEN+). This constraint is violated when the velic opening gesture is not as long as required. It should also be noted that both versions of VELICOPEN enforce N-to-V nasal coarticulation. The other two constraints that are relevant to the current analysis are MAX[-NASAL] and MAX[+NASAL]. MAX[-NASAL] requires oral vowels to have no nasality at all, and is only at work when a language have a phonemic nasality contrast in vowels. MAX[+NASAL] bans deletion and insertion of nasality. This constraint is ranked higher than MAX[-NASAL] in languages like French, where a the oral-nasal contrast in voiced stops is definitely phonemic.

The goal for the analysis of Taiwanese is to rule out the unattested [*ma] and [*b̃a]. [*ma] will be ruled out in Phonetic Realization since VELICOPEN++ requires nasal coarticulation, but the version with coarticulation will also be ruled out by MAX[-NASAL], which requires oral vowels to be fully oral. As for [*b̃a], VELICOPEN++ forces it to have a fully nasalized vowel, which weakens stop burst and makes it less distinctive from [mā] and will be ruled out in ESC where the distinctiveness of surface contrasts are evaluated.

In Taiwanese, the constraint ranking in Phonetic Realization is VELICOPEN++ ⇒ MAX[-NASAL] ⇒ MAX[+NASAL]. Only analyses on /bā/ and /ma/ are shown, as /ba/ and /mā/ are able to easily surface as the winner faithfully. Assuming that the inventory of stops contains /b/ and /m/, when the input is /bā/, the requirement of a big velic opening gesture forces full nasality. As for the input /ma/, requiring a big nasal gesture forces N-to-V coarticulation, which is also ruled out by MAX[-NASAL] because the integrity of the oral vowel is affected.

(1) Phonetic Realization in Taiwanese

<table>
<thead>
<tr>
<th></th>
<th>VELICOPEN++</th>
<th>MAX[-NASAL]</th>
<th>MAX[+NASAL]</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>b̃a</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>b̃a</td>
<td></td>
<td>*!W</td>
</tr>
</tbody>
</table>
For the analysis of Taiwanese, being able to go from /ma/ to [ba] is important because it is sometimes argued that /b/ and /m/ belong to the same phoneme (e.g., Pan, 2004), and both historical evidence (e.g., Norman, 1988) and the perceptual/acoustic distance of /m/ and /b/ with other stops suggests that /m/ is likely the underlying form.

The outputs of Phonetic Realization become the input in ESC, where only the realizations from the previous stage are evaluated, and the inventory is only allowed to be faithful, or to shrink by merging forms. For Taiwanese, syllables with voiced stops followed by fully nasal vowels are ruled out here. The crucial constraint is $\text{MINDIST} = \text{BURST} : 2$, which requires distinctiveness of stop burst/release, based on the scale shown in (2) that reflects the perceptual closeness of syllables containing voiced segments. The full analysis of Taiwanese ESC is shown in (3).

(2) The stop burst/release perceptibility scale in context:

<table>
<thead>
<tr>
<th>m̃</th>
<th>b̃</th>
<th>b̃</th>
<th>p̃</th>
<th>p̃</th>
<th>p̃̂</th>
<th>p̃̂</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>6</td>
<td>8</td>
<td>10</td>
</tr>
</tbody>
</table>

(3) Evaluation of Surface Contrast in Taiwanese

<table>
<thead>
<tr>
<th>{m̃a, b̃a, ba, p̃a, pa}</th>
<th>MD = BURST : 2</th>
<th>*MERGE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. {m̃a, b̃a, ba, p̃a, pa}</td>
<td>*!W</td>
<td>L</td>
</tr>
<tr>
<td>b. {m̃a, b̃a, ba, p̃a, pa}</td>
<td>**!W</td>
<td>L</td>
</tr>
<tr>
<td>c. {m̃a, pa}</td>
<td>***!W</td>
<td></td>
</tr>
</tbody>
</table>

As for languages like French, in Phonetic Realization, the constraint ranking is $\text{VELICOPEN++} \gg \text{MAX}[-\text{NASAL}]_V \gg \text{MAX}[+\text{NASAL}]$. It derives the following realizations: $\{\text{m̃a, b̃a, b̃a}\}$. Among these realizations, $\{\text{b̃a}\}$ is ruled out in ESC, which is the same for Taiwanese and French. Note that for French, $\{\text{b̃a}\}$, with delayed nasalization, does not incur additional $\text{MINDIST} = \text{BURST} : 2$ violations as it is seen as the same category as [ba], thus is a viable surface form.

The analysis has the following advantages. First, it reflects language-specific phonetic properties. Second, the presence of $\text{MAX}[-\text{NASAL}]_V$ and the ranking of $\text{MAX}[-\text{NASAL}]_V$ and $\text{MAX}[+\text{NASAL}]$ correlates with language-specific phonemic properties. Also, for Taiwanese, this analysis derives the attested surface forms regardless of which view on the phonemic nature of the nasal contrast in voiced stops is adopted. Finally, the $\text{VELICOPEN}$ constraint makes explicit predictions on the lower bound of nasal duration in attested syllable types. For example, it predicts that the minimal nasalized portion for /ma/ and /p̃a/ should be roughly similar.

References
No More Conflicting Directionality:  
Metrical Conditions on Tianjin Chinese Trisyllabic Tone Sandhi

**Introduction**  
Tianjin Chinese (hereafter Tianjin) exhibits complex interactions among its disyllabic tone sandhi rules, leading to both left-to-right and right-to-left rule applications in trisyllabic sequences (e.g. Chen 1986, Lin 2008). Which directionality to adopt for each particular sequence is arbitrary and cannot be accounted for by any known principles. Based on the results of a multi-speaker acoustic study, we propose that the seemingly ungoverned directionality of tone sandhi application can be attributed to the interaction of metrical structure and disyllabic tone sandhi. We claim that Tianjin tone sandhi rules apply when both metrical and tonal complexity conditions are satisfied, thereby removing the need for conflicting directionality.

**Background**  
Tianjin has four lexical tones: T1(11/21), T2(45/34), T3(213/214) and T4(54), and several disyllabic tone sandhi rules have been reported, as shown in (1) and (2).

(1) The four traditional disyllabic tone sandhi rules

<table>
<thead>
<tr>
<th>Tone Sandhi Rules</th>
<th>Examples</th>
<th>Glosses</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. T1+T1</td>
<td>T1+T1 → T3+T1</td>
<td>fei ji (21.21) → fei ji (213.21)</td>
</tr>
<tr>
<td>b. T3+T3</td>
<td>T3+T3 → T2+T3</td>
<td>mai ma (213.213) → mai ma (45.213)</td>
</tr>
<tr>
<td>c. T4+T1</td>
<td>T4+T1 → T2+T1</td>
<td>jiao shi (54.21) → jiao shi (45.21)</td>
</tr>
<tr>
<td>d. T4+T4</td>
<td>T4+T4 → T1+T4</td>
<td>jiao shou (54.54) → jiao shou (21.54)</td>
</tr>
</tbody>
</table>

(2) The two newly reported tone sandhi rules

<table>
<thead>
<tr>
<th>Tone Sandhi Rules</th>
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<th>Glosses</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. T3+T2</td>
<td>T3+T2 → T1+T2</td>
<td>fen hong (213.45) → fen hong (21.45)</td>
</tr>
<tr>
<td>b. T3+T4</td>
<td>T3+T4 → T1+T4</td>
<td>kuan dai (213.54) → kuan dai (21.54)</td>
</tr>
</tbody>
</table>

Tianjin trisyllabic tone sandhi traditionally refers to seven sequences involving two applications of the traditional sandhi rules in (1). Some patterns are derived from left to right (e.g. T3+T3→T2+T3→T2+T3), while some others are derived from right to left (e.g. T1+T1+T1→T1+T3+T1). With two new disyllabic tone sandhi reported in Wee (2004) and Zhang & Liu (2011) as in (2), there should be eight more trisyllabic sequences with two applications of disyllabic tone sandhi, but no acoustic experiments have been done on these new trisyllabic sequences.

**Experiments**  
The present study examines 15 Tianjin trisyllabic sequences that involve two applications of disyllabic tone sandhi rules in (1) and (2). The tokens contain three parts: (i) Forty monosyllabic words, ten for each of the four lexical tones; (ii) sixty disyllabic sequences, ten for each of the six disyllabic tone sandhi patterns; (iii) 144 trisyllabic sequences, 8 for each of the 15 trisyllabic combinations potentially containing two applications of disyllabic tone sandhi and 4 for each of the X+T4+T1, T4+T1+X and T4+T1+N patterns (X=any tone; N=neutral tone). Sixteen native speakers of Tianjin (M=8, F=8, Average age=21.1) took part in the experiments. All acoustic analyses were conducted in Praat (Boerma and Weenink, 2013), and all acoustic data were manually annotated. The F0 at every 10% of the rhyme duration was extracted, giving eleven F0 measurements for each syllable. For each participant, all valid tokens for each test tone pattern were averaged, so each participant contributed one set of F0 values for analyses.

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1 The transcriptions are given in “Chao numbers”. A speaker’s tonal range from low to high is represented by a numerical scale from “1” to “5” (Chao, 1968).
Results and proposed phonological analysis

Table 1 Results of 15 trisyllabic sequences

<table>
<thead>
<tr>
<th>Inputs</th>
<th>Outputs</th>
<th>Directionality</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1+T4+T4</td>
<td>T1+T1+T4</td>
<td>left→right</td>
</tr>
<tr>
<td>T3+T1+T1</td>
<td>T3+T2+T1</td>
<td>left→right</td>
</tr>
<tr>
<td>T3+T3+T3</td>
<td>T2+T2+T3</td>
<td>left→right</td>
</tr>
<tr>
<td>T1+T1+T1</td>
<td>T1+T2+T1</td>
<td>right→left</td>
</tr>
<tr>
<td>T4+T1+T1</td>
<td>T4+T2+T1</td>
<td>right→left</td>
</tr>
<tr>
<td>T4+T4+T1</td>
<td>T4+T2+T1</td>
<td>right→left</td>
</tr>
<tr>
<td>T4+T4+T4</td>
<td>T4+T1+T4</td>
<td>left→right</td>
</tr>
</tbody>
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<td>left→right</td>
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<td>T4+T4+T4</td>
<td>T4+T1+T2</td>
<td>left→right</td>
</tr>
</tbody>
</table>

Our acoustic study results show that T1+T1 becomes T2+T1, which is different from the traditional description in (1a). Table 1 shows that there are only three cases of right-to-left sandhi rule application. Assuming that Tianjin trisyllabic sequences have the metrical structure as in (3) (cf. Shi 1988, Huang, Yan & Lu 2005), the right-to-left directionality can be dispensed with.

(3) Tianjin trisyllabic metrical structure

(1=primary stress, 2=secondary stress, 3=weak syllable)

2 3 1
tu shu guan (library)

As shown in the underlined sequences in Table 1, tone sandhi applies when T1+T1, T4+T1 and T4+T4 are right-aligned in a trisyllabic sequence; however, tone sandhi does not apply when they are left-aligned even when sandhi conditions are met. When T1+T1, T4+T1 and T4+T4 are left-aligned, the first tones are on the secondarily stressed syllable and keep their underlying tone. When they are right-aligned, the first tones are on the weak syllable and hence undergo tone sandhi. This metrically-based analysis is further supported by our experimental results showing that T4+T1 in X+T4+T1 (X=any tone) always undergoes tone sandhi, but that in T4+T1+X never does. However, in a T4+T1+N sequence (N=neutral tone) where the metrical structure becomes [weak-strong-weak], the left-aligned T4+T1 does undergo tone sandhi since T4 is in a weak position. In comparison, tone sandhi for T3+T3, T3+T2, and T3+T4 is consistently applied regardless of their edge alignment in a trisyllabic sequence. We propose that this difference in response to metrical conditions can be attributed to the difference in tonal complexity. According to Yip (2002: 27-30), tonal complexity order is rising, falling, high and low.

(4) Order of tonal complexity (Yip 2002:27-30): Rising>Falling>High>low

T3 (213) is the most complex tone in Tianjin, and we suggest that it is retained only when it occupies the prosodic head (i.e. the third syllable). Therefore, a T3 in the first or second syllable that satisfies the sandhi condition (i.e. T3+T3, T3+T2, and T3+T4) undergoes tone sandhi in left-to-right rule application, as shown in Table 1.

Conclusion We conclude that the seemingly irregular directionality in Tianjin trisyllabic tone sandhi application does not exist if metrical structures and differences in tonal complexity are taken into consideration. Tianjin thus provides a case study demonstrating how metrical structure and tonal properties interact to influence tone sandhi rule applications beyond the typical disyllabic domain.
Title: The role of phonological phrasing in Vietnamese lục bát meter

The Vietnamese epic poem Truyện Kiều (or Kiều) is written in the lục bát (six-eight) verse form, a famous meter popular for its regularity in rhythm, tone pattern, and rhyme. It is traditionally described as being composed of couplets containing a 6-syllable line followed by an 8-syllable line. Within each couplet, syllables are specified for one of two tone categories: flat tones (ngang or huyện), or sharp tones (sắc, nặng, hỏi, or ngã). The poet also employs a popular rhyming scheme of the lục bát verse form. This is illustrated schematically in (2).

(1) Lục bát Rhyming Scheme

\[
\begin{array}{cccccc}
\sigma & \sigma & \sigma & \sigma & \sigma & A \\
\sigma & \sigma & \sigma & \sigma & \sigma & A & \sigma & B \\
\sigma & \sigma & \sigma & \sigma & \sigma & B \\
\sigma & \sigma & \sigma & \sigma & \sigma & B & \sigma & C \\
\end{array}
\]

The traditional description is fairly detailed in terms of tones and rhyme, but offers little in terms of rhythmic specifications. Apart from the macro-level rules on syllable numbers in each line of the couplet, there are no further specifications on line-internal structure in the lục bát meter. However, as the theory of phonological phrasing asserts, languages do not simply count out linear strings of phonological material. Rather, this material is organized into a prosodic hierarchy in which rhythmic units of various sizes are nested under larger rhythmic units (Nespor & Vogel, 1986). That is, utterances are composed of one or more intonational phrases, intonational phrases are composed of one or more intermediate phrases, intermediate phrases are composed of one or more feet, etc. This is paralleled by the classical layering theory of structure in meter, in which metrical units (i.e. syllable, foot, hemistich, line, couplet) are also hierarchically organized (e.g. Hayes, 1989).

In this paper, I present evidence for tacit rhythmic structure in Kiều missed by traditional scholarship, showing that the lục bát meter does have hierarchical metrical organization beyond macro-level syllable counts. Specifically, I assert that the poem has a largely iambic structure, in which two syllables form a foot, two feet form a hemistich, and two hemistich form a line. This can be most clearly observed in the 8-syllable line, schematized below. (The full presentation also covers the 6-syllable line, which involves further complications.)

(2) Rhythmic structure of the 8-syllable line

This hypothesis was tested in a preliminary study, in which a juncture profile was created for the first 204 lines of the 3254-line poem based on glosses obtained from work with a language consultant as well as existing punctuation in the text. The data was numerically coded for break size after each syllable on a four-level scale, where 4 is the largest break (end of Intonational Phrase) and 1 is the smallest break (word-internal). The 6-syllable line ended almost exclusively with level 3 breaks, marking the end of the first line in a couplet, while the 8-syllable line ended almost exclusively with the largest break size (level 4), marking the end of the couplet. Although the between-word level break (level 2) was most prevalent within lines, variation in the frequency of different break levels revealed smaller rhythmic units. For example, after the fourth syllable in the 8-syllable line, the number of level
3 breaks increased, indicating the division between two hemistich. Binary foot structure can also be observed as the frequency of within-word breaks (level 1) increased after odd syllables and decreased after even syllables. Thus, the left and right edges of non-decomposable binary words tended to align with the left and right edges of metrical feet. Additionally, the frequency of level 1 breaks increased before the ends of larger metrical structures (i.e. before the end of a line or couplet), showing that there is also a tendency to have disyllabic words in these positions to mark line-final bridges. In sum, there is a systematic echoing of metrical structure by phonological phrasing, throughout the hierarchy of (2).

This descriptive analysis was formalized and tested using a MaxEnt model (Goldwater & Johnson, 2003). The GEN component included all possible combinations of break level sequences for the 6-syllable line (4^6 candidates) and the 8-syllable line (4^8 candidates). The CON component consisted of all 25 logically possible Prominence Alignment Constraints (Prince & Smolensky, 1993 based on the Generalized Alignment Theory from McCarthy & Prince, 1993), specifically aligning all prosodic categories with all metrical categories. I also included a general markedness constraint that disfavors level 1 breaks in all positions. Constraint weights were computed using OTSoft (Hayes et al., 2013), and the model was pared down using likelihood ratio tests. A large number of constraints (21) remained in the model, having obtained significant weights, and the final constraint set predicted 91% of the variation in the data (r^2 = 0.91) as shown below.

(3) Model fit: observed vs. predicted probabilities

![Model fit graph](image)

References:


The realization of mutation in Chinese dialects

**Overview:** This paper introduces two different mutation processes in two Chinese dialects. Though mutation can be analyzed in various ways, such as MAXFLT (Wolf 2007) and REALIZEMORPHEME (Kurisu 2001), neither of these approaches can adequately explain both cases in question. More generally, a parallel analysis cannot show certain crucial intermediate outputs. This paper argues for an alternative machinery (MAX-E) which can provide a unified account for the data in two dialects, and also shows the preference of a serial analysis to a parallel one.

**Data:** ‘-zi’ (pronounced as [tsi]) is a highly productive derivational suffix in Mandarin Chinese. In certain dialects it is realized as a featural or moraic affix, which can be viewed as mutation. Two types of zi affix from Heshun Chinese (Tian 1986) and Yangcheng Chinese (Hou 1985) are shown in (1). Lin (1989, 1993) analyzes these data in rule-based approach, and proposes that the lengthening is due to the incorporation of an affixal mora, while the change of vowel quality in Yangcheng is attributed to the suffixification of two floating features. Due to the requirement of monosyllabic output, *[μµz]*, and the pressure to manifest the affixal mora (indexed as ‘*µz’*), Lin (1993) proposes the derivation in (2), in which the incorporation of the affixal mora makes one mora in the stem extraprosodic and then deleted.

**Problem:** Mutation can be analyzed by various constraints such as MAXFLT (Wolf 2007), which requires the floating elements be docked properly, and REALMORPH (Kurisu 2001), which requires the output be different from the input. However, MAXFLT cannot motivate the attested output (2c). Three crucial candidates are shown in (3), in which (3a) harmonically bounds (3b) and (3c). Kurisu’s RM could produce the expected output of Heshun affixation, but its major drawback is that it cannot well handle the multiple exponentence in Yangcheng.

**Proposal and Analysis:** This paper provides a unified account for the realization of mutation in both Heshun and Yangcheng, and proposes that the constraint MAX-E (Kimper 2009) is the major driving force for realizing the mutation-triggering morpheme. Following the proposals of Wolf (2008), Kimper (2009) etc., a morpheme is associated by a morph, which contains ordered pairs

\[
\begin{array}{c|c|c}
\text{Heshun} & \text{Yangcheng} & \text{(1)} \\
\text{stem} & \text{zi-affixed} & \text{stem} & \text{zi-affixed} \\
t^3\text{aj} & t^3\text{a:j} & \text{‘bag’} & t^\text{j}:e & \text{t}^\text{j}:\text{o} & \text{‘blanket’} \\
t^\text{l} \text{a} & t^\text{l} \text{a}:w & \text{‘sleeve’} & c^\text{j} & c^\text{j}: & \text{‘the blind’} \\
\text{l} \text{i} \text{n} & \text{l} \text{i} & \text{‘collar’} & t^\text{sw} & t^\text{sw}: & \text{‘claw’} \\
\text{affix: } \mu & \text{affix: } \mu, [+\text{bk}], [+\text{rd}] & \\
\end{array}
\]

\[
\begin{align*}
(2) & \quad \mu & \mu & \mu & \mu \\
& \quad \mu & \mu & \mu & \mu \\
& \quad \mu & \mu \\
& \quad \mu & \mu \\
\end{align*}
\]

\[
\begin{align*}
a. & \quad \mu \quad \mu \quad \mu \\
b. & \quad \mu \quad \mu \quad \mu \\
c. & \quad \mu \quad \mu
\end{align*}
\]

\[
\begin{align*}
(3) & \quad \mu \quad \mu \quad \mu \\
& \quad \mu \quad \mu \quad \mu \\
& \quad \mu \quad \mu \\
& \quad \mu \quad \mu
\end{align*}
\]

\[
\begin{align*}
(4) & \quad \text{MORPH} & \quad \text{Zi} & \quad \text{INSERT(µ)} & \quad \text{INSERT([+bk])} \\
& \quad \quad \quad & \quad \quad & \quad \quad & \quad \quad
\end{align*}
\]
of features \((F)\) and exponents \((E)\). The exponents provide the phonological expression, which can be operations (such as ‘INSERT’). The morph structure for Yangcheng ‘zi’ is given in (4). As is shown in (4), the feature corresponds to multiple exponents, and the morpheme is realized phonologically by maximally preserving the correspondence relation between the feature and the exponent. Kimper (2009) proposes that the exponents will be protected by a MAX constraint, i.e. MAX-E, and this paper further proposes that this constraint can be indexed and ranked in order to protect the designated correspondence relation. Harmonic Serialism is adopted in this approach, which can produce the intermediate output such as (2b), and this will lead to the attested output.

In Heshun, there is only one exponent in the morph of morpheme zi, and this exponent will be protected by MAX-E. The constraint ranking for Heshun is given in (5) and the optimal derivation is shown in (6). High-ranked MAX-E ensures the incorporation of mora in the first step, with consonant germination and vowel lengthening penalized by the constraints \(*\text{GEMINATION}(*\text{GEM})\) and \(*\text{LONG VOWEL}(*\text{LV})\) respectively, and (6a) is selected as optimal. In the second step, the trimoraic output is banned. At the same time, ALIGN-R(\(\mu_z, W_d\)) (cf. Davis and Ueda 2002), which favors the floating mora to be a suffix, is used to decide which mora should be deleted. Next, the coda in the intermediate output (6b) links to a mora under the pressure of \text{WEIGHT-BY-POSITION} (WBP), generating (6c). Then the analysis converges as (6d). For the case of Yangcheng, a similar analysis can be conducted. The high-ranked MAX-E constraints for \(\mu_z, [+\text{back}]\) and [+round] will ensure the realization of multiple exponents. The crucial constraints and intermediate outputs for Yangcheng ‘cja → cjo’ are given in (7) and (8) respectively.

\[
\begin{align*}
\text{(5) } & \quad \text{MAX-E, *FLOAT, *GEM} >> \{[\mu_0\mu]\} >> \text{MAX-}\mu >> \text{ALIGN-R} >> \text{WBP, *DELINK, *LV} \\
\text{(6) } & \quad \begin{array}{cccc}
\text{a. Step 1} &  & \text{b. Step 2} &  \\
\mu & \mu & \mu & \mu \\
\text{c. Step 3} &  & \text{d. Step 4 (converge)} &  \\
\mu & \mu & \mu & \mu \\
\end{array} \\
\begin{array}{cccc}
l & i & \eta & \\
l & i & \eta & \\
\end{array} & \quad \begin{array}{cccc}
l & i & \eta & \\
l & i & \eta & \\
\end{array} & \quad \begin{array}{cccc}
l & i & \eta & \\
l & i & \eta & \\
\end{array} & \quad \begin{array}{cccc}
l & i & \eta & \\
l & i & \eta & \\
\end{array}
\end{align*}
\]

\[
\begin{align*}
\text{(7) } & \quad \text{MAX-E}_1 >> \text{MAX-E}_2 >> \text{MAX-E}_3 >> \star \text{FLOAT} >> \text{MAX-}\mu >> \text{IDENT(bk), IDENT(rd)} >> \star \text{LV} \\
\text{(8) } & \quad \begin{array}{cccc}
\text{a. Step 1} &  & \text{b. Step 2} &  \\
\mu & \mu & \mu & \mu \\
\text{c. Step 3} &  & \text{d. Step 4 (converge)} &  \\
\mu & \mu & \mu & \mu \\
\end{array} \\
\begin{array}{cccc}
c & j & a & \\
c & j & a & [+bk] \\
\end{array} & \quad \begin{array}{cccc}
c & j & a & \\
c & j & a & [+bk] \\
\end{array} & \quad \begin{array}{cccc}
c & j & a & \\
c & j & a & [+bk] \\
\end{array} & \quad \begin{array}{cccc}
c & j & a & \\
c & j & a & [+bk] \\
\end{array}
\end{align*}
\]

In sum, MAX-E can successfully analyze various mutation processes in Chinese dialects. Further, the intermediate outputs are crucial to the selection of the attested outputs in question, which provides additional support for the preference of serial analysis to a parallel one.

**Selected References**


Against root faithfulness in Cupeño stress

It is generally agreed that word stress in Cupeño (Takic, Uto-Aztecan) is preferentially assigned to morphemes that are lexically pre-specified for prominence (Alderete 1999, 2001a,b; cf. Hill and Hill 1968); this stress-preferring feature (ACCENT) can be observed in (1a–1b), while (1c) shows the emergence of “default” (i.e. phonologically determined) leftmost word stress in the absence of accented morphemes (all data from Hill 2005):

(1)  
a. /pəwás–wána/ → [pəwás-wána] ‘(They) lose’ (lose – CUST.PL)  
b. /max–qá/ → [max-qá?] ‘gives’ (give – PRS.SG)  
c. /max–wána/ → [máx-wána] ‘(They) give’ (say – CUST.PL)  
d. /ʔáyu–qá/ → [ʔáyu-qá] ‘wants’ (want – PRS.SG)

Less clear, however, is the motivation for the stress pattern in (1d). Alderete (1999, 2001a,b) argues that Cupeño has ROOT-CONTROLLED ACCENT (RCA): stress is assigned to the root in examples like (1d) because the lexically specified accent of the root (/ʔáyu/) takes precedence over the accent of the affix (/qá/). Within Optimality Theory (Prince and Smolensky 1993/2004), Alderete interprets this “root dominant” stress pattern as an effect of the privileged status of faithfulness relations in roots relative to other morphemes (McCarthy and Prince 1995, 1999; Beckman 1998). Yet while privileged root faithfulness has been well established for phonological processes such as vowel harmony and assimilation, Cupeño would be typologically exceptional among languages with lexical accent systems requiring root faithfulness as an independent principle to account for the surface distribution of word stress (cf. Revithiadou 1999).

I propose an alternative account of Cupeño stress assignment, termed here the LEFTMOST (LM) analysis. I argue that stress is assigned to the root in examples like (1d) because it is the leftmost accented morpheme, which optimally satisfies both the general prosodic faithfulness constraints responsible for assigning stress to accented morphemes in (1a–1b), and the markedness constraint driving default left-edge word stress in (1c) (i.e. ALIGN-L(Pk, ω)). The interaction of these constraints is illustrated for (1d) in the tableau in (2):

(2)  

<table>
<thead>
<tr>
<th></th>
<th>CULMINATIVITY(^a)</th>
<th>MAX(Accent)(^b)</th>
<th>ALIGN-L(Pk, ω)</th>
<th>DEP(Accent)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a.</td>
<td>??áyuqá</td>
<td>*!</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.</td>
<td>??áyuqa</td>
<td>*</td>
<td>**</td>
<td></td>
</tr>
<tr>
<td>c.</td>
<td>??áyuqá</td>
<td>*</td>
<td>*!</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\)CULMINATIVITY enforces the requirement that every Cupeño word bears a single stress

\(^b\)MAX and DEP militate against deletion and insertion of accents between input and output representations.

Under this constraint ranking, Cupeño stress falls on a word’s leftmost accented morpheme, else its leftmost syllable.

I demonstrate that the LM analysis attains the same empirical coverage as RCA while employing only a subset of the latter’s constraints — excluding, most significantly, the constraint that privileges accentual root faithfulness. To establish this hypothesis, I examine evidence alleged to support the RCA analysis against LM — in particular, Alderete’s (2001b) claim that the so-called “PN-prefixes,” which encode the person/number of verbal subjects and nominal possessors, are accented. According to Alderete, their accentedness explains why, when prefixed to unaccented roots, these prefixes are stressed instead of (underlined) “object markers” to their left, e.g. [ʔí-pé- max] ‘they gave you’ (2S.O-3PL-give); however, the implicit assumption that “object markers” are stressable is undermined by the fact that they are unstressed when
attached directly to unaccented roots, which in turn suggests that the “object markers” are clitics (e.g. “free clitics” in the sense of Selkirk 1996) rather than affixes (cf. Hill 2005:111–4 for morphosyntactic arguments to this end). Such object clitic-word complexes must therefore be derived as in (3a) (“=” marks a clitic boundary):

(3)  

a. /mᵢ = √₃PL.O = give - CUST.PL  

b. /ʔᵢ = ñom - √₃PL - give  

c. /ñom - √Não - _RAM:  

(3a) has two important implications for Cupeño stress. First, it shows that examples like (3b) provide no evidence that the PN-prefixes are accented, since they may receive default stress by virtue of their position at the left-edge of the prosodic word (i.e. the stressable domain). Furthermore, examples like (3c) cannot be used to establish that root accent dominates the accent of affixes to its left, since the PN-prefixes — the only non-clitic morphemes that linearly precede roots — may equally be analyzed as unaccented.

Analyzing the PN-prefixes as unaccented in fact has the more general consequence of eliminating all counter-evidence to the LM analysis which, as I show, extends to other Cupeño stress phenomena, including pre-accentuation (cf. Halle and Kenstowicz 1991; Idsardi 1992; Inkelas 1999, i.a.) and the “nominalizer” suffix /-ı/, whose stress patterns require special stipulation under the RCA analysis, but behaves just like other accented affixes under LM — e.g. in (4), where it dominates an accented suffix (/q₂al/) to its right:

(4)  

a. /pə - √₃SG.eat - ABLT - DES - PST.IPV.SG  

b. /pə - √₃SG.eat - ABLT - DES - PST.IPV.SG

Beyond its economy, I identify two further advantages of the LM analysis. First, Cupeño stress assignment is not governed by special root faithfulness, a feature that is otherwise cross-linguistically rare or perhaps even unattested in lexical accent systems; rather, it fits naturally into the category of stress systems described by Revithiadou (1999) as “morphology dependent” in which purely phonological principles both resolve conflicts between underlying accents and assign stress in their absence. In addition, the identification of a clear phonological preference for left-edge word stress paves the way for a reanalysis of Cupeño as having trochaic structure (rather than the iambsy posited by Crowhurst 1994). I suggest that a trochaic analysis of Cupeño accounts for several disparate phonological facts, including glottal stop epenthesis in words with final stressed vowels (/hiqsá/ → [hiqs´ aP] ‘will sigh’) as a repair for word-final degenerate feet, and the distribution of accents in the lexicon, which is skewed heavily toward first syllable accent in disyllabic roots (Hill 2005:23). Moreover, comparative and diachronic evidence support the trochaic pattern, which is also observed in Cahuilla (Hayes 1995:132–40; Levin 1988; Crowhurst and Hewitt 1995) and is likely reconstructible for the common ancestor of Cahuilla and Cupeño (Mamet 2011, Yates 2016).
Onset Skipping in the Serial Template Satisfaction Model of Reduplication

**INTRODUCTION:** McCarthy, Kimper, & Mullin (2012) [henceforth MKM] construct a framework for analyzing reduplication within Harmonic Serialism (HS) called Serial Template Satisfaction (STS). The proposal focuses on deriving (and refining) the typology of reduplicant shapes and reduplication-phonology interactions. One type of pattern which MKM discuss only briefly is onset skipping effects, wherein a complex onset in the base surfaces in the reduplicant as a singleton onset. Upon considering a wider range of such effects than are analyzed by MKM, we find that several amendments to the theory are required.

First, STS cannot uphold its claim that it does not predict the unattested reduplicant-medial coda skipping pattern, as this pattern is generated by the same mechanics that generate onset skipping. Second, the cluster-dependent skipping patterns in Sanskrit, Gothic, and Klamath confirm that ANCHOR must be admitted into the set of faithfulness constraints in STS/HS. Lastly, the behavior of Ancient Greek demonstrates that the inventory of reduplicative templates must be expanded to include underspecified C, contrary to the Prosodic Morphology Hypothesis (PMH).

**DATA:** MKM illustrate the STS analysis of onset skipping with Sanskrit (pp. 217-220). Sanskrit displays onset cluster skipping in reduplication, as shown most clearly in roots with initial rising-sonority clusters (1a.i). Among related Indo-European (IE) languages, the exact same pattern is present in Gothic (1b.i), and also (with a small but significant difference) in Ancient Greek (1c.i); outside of IE, this pattern is also found in Klamath (cf. Barker 1964, Steriade 1988). In each of these languages, CV roots reduplicate in CV: e.g. Ancient Greek √pemp p-e-pemp. Of major interest is the deviation from the skipping pattern observable in all languages for roots beginning in obstruct clusters, exemplified in (1a,b,c,ii) with st-clusters, though the same behavior obtains in Ancient Greek for TT, TS, and NN clusters (e.g. kt, ps, mn), and in Klamath for TT, RC, and SC clusters (e.g. kt, lm, lw, wt, sl, s; Steriade 1988:136). For these cluster-types, Klamath shows the cluster-copying pattern of Gothic: e.g. √sda gal sda-sdag al. Any analysis of these reduplicative systems must simultaneously account for the differential treatment of the two cluster types.

<table>
<thead>
<tr>
<th>(1)</th>
<th>ROOT SHAPE</th>
<th>RED. SHAPE</th>
<th>EXAMPLE</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Sanskrit</td>
<td>i. Rising clusters</td>
<td>C₁V</td>
<td>√druv/</td>
</tr>
<tr>
<td></td>
<td>ii. Obstruct clusters</td>
<td>C₂v</td>
<td>√stbā/-</td>
</tr>
<tr>
<td>b. Gothic</td>
<td>i. Rising clusters</td>
<td>C₁e</td>
<td>√grōt/</td>
</tr>
<tr>
<td></td>
<td>ii. Obstruct clusters</td>
<td>C₁C₂e</td>
<td>√vtald/</td>
</tr>
<tr>
<td>c. A.Greek</td>
<td>i. Rising clusters</td>
<td>C₁e</td>
<td>√eklín/-</td>
</tr>
<tr>
<td></td>
<td>ii. Obstruct clusters</td>
<td>-e</td>
<td>√vtstal/-</td>
</tr>
</tbody>
</table>

**STS, ONSET SKIPPING, AND PREDICTIONS:** In STS, reduplicative morphemes are lexical entries that consist of empty prosodic structure (foot, syllable, or mora, per the PMH; McCarthy & Prince [M&P] 1986/1996). These are endowed with phonological content by an operation that copies a contiguous string of constituents of type X from the base: COPY(X). This copying operation is motivated by the need for prosodic constituents to have heads: HEADEDNESS(X). Since MKM limit copying to contiguous strings, the skipping pattern cannot be generated by a single derivational step. Skipping must result from first copying the whole cluster + vowel, then reducing the cluster:

(2) Sanskrit /druv/ (copying) dru-{druv}_root (non-root cluster reduction) [du-{druv}_root] Reduplicative cluster reduction is thus a case of the emergence of the unmarked (M&P 1994), and requires the ranking MAXROOT » *COMPLEX » MAXAFFIX (such that base clusters are not also reduced). This root vs. affix faithfulness asymmetry, however, predicts equivalent reduction effects on reduplicant-medial clusters: MAXROOT » NOCODA » MAXAFFIX. This is schematized in (3):

(3) /palti/ (copying) palti-{palti}_root (non-root coda reduction) *[palti-{palti}_root]
MKM argue that this sort of pattern is unattested, and that STS is incapable of generating such a pattern. However, if STS is to maintain its analysis of onset skipping effects, then it must admit also of coda skipping effects. This then does not constitute a point of divergence between STS and Base-Reduplicant Correspondence Theory (BRCT; M&P 1995), which also predicts such effects.

**SANSKRIT, GOTHIC, AND KLAMATH:** While an emergent *COMPLEX motivates reduplicant cluster reduction, it does not specify how the cluster will be reduced. For Sanskrit, MKM assume that the consonant which would make the best onset (in terms of the Onset Margin Hierarchy (OMH); Prince & Smolensky 1993/2004) is selected (Fleischhacker 2005, Keydana 2006, Kennedy 2011; cf. Steriade 1988). Since stops are the most harmonic onsets, this selects C₁ in *stop-sonorant* (TR) (and *stop-sibilant*) clusters but C₂ in *sibilant-stop* (ST) clusters. (Sanskrit has no roots in initial *stop-stop.*) However, the *COMPLEX + OMH analysis is not sufficient for Gothic and Klamath, where, in initial ST-clusters (and others for Klamath), the cluster is not reduced at all.

A motivation for blocking onset skipping in ST-clusters can be identified if we set aside the OMH and appeal to a different generalization: reduction preferentially selects C₁, regardless of consonant type. In a BRCT analysis, this would be effected by high-ranking ANCHORBR or LOCALITY. This preference can be blocked, however, by a ban on consonant repetitions in pre-obstruent position: *CV.CV.Tₕ. (This is derived from facts about phonetic cues and perception; cf. Zukoff 2015.*) A sequence SVST violates this constraint, but a sequence TVTR does not.

MKM replace ANCHORBR/LOCALITY with a constraint COPY-LOCALLY, which penalizes material intervening between the copy and the copied string. Since the record that a string is the result of copying is crucially discarded on subsequent steps, COPY-LOCALLY can have no role in determining the type of cluster reduction that occurs after copying. In order to enact a preference for retaining C₁, then, Anchor must be the motivation. This Anchor constraint can be the equivalent of ANCHOR-IO (rather than -BR) in OT, since the relevant consonant is in the input to the reduction step. This demonstrates that Anchor is an indispensable piece of STS/HS. MKM argue that Anchor is consistent with STS/HS, but had not yet found any necessary applications for it.

**ANCIENT GREEK:** Ancient Greek differs from Sanskrit, Gothic, and Klamath in that the reduplicative vowel is *underlying* (i.e. morphologically fixed, a la Alderete et al. 1999) rather than arising through (potentially imperfect) copying (cf. Zukoff 2014). This makes it impossible to posit a syllable template. If Greek did possess a syllable template (yielding a UR like /CᵥS.CV.ₕpempₜₜroot/), the empty RED syllable could acquire its head by being associated to the underlying reduplicative vowel (/e/) (*CᵥS.CV.ₕpempₜₜroot*). Further copying would then be *unmotivated*, since the language does not repair onsetless syllables through phonological copying. Alternatively, if association of the reduplicative vowel to the template could be blocked, this would predict copying of the initial C(C)V sequence of the root to fill the template (intermediate peₜₜred-e-pempₜₜroot). If this sequence were concatenated with the underlying /ε/ affix, we would expect mora-preserving coalescence (cf. Smyth 1984, de Haas 1986) to yield a long vowel (*peₜₜred-e-pempₜₜroot*), contrary to fact.

The only feasible STS analysis is one in which the reduplicative template is simply an underspecified consonant (/Cᵥred-e-pempₜₜroot/ [peₜₜred-e-pempₜₜroot]). While this requires giving up on a core principle of the PMH – namely, that the set of templates consists only of genuine units of prosody, which does not include the segment – it can be accomplished within the general STS schema. It requires COPYFEATURE to be added to the set of copy operations, and for this operation to be motivated by a HEADEDNESS(C) constraint. This constraint (in slightly different terms) is already employed by McCarthy (2008, 2011) in the analysis of CODACOND effects in HS. STS thus can account for the range of onset skipping effects; however, doing so requires significant amendments to the proposal with respect to its inventory of templates and its typological predictions.