Friday, October 9 (Room C300, UBC Robson Square)

8:30 - Registration opens

Tutorial sessions

- 9:00-10:15 - Ultrasound imaging (Murray Schellenberg, UBC)
- 10:15-11:30 - Phonological CorpusTools (Kathleen Currie Hall, UBC)
- 11:30-12:45 - Fieldwork on indigenous languages (Suzanne Urbanczyk, UVic)

12:45-2:00 Lunch (registration open)

2:00-2:15 Welcome address (Larry Grant, Musqueam/UBC)

2:15-2:45 Paradigm uniformity in the lab: prior bias, learned preference, or L1 transfer? Adam Albright (MIT) & Youngah Do (Georgetown)

2:45-3:15 Neutralization avoidance and naturalness in the learning of palatalization. Heng Yin & James White (University College London)

3:15-3:45 The phonological grammar is probabilistic: new evidence pitting abstract representation against analogy. Claire Moore-Cantwell (Yale)

3:45-4:00 Coffee break

4:00-4:30 Environmental shielding is contrast preservation. Juliet Stanton (MIT)

4:30-5:00 Vowel height and dorsals: allophonic differences cue contrasts. Gillian Gallagher (NYU)

5:00-6:00 Plenary talk: Prosodic smothering in Macedonian and Kaqchikel. Ryan Bennett (Yale)

Saturday, October 10 (Room C300, UBC Robson Square)

8:30am - Registration opens

9:00-9:30 Learning opaque and transparent interactions in Harmonic Serialism. Gaja Jarosz (UMass)

9:30-10:00 Stratal OT and underspecification: evidence from Tundra Nenets. Darya Kavitskaya (Berkeley) & Peter Staroverov (Leipzig)

10:00-11:30 Poster session 1 (see list below; coffee available during session)

11:30-12:00 Guttural semi-transparency. Rachel Walker (USC) & Sharon Rose (UCSD)

12:00-12:30 A gestural account of neutral segment asymmetries in harmony. Caitlin Smith (USC)

12:30-2:00 Lunch (registration open)

2:00-2:30 Morphologically-conditioned tonotactics in multilevel Maximum Entropy grammar. Stephanie Shih (UC Merced) & Sharon Inkelas (Berkeley)

2:30-3:00 Asymmetrical generalisation of harmony triggers. Wendell Kimper (Manchester)

3:00-3:30 Learnability of two vowel harmony patterns with neutral vowels. Hyun Jin Hwangbo (Delaware)

3:30-5:00 Poster session 2 (see list below; coffee available during session)

5:00-6:00 Plenary talk: What kinds of processes are postlexical (and how powerful are they)? Ellen Kaisse (Washington)

7:00-... Conference dinner (Vancouver Room, Metropolitan Hotel Vancouver, 645 Howe Street)

Sunday, October 11 (Room C150/C180, UBC Robson Square)

9:00-9:30 Perceptually weak and strong unmarked patterns: a message-based approach. Elizabeth Hume (Canterbury), Kathleen Currie Hall (UBC) & Andrew Wedel (Arizona)

9:30-10:00 On the phonetics and phonology of focus marking in Boro. Shakuntala Mahanta, Kalyan Das & Amalesh Gope (Indian Institute of Technology Guwahati)

10:00-11:30 Poster session 3 (see list below; coffee available during session)

11:30-12:00 Solving Chuvash stress with sonority-sensitive feet. Kate Lynn Lindsey (Stanford)

12:00-12:30 Phonological and metrical variation across genres. Arto Anttila & Ryan Heuser (Stanford)

12:30-2:00 Lunch (catered) + AMP business meeting

2:00-3:00 Plenary talk: Morphologically complex words: pure reduction vs. structure. Kie Zuraw (UCLA)

Poster session 1 (Saturday 10:00-11:30; foyer outside Room C300)

Numbers in brackets indicate assigned poster board locations.

Perceptual deafness as a consequence of nonconcatenativeness. Yahya Aldholmi (Wisconsin-Milwaukee) [1]

Justified naivety: limits on constraint conjunction in inflectional morphology. Blake Allen (UBC) [2]

Generalization beyond similarity: support for abstract phonology. Sara Finley (Pacific Lutheran University) [3]

Hyperhypervoicing in Crow. Chris Golston (CSU Fresno) [4]

Typological and structural aspects of nasal-lateral assimilations. Deepthi Gopal (Manchester) [5]

Stress and grades in the Creek stem: a consequence of cyclic structure. Peter Guekguezian (USC) [6]

The prosodic effects of VP and embedded CP boundaries in Japanese. Manami Hirayama (Ritsumeikan) & Hyun Kyung Hwang (NINJAL) [7]

To epenthesize or not? Adaptations of English coda [m] in Standard Mandarin loanwords. Ho-Hsin Huang & Yen-Hwei Lin (Michigan State University) [8]

On the relationship between learning sequence and rate of acquisition. Karen Jesney (USC) [9]

Resolving the issue of the target of vowel copy in Fijian loanwords. Gakuji Kumagai (Tokyo Metropolitan University) [10]

What matters in artificial learning, sonority hierarchy or natural classes?. Yu-Leng Lin (Toronto) [11]

Vowel dispersion in English diphthongs: evidence from adult production. Stacy Petersen (Georgetown) [12]

Learning alternations affects phonotactic judgments. Presley Pizzo & Joe Pater (UMass) [13]

Specific exceptions driving variation: the case of spirantization in Modern Hebrew. Michal Temkin Martinez & Ivana Müllner (Boise State University) [14]

Sign language phonetic annotation meets Phonological CorpusTools: towards a sign language toolset for phonetic notation and phonological analysis. Oksana Tkachman, Kathleen Currie Hall, André Xavier & Bryan Gick (UBC) [15]

The phonology of contrastive focus in Standard Colloquial Assamese. Asim Twaha & Shakuntala Mahanta (Indian Institute of Technology Guwahati) [16]

Morphoprosodic structure and categorization in Blackfoot nominals. Natalie Weber (UBC) [17]

A voicing asymmetry in nonnative cluster epenthesis: perception vs. production. Colin Wilson (Johns Hopkins) & Lisa Davidson (NYU) [18]

Poster session 2 (Saturday 3:30-5:00; foyer outside Room C300)

Numbers in brackets indicate assigned poster board locations.

The relative and the absolute: the Tunica stress conspiracy revisited. Eric Baković (UCSD) [1]

Adjunction and branchingness effects in Match Theory. Jennifer Bellik & Nick Kalivoda (UCSC) [2]

Long-last in language, short-last in verse. Lev Blumenfeld (Carleton) [3]

Abstract morphological information cued by phonotactics: noun class disambiguation in Xhosa. Aaron Braver (Texas Tech) & William Bennett (Rhodes) [4]

A foot-based Harmonic Serialism typology of Bantu bounded tone. Jeroen Breteler (Amsterdam) [5]

Extrametricality and second language acquisition. Guilherme Duarte Garcia (McGill) [6]

Shift happens! Shifting in Harmonic Serialism. Frederick Gietz, Peter Jurgec & Maida Percival (Toronto) [7]

Sahaptin: between stress and tone. Sharon Hargus (Washington) & Virginia Beavert (Oregon) [8]

Prosodic subcategorization, infixation, and relation-specific alignment. Brett Hyde & Jonathan Paramore (Washington State University) [9]

The typology of Headed Agreement By Correspondence. Luca Iacoponi (Rutgers) [10]

Well-formed tone mappings with local, inviolable surface constraints. Adam Jardine & Jeffrey Heinz (Delaware) [11]

Long-distance licensing in Harmonic Grammar. Aaron Kaplan (Utah) [12]

Partial identity preference in Oromo co-occurrence restrictions. Avery Ozburn (UBC) [13]

Constraints on URs and blocking in nonderived environments. Ezer Rasin (MIT) [14]

Sonority-driven stress does not exist. Shu-hao Shih (Rutgers) [15]

The emergence of the binary foot in Mandarin. Jason Brown & Shuxia Yang (Auckland) [16]

Complete flapping through polysyllabic shortening in English. Gwanhi Yun (Daegu University) [17]

Poster session 3 (Sunday 10:00-11:30; Room C150/C180)

Numbers in brackets indicate assigned poster board locations.

Formally mapping the typologies of interacting ABCD systems. William Bennett (Rhodes) [1]

Exploring the relationship between static and dynamic generalizations in learning. Adam Chong (UCLA) [2]

"Tense" /æ/ is still lax: a phonotactics study. Daniel Duncan (NYU) [3]

Learning generalisations in the face of ambiguous data. Karthik Durvasula & Adam Liter (Michigan State University) [4]

Articulatory retiming: investigations from cross-modal linguistic evidence. Shelece Easterday & Corinne Occhino-Kehoe (UNM) [5]

Onset weight with branchingness constraints: the case of Pirahã. Ben Hermans (Meertens/VU Amsterdam) & Francesc Torres-Tamarit (CNRS/Paris 8) [6]

Exploring the syntax-phonology interface: the effect of freestanding form. Yujing Huang (Harvard) [7]

An acoustic and theoretical analysis of the nasal vowels of Mẽebêngôkre and Panarà. Myriam Lapierre (Ottawa) [8]

Modeling the gradient evolution and decay of harmony systems. Adam McCollum (UCSD) [9]

Learning the context-dependent perception of novel speech sounds. Masaki Noguchi & Carla Hudson Kam (UBC) [10]

Blocking in Slovenian sibilant harmony: a perception experiment. Avery Ozburn (UBC) & Peter Jurgec (Toronto) [11]

An 'unnatural' pattern of variation in vowel harmony: a frequency-based account. Péter Rebrus & Miklós Törkenczy (Hungarian Academy of Sciences) [12]

Phonological movement in Ukrainian. Victoria Teliga (London), Brian Agbayani (CSU Fresno) & Chris Golston (CSU Fresno) [13]

Tonal suppletion as multi-modal featural affixation. Eva Zimmermann (Leipzig) [14]

Plenary Talk #1 (Friday, October 9, 5:00–6:00 pm)

Prosodic smothering in Macedonian and Kaqchikel

Ryan Bennett, Yale University

[joint work with Boris Harizanov (Stanford University) and Robert Henderson (University of Arizona)]

It is well known that dependent morphemes (affixes, clitics) may idiosyncratically select for prosodic properties of their hosts (Inkelas 1990, Zec 2005, etc.). For example, the English comparative suffix *-er* does not attach to stems of greater than two syllables in size (*sunni-er* vs. **insightful-er*). Prosodic subcategorization is typically understood to be *lateral* and *local*: dependent morphemes may select for prosodic properties of an immediately preceding or immediately following element.

Less attention has been paid to the vertical dimension of prosodic subcategorization—the prosodic constituent *produced* by the attachment of a dependent morpheme to its host. We argue that vertical subcategorization is responsible for the variable prosody of certain functional items in Macedonian (Slavic) and Kaqchikel (Mayan), two genetically and geographically distinct languages. In short, the vertical subcategorization requirements of an outer morpheme can alter the prosodic parsing of an inner morpheme in the same complex. This gives rise to prosodic alternations like [A [B]] ~ [X A B], in which the prosodic boundary between A and B is sensitive to the presence or absence of outer morpheme X. We refer to this phenomenon as *prosodic smothering*.

In Macedonian, preverbal object clitics are typically unstressable (<go VIde> '(s)he saw him', *<GO vide>). But in the presence of *wh*-words or sentential negation such clitics are parsed into the same prosodic word as the verb, and may then bear stress (<koj GO vide> 'Who saw him?'). This rather puzzling pattern can be analyzed as a case of prosodic smothering: the prosodic subcategorization requirements of sentential negation and *wh*-words force a deviation from the default prosodic parse that would otherwise be observed for the clitics.

In Kaqchikel, a variety of diagnostics indicate that absolutive agreement markers show a different prosodic parse depending on the presence or absence of outer aspect marking, e.g. [x-in-b'e] 'I went' vs. [in=jwi'] 'I am intelligent'. Exactly as in Macedonian, this prosodic variation owes to the vertical subcategorization requirements of an outer morpheme, in this case the outer aspect marker. There is thus strong evidence that vertical subcategorization can induce prosodic restructuring of lower elements. We conclude with a discussion of the theoretical and methodological implications of our proposal.

Plenary Talk #2 (Saturday, October 10, 5:00–6:00 pm)

What kinds of processes are postlexical (and how powerful are they)?

Ellen Kaisse, University of Washington

The literature on phonological processes that apply between words is full of cases like tone sandhi in Chinese languages, tone spread in Bantu, the placement of intonational boundary tones, and local cases of resyllabification, vowel deletion, voicing assimilation, or place assimilation between the final segment of one word and the initial segment of the next. But some kinds of processes are profoundly underrepresented. Initial stress assignment always seems to be word-bounded, or clitic-group bounded at the most. Vowel harmony likewise rarely extends beyond the word or clitic group, and in the very few cases reported to continue into the next word, it extends only one syllable onward, rather iterating so as to affect the whole word, as its lexical counterparts do. In this paper, I will report on an initial survey of processes in the phonological literature described as applying across words, and I will speculate on why postlexical application is so strongly skewed towards certain kinds of processes and not others.

Plenary Talk #3 (Sunday, October 11, 2:00–3:00 pm)

Morphologically complex words: pure reduction vs. structure

Kie Zuraw, University of California, Los Angeles

Variable phonology often shows influences from frequency, such as applying more often in more-frequent words. Especially if the phonological process is deletion or lenition, this can look like pure reduction: more-frequent words get pronounced with shorter duration, leading to gestural reduction and overlap.

This talk examines some cases that on the one hand are like this—they are lenitory and apply more often in frequent words—but on the other hand cannot be pure reduction. In each case, the process is governed by morphological structure, and in some cases it is phonetically categorical rather than continuous.

A better description can be achieved with two ingredients. First, as in previous phonological analyses, the grammar imposes prosodic structure to ensure obligatory outcomes in some environments. Second, the grammar allows variation in other environments, and is sensitive to production processing in a way that allows the observed frequency effects in the variation.

Tutorial #1 (Friday, October 9, 9:00–10:15 am)

Ultrasound Imaging

Murray Schellenberg, University of British Columbia

Ultrasound provides a safe, non-invasive way to observe actions inside the body. In linguistics it is used primarily to observe tongue movement and this workshop will introduce basic ultrasound techniques focusing on tongue imaging. We will cover setting up for and recording ultrasound images as well as an introduction to extracting and annotating images. Participants should prepare by downloading the free *Image-J* software program (http://imagej.nih.gov/ij/download.html) and also the zip file of images from https://www.dropbox.com/sh/dn2i7lw2imb5513/AADg9tepp-Ct52O0aT0RzRvHa?dl=0&s=sl. Participants are asked to bring a laptop with the program and images loaded on it to the tutorial.

Tutorial #2 (Friday, October 9, 10:15–11:30 am)

Phonological CorpusTools

Kathleen Currie Hall, University of British Columbia

Phonological CorpusTools is free, open-source software built at UBC that is designed to be a search and analysis aid for dealing with questions of phonological interest in corpora. In this tutorial, the software will be introduced, and the basics of creating and loading corpora, setting up transcription-to-feature systems, doing phonological searches, and implementing various types of phonological analysis (e.g., phonotactic probability, functional load, mutual information, predictability of distribution, acoustic similarity) will be discussed. Participants should prepare by downloading the software following the directions at http://phonologicalcorpustools.github.io/CorpusTools/ and should come to the tutorial with a laptop, ready to work through some examples.

Tutorial #3 (Friday, October 9, 11:30 am – 12:45 pm)

Fieldwork on Indigenous Languages

Suzanne Urbanczyk, University of Victoria

In many areas of the world, Indigenous languages are highly endangered. While there is an urgent need to document these languages, there are also important considerations in the how to approach the work that is respectful of the community's needs and goals. Finding ways to acknowledge and incorporate these needs and goals into one's project while balancing these with the goals of linguistic documentation and inquiry is a growing area of methodological concern in linguistics. This workshop will cover topics related to methods, practicalities, pitfalls and ethical issues that arise when doing fieldwork on Indigenous languages. The workshop will also be an opportunity for participants to share ideas and insights regarding their experiences and/or aspirations in documenting Indigenous languages.

Paradigm uniformity in the lab: prior bias, learned preference, or L1 transfer?

Adam Albright (MIT) and Youngah Do (Georgetown University)

Participants in artificial grammar (AG) learning experiments frequently favor uniform paradigms, even when they are trained on languages that show consistent stem alternations (Pater and Tessier 2003; Wilson 2006; White 2014). For example, Albright and Do (2013) trained participants on singular∼plural noun paradigms in which 100% of stop-final items alternated in voicing or continuancy, and yet 27% of participant responses failed to apply alternations to unseen items in the testing phase, favoring non-alternating paradigms instead. This preference mirrors errors in language acquisition (Kazazis 1969; Do 2013) and diachronic change (Malkiel 1968; Schindler 1974), raising the intriguing possibility that artificial grammar learning experiments can be used to investigate experimentally the forces that drive paradigm leveling in language change. A prior (innate) paradigm uniformity preference is not the only explanation for non-alternation errors in the lab, however. It is also possible that participants favor non-alternation because of experience with their native language (L1 transfer) or with non-alternating filler items (a learned preference; Albright 2005). We present here the results of an AG experiment in which we manipulate the amounts of evidence available from non-alternating fillers, and also compare how participants generalize to segments that do or do not alternate in their native language. As in previous studies, we find significant numbers of non-alternating responses, even for stem types that showed consistent alternations in training. Furthermore, the rate of non-alternation is not increased by exposure to more non-alternating fillers, or by non-alternation in L1. The only factor that systematically affects non-alternation is greater exposure to alternating items; we model these results with a MaxEnt learning model, incorporating a prior paradigm uniformity bias (OO-FAITHFULNESS constraints).

To test the influence of alternating and non-alternating items in the acquisition of alternations, we devised a set of 5 artificial languages, independently varying the number of each: 4, 8 or 12 alternating items with 8 non-alternators, and 4, 8 or 12 nonalternators with 8 alternators. If learners start with a prior bias for non-alternation (e.g., high-ranking OO-FAITH constraints), we predict that increasing the number of alternating items should increase the probability of generalizing alternations, while increasing the number of non-alternating items should have no effect, since learners already expect non-alternation. Conversely, if learners simply match the relative proportion of alternating items in the data, generalization of alternations should increase with more alternators, and decrease with more non-alternators. In the artifical languages, stop-final stems showed voicing alternations (seɪp ∼ seɪbi, bɹik ∼ bɹigi), while fricative- and nasal-final stems showed no alternations (dɹun ∼ dɹuni, kluf ∼ klufi). American English has extremely productive voicing alternations for coronals (flapping: *weigh*[t] ∼ *weigh*[ɾ]*y*) and limited voicing alternations for fricatives (*hou*[s]*e* ∼ *hou*[z]*es*), but no systematic voicing of /p/ or /k/. Thus, it is also possible to detect L1 transfer by examining generalization to /t/-final stems: if participants are using English rankings, then they should apply voicing alternations to /t/ (and perhaps even /s/) at higher rates than /p/ or /k/.

Alternating and non-alternating items were embedded in an implicit learning task, in which participants were instructed to pay attention to the plural suffix (-i after consonants, -nu after vowels); the total number of training items was held constant across all languages. The test items included novel stop-final items (trained /p/, /k/; withheld /t/) and fricative-final items, and participants were forced to choose between unvoiced (non-alternating) and voiced (alternating) plurals. 250 adult native English speakers participated on Amazon Mechanical Turk, and responses were analyzed using mixed effects logistic regression. The results show that voicing was generalized more often to trained p, k than to t (β=.15, t=4.10). This is unexpected if participant preferences are due to L1 transfer, since English actually favors voicing alternations for coronals. Furthermore, the number of alternating responses increased systematically with the number of alternating training items (Fig. 1), but did not decrease systematically with the number of non-alternating training items (not shown). This is expected if learners are employing a prior bias for non-alternation, which can be suppressed with data from alternating items, but need not be reinforced with data from non-alternating items. It is not expected, however, if learners are simply mimicking the proportion of alternating items in the training data. Thus, the results support a model in which artificial language learners employ a prior bias for non-alternation, mirroring the OO-Faith $\gg$ Markedness bias that has independently been posited for L1 acquisition (McCarthy 1998; Hayes 2004; Do 2013).

We model these results using a regularized Maximum Entropy model of weighted constraints (Goldwater and Johnson 2003; Jäger 2007). We implement the paradigm uniformity bias by including OO-Faith constraints in the grammar, with a prior weight above that of Markedness. Since the model initially favors non-alternation and learning is error-driven, the grammar changes only in response to alternating training items, and not to non-alternators; this captures a key finding of the experiment. Learning alternations consists (in part) in promoting Markedness constraints that favor alternations, such as *V[obstruent]V, *V[voiceless stop]V, and *V[k]V, so that their cumulative weight exceeds that of OO-Faith. In the MaxEnt framework, training on p∼b and k∼g results in promotion of all relevant markedness constraints, so that they ‘share the credit’ for explaining alternations. A prediction of this approach, illustrated in Fig. 2 is that alternations should be generalized most to trained alternations, where specific constraints such as *VkV also support them, and less to untrained alternations, where the relevant specific constraints have not been promoted (e.g., *VtV). This captures the second experimental finding: participants only partially generalized alternations from /p/, /k/ to /t/, in spite of the fact that English favors voicing alternations for coronals.

The results here are novel, in that few prior AG experiments on phonological alternations have been designed to rule out L1 transfer as the source of an observed bias. (In fact, most studies cited above do not even discuss the possibility of L1 transfer.) Furthermore, the modeling results show that an independently successful model of L1 grammar learning can capture important properties of how humans learn and generalize phonological patterns in an artificial grammar setting. Of course, this alone does not prove that participants in AG experiments are solving the task in exactly the same way that they learn L1, but it does contribute to a growing body of work showing that AG experiments are a useful tool in probing the mechanisms of L1 language learning.

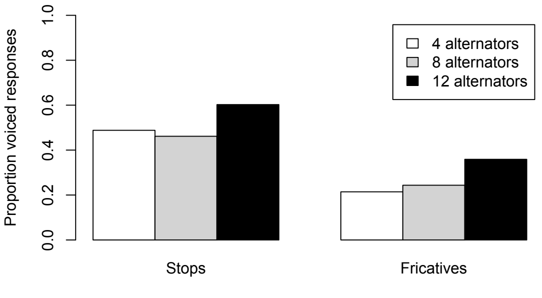


Figure 1: Voiced responses increase with number of alternating training items

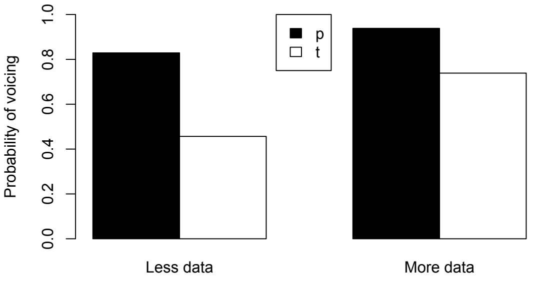


Figure 2: Model predictions: partial generalization to unseen /t/

Author: Yahya J. Aldholmi
Affiliations: UW-Milwaukee & King Saud University

Perceptual Deafness as a Consequence of Nonconcatenativeness

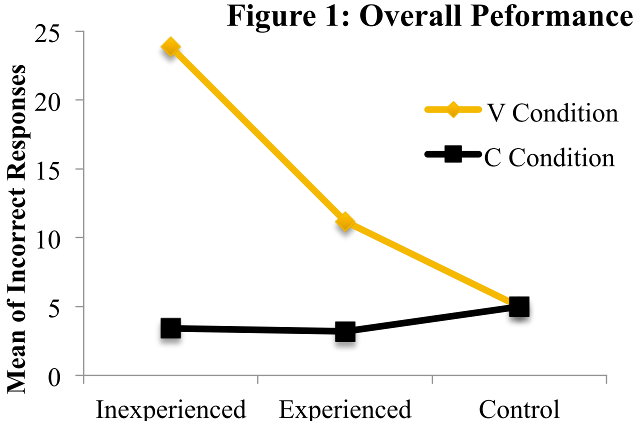
A distinguishing feature of Semitic languages such as Arabic and Hebrew is a nonconcatenative morphological system in which consonants and vowels each have a distinct status (Holes 2002, McCarthy 1981, Watson 2007). The root, which consists of consonants such as /k,t,b/ “writing”, signals the semantic information, whereas vowels get intercalated to signal affix-like morphosyntactic information, such as voice as in /k**a**t**a**b “wrote” vs. /k**u**t**i**b/ “was written”, and agentivization as in /k**aa**t**i**b/ “writer”.

Many researchers (cf. Berent & Shimron, 2002; Bick, Goelman & Frost, 2011; Boudelaa & Marslen-Wilson, 2000 & 2001; Ravid, 2002, among others) have argued that the root is the fundamental unit of the mental lexicon, and that listeners give priority to roots over affixes when processing auditory and written words. Arabic presents an interesting example in which roots and affixes are confounded with consonants and vowels, respectively. Accordingly, I hypothesize that Arabic speakers, especially those who have limited or no exposure to foreign languages, will accurately perceive consonants in foreign or nonsense words, but remain insensitive or “deaf” to vowels.

This hypothesis was examined by testing three types of participants: inexperienced Arabic speakers who have limited exposure to English, experienced Arabic speakers who have learned English for over one year, and control English speakers who speak no Semitic languages. The participants were presented with nonsense words that differed in either a single consonant (jabirfugas – zabirfugas) or a single vowel (jabirfugas – jibirfugas), and their task was to judge whether the words were the same or different. The location of the consonant or vowel difference was varied across four possible word positions. An identity-distractor condition was included as a baseline, as was an unrelated-distractor condition. All of the segments used to construct stimuli occur in the inventories of both English and Arabic. The stimuli were recorded by an English-Arabic bilingual talker.

The findings show that Arabic speakers successfully detected consonant change but were deaf to vowel change, regardless of the vowel or consonant position. This effect was greatest for inexperienced participants, $F(18, 1) = 145.86$, $p < 0.001$, $\eta^2 = 0.89$ (89%), and contrasted with results for the English native speakers, who showed balanced performance in both conditions, $F(6,1) = 00$, $p> 1$, $\eta^2 = 0.00$ (0%), (see Figure 1). That is, the Arabic speakers reported more *Same* responses in the vowel condition while the English speakers reported almost an equal number of *Same* vs. *Different* in both conditions. This is taken as evidence that the Arabic speakers give perceptual priority to consonants over vowels, and this observation is believed to be a consequence of the nonconcatenative system of Arabic.

Figure 1: Overall Peformance



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Blake Allen, UBC

Justified naivety: limits on constraint conjunction in inflectional morphology

Context and motivation: Recently, sublexical phonology (Becker and Gouskova 2013, Allen and Becker in review) has applied the probabilistic, constraint-based phonological formalism of MaxEnt Harmonic Grammar (Hayes and Wilson 2008) to the domain of inflectional morphology. The scope of this approach has been limited to making predictions given a single known "base" cell in an inflectional paradigm, e.g. modeling the task of predicting the plural form of a novel noun from its singular form. Consequently, the question of how predictions can be made from multiple known base forms of a word has been left unresolved, even though the complexity of many of the world's inflectional systems suggests that such inference must be possible (Stump and Finkel 2013).

This potential complexity poses a severe problem for learnability. Even relying on only a single base cell, the space of constraints to search while learning the phonological correspondences between that cell and the derivative cell is potentially infinite, and it must be reduced to a manageable size through simplyfing assumptions (Hayes and Wilson 2008). In the case of multiple base cells, there is no reason *a priori* to exclude constraints that are conjunctions of constraints on different base cells, e.g. a constraint [*NominativeSingular:* *e# & *GenitiveSingular:* *i#]. The space of these conjoined constraints grows far more quickly than that of non-conjoined constraints. Moreover, it is possible to construct hypothetical inflectional systems that require such *cross-base constraint conjunctions*, meaning that such languages could exist.

Proposal: In this presentation, I provide evidence that no cross-base constraint conjunctions are required by existing inflectional systems. To do so, I show that a computationally implemented model of grammar without these constraints accurately accounts for a variety of inflectional systems selected to provide wide coverage of the morphological typology. I then schematize the type of hypothetical inflectional system that *does* require these constraints. From this mismatch between the typology and the space of possible inflectional systems, I conclude that cross-base constraint conjunctions are absent from the constraint search space. Finally, casting this finding in the language of probability theory, I show that the combinatorial problem posed by cross-base constraint conjunction directly parallels a more general issue in the domain of statistical machine learning, and also that the solution proposed here of disallowing constraint conjunction is effectively equivalent to the well-studied statistical model known as Naive Bayes, opening up to phonologists the extensive literature on this model.

Methods and evidence: I test the adequacy of a model of grammar without cross-base constraint conjunctions on the following datasets: Spanish present tense verbs, Latin "principal parts" and their associated forms, Japanese verbs, and Kwerba nouns. These inflectional systems vary substantially in the predictiveness relations that hold among their various cells (Stump and Finkel 2013), and so I conclude that a model of grammar able to account for all of these datasets can be tentatively assumed to account for inflectional morphology more generally, pending investigation of additional datasets. The testing procedure amounts to performing leave-one-out cross-validation on each paradigm, essentially hiding each form of each word's paradigm one at a time, and having the model predict it from the other forms.

The model lacking cross-base constraint conjunctions that I have tested on these datasets is a simple generalization of the sublexical grammar architecture (Becker and Gouskova 2013, Allen and Becker in review). In order to ban cross-base constraint conjunctions when the probability of an output candidate is predicted from multiple bases, this probability must be derived from only constraints that each refer to a single base form, e.g. two constraints [*NominativeSingular:* *e#] and [*GenitiveSingular:* *i#], but not a single conjoined constraint [*NominativeSingular:* *e# & *GenitiveSingular:* *i#]. I impelement this restriction as follows: for each available base, allow it to predict the probability of the output candidate $p(c|base)$ in the standard way, using only constraints that refer to that base, and then multiply these probabilities across all available bases to reach the final predicted probability for the output candidate. Note that normalization is omitted in this simplified description but not in the model itself.

This model has the advantage of being falsifiable. I will describe examples of hypothetical inflectional systems that this model of grammar predicts to be non-existent, unproductive, or diachronically unstable. Despite the author's efforts to search for such inflectional systems in natural languages, none have yet been found. A generalized description of the property shared by these inflectional systems is forthcoming, but for now the search will be continued by running the leave-one-out cross-validation procedure described above on additional datasets.

Assuming that no such inflectional systems are found, the finding that cross-base constraint conjunctions are outside the constraint search space has a beneficial implication for phonologists: inflectional morphology can be expressed using a statistical model called Naive Bayes. Definitionally, supposing a set of candidates for the unknown form of a word, the probability of one candidate form c given a subset of the other forms of that word $f_1, f_2, ...f_n$ can be written as $p(c|f_1, f_2, ...f_n)$. Applying Bayes's theorem, this probability is proportional to $p(f_1, f_2, ...f_n|c)p(c)$, where $p(c)$ is the prior probability of the candidate c. The term $p(f_1, f_2, ...f_n|c)$ permits the influence of cross-base constraint conjunctions, as the probability of one base form given c can depend on the probabilities of the other base forms. Disallowing cross-base constraint conjuctions, we can decompose this term into $p(f_1|c)p(f_2|c)...p(f_n|c)$, which is equivalent to the generalized sublexical model described above. Notably, this new definition, $p(c|f_1, f_2, ...f_n) \propto p(c)p(f_1|c)p(f_2|c)...p(f_n|c)$, is identical to the form of the Naive Bayes model from statistical machine learning (Maron and Kuhns 1960). This result means that phonologists interested in applying the sublexical approach to inflectional morphology can make use of the extensive literature on Naive Bayes, including papers on its learnability properties and its numerous implementations in various programming languages.

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Phonological and metrical variation across genres

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Problem. Speech and writing are rhythmically structured in ways that vary across individuals, styles, and genres. In metrical verse, the natural rhythm of speech is set against a conventional meter that is recognized by hearers and readers, creating a tension the poet manipulates for artistic effect. For example, the ten-syllable sentence *I can't believe that I forgot my keys* is easily recognizable as iambic pentameter ws/ws/ws/ws/ws/ whereas another ten-syllable sentence *It rains almost always when I visit* is not (Steele 1999). In this study, we asked whether standard phonological and metrical constraints proposed by phonologists and metricists on independent grounds can reliably identify arbitrary lines of text as (metrical) verse vs. (non-metrical) prose. We focused on two unrelated languages, English and Finnish.

Data. Our data come from nine English and nine Finnish authors (https://www.gutenberg.org/): Keats, Shelley, Whitman, Wordsworth, Yeats (both prose and verse); Hopkins, Milton, Pope, Shakespeare (only verse); Erkko, Kaatra, Leino, Lönnrot, Siljo (both prose and verse); Hellaakoski, Kailas, Koskenniemi, Kramsu (only verse). We converted all texts to versions of themselves in which each line has exactly five words, with no punctuation, in order to guarantee that any phonological or metrical difference between prose and verse that might emerge would have nothing to do with line length, but only with the local phonological and metrical arrangement of words. Our dataset consists of 500 randomly sampled lines for each author-genre pair, totaling approximately 14,000 lines.

Analysis. To analyze the dataset phonologically and metrically we used PROSODIC (Heuser, Falk, and Anttila 2010-2011, https://github.com/quadrismegistus/prosodic), a software package that provides a phonological analysis and metrical scansion for raw text. While less accurate than hand-coding (see, e.g., Hayes, Wilson, and Shisko 2012 for a recent example), machine analysis yields a reasonable baseline and opens up much larger datasets. The phonological analysis syllabifies the data and annotates it for stress and weight using the CMU Pronouncing Dictionary (Weide 1998) and OpenMary (http://mary.dfki.de/), allowing for stress ambiguity in monosyllabic function words (e.g., *have* vs. *háve*) based on a classification informed by Hirschberg 1993. The metrical analysis provides a scansion based on constraints from Hanson and Kiparsky 1996 (H&K). These constraints regulate the correspondence between metrical positions (s vs. w) and their phonological realization, governing position size (syllable vs. foot), prominence site (s vs. w), and prominence type (stress vs. strength vs. weight). H&K make the interesting claim that mainstream metrical traditions in Finnish and English differ in prominence site and type: in Finnish iambic-anapestic (trochaic-dactylic) meters a strong metrical position may not contain an unstressed syllable; in Shakespeare's iambic pentameter a weak metrical position may not contain a strong syllable, where strength is defined as follows: a constituent is strong iff it is the head of a branching constituent and weak iff it is the non-head of a branching constituent. Thus, in *mány* the stressed syllable is strong, a.k.a. "peak", and the unstressed syllable is weak, a.k.a. "trough", whereas *kéen* is neither. These metrical constraints are observed to varying degrees by individual poets.

Given a line of text, PROSODIC starts from a candidate space of possible s/w scansions; for a line of 10 syllables the upper bound is 2^{10} = 1,024 scansions. PROSODIC assigns each scansion a constraint violation vector, discards harmonically bounded scansions in the sense of Optimality Theory (Prince and Smolensky 1993/2004), allowing for resolution in weak positions which may contain up to two syllables, and returns the remaining scansions, with violation patterns for each phonological and metrical constraint. Stress ambiguities in monosyllabic function words (e.g., *have* vs. *háve*) are resolved by scansion. Violation counts are normalized by dividing the sum of violations by the number of scansions and the number of syllables in the line. We assumed four phonological constraints: PEAKPROM 'No stressed lights', WSP 'No unstressed heavies', NOCLASH 'No adjacent stressed syllables', and NOLAPSE 'No adjacent unstressed syllables' (see, e.g., Prince 1990, Prince and Smolensky 1993), and four metrical constraints drawn from H&K, which crucially include *S/UNSTRESSED 'A strong position may not contain an unstressed syllable' and *W/PEAK 'A weak position may not contain a peak'. For example, the first foot of the line *Néver/ cáme pói/son fróm/ so swéet/ a pláce/* violates *W/PEAK on the weak beat and *S/UNSTRESSED on the strong beat (inversion). These two constraints embody the key difference between Finnish and English meters noted by H&K. Since PROSODIC blindly analyses any text, verse or prose, the resulting violation profiles yield rich information about the phonological and metrical differences among texts. This information is interesting because it allows us to figure out how verse differs from prose and to put H&K's claim to empirical test.

Results. We modeled the data using mixed-effects logistic regression using the R lme4 package (Bates et al. 2013), with genre (prose vs. verse) as the dependent variable, the four phonological and two metrical constraints as independent variables, with violation counts normalized and centered, and author as a random variable. Three main discoveries emerged.

First, the purely phonological constraints register the same differences between prose and verse in both languages, suggesting that in this sense phonology is universal. Violations of PEAKPROM, WSP, and NOLAPSE are highly predictive of prose in both languages (p = 0.01-0.001) showing that such violations are avoided in verse. In contrast, violations of NOCLASH are highly predictive of verse in both languages (p = 0.001) showing that such violations are avoided in prose (Shih 2014). We note that the number of PEAKPROM and WSP violations almost completely depends on word choice (up to stress ambiguity) whereas the number of NOCLASH and NOLAPSE violations is sensitive to both word choice and linearization. This suggests that word choice and possibly linearization are sensitive to genre in the same way in both languages.

Second, the metrical constraints register the difference between prose and verse differently in the two languages, presumably because metrical traditions are language-specific. We found H&K's claim about the difference between Finnish and English to be supported: in Finnish, violations of *S/UNSTRESSED 'A strong position may not contain an unstressed syllable' are predictive of prose (p = 0.05) while violations of *W/PEAK 'A weak position may not contain a peak' do not reach significance. In contrast, in English violations of *W/PEAK are highly predictive of prose (p = 0.001) and violations of *S/UNSTRESSED are highly predictive of verse (p = 0.001). This is consistent with the view that English verse controls weak positions and cares about strength whereas Finnish verse controls strong positions and cares about stress, hence the prose vs. verse difference is most clearly visible in exactly these prominence sites and types.

Third, we observe that on an average the number of possible scansions is larger in prose than verse. This is not surprising: one would expect prose which by definition does not have meter to be metrically more ambiguous and allow more scansions than metrical verse.

The relative and the absolute: the Tunica stress conspiracy revisited

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Summary Kisseberth (1970b) distinguishes rules in Tunica (Haas 1940) that are subject to a constraint penalizing adjacent stresses from rules that are not subject to this constraint. This distinction appears on the surface to be particularly suited to a straightforward analysis within Optimality Theory (OT; Prince & Smolensky 1993): NoClash is ranked above constraints responsible for the rules that are subject to it and below constraints responsible for the rules that are not. The full range of relevant facts in Tunica suggest that NoClash is only crucially dominated and violated lexically, however; postlexically, NoClash is undominated and there are no adjacent stresses on the surface. A full analysis is presented within Stratal OT (Bermúdez-Otero 1999, Kiparsky 2000).

Background In his analysis of syncope rules in Tunica (Haas 1940), Kisseberth (1970b) argues for a general distinction between *relatively obligatory* and *absolutely obligatory* rules. (See also Kisseberth 1970a: 305 and Kisseberth 1972: 223*ff*.) With respect to an output constraint that unifies a set of rules involved in a 'conspiracy', relatively obligatory rules are those that are subject to the constraint and absolutely obligatory rules are those that are not subject to it. The immediate output of an absolutely obligatory rule may thus violate the constraint while the immediate output of a relatively obligatory rule may not (i.e., the constraint blocks the relatively obligatory rule).

There are two syncope rules in the analysis. Internal syncope deletes unstressed, morpheme-final but word-internal vowels, *even if* the immediate output contains a stress clash between the syllables flanking the deleted vowel; internal syncope is thus *absolutely obligatory* with respect to a constraint against stress clash. The resulting stress clashes are subsequently repaired by a destressing rule.

hára+ʔáki $\xrightarrow{\text{I-SYNC}}$ hár+ʔáki $\xrightarrow{\text{DESTR}}$ hár+ʔaki 'she sang'

External syncope, on the other hand, deletes unstressed, word-final vowels, *except when* the output of this deletion results in a stress clash between the syllables flanking the deleted vowel; external syncope is thus *relatively obligatory* with respect to the constraint against stress clash.

yúru##ʔámarʔɛhɛ $\longrightarrow$ yúru##ʔámarʔɛhɛ 'not long enough'
($\xrightarrow{\text{E-SYNC}}$ *yúr##ʔámarʔɛhɛ $\xrightarrow{\text{DESTR}}$ *yúr##ʔamarʔɛhɛ)

The Problem On the face of it, the distinction between relatively and absolutely obligatory rules appears to provide further evidence for the constraint-ranking explanation of conspiracies in OT: if the output constraint is $\mathbb{C}$, the markedness constraint responsible for the relatively obligatory rule is $\mathbb{R}$, and the markedness constraint responsible for the absolutely obligatory rule is $\mathbb{A}$, then the ranking $[\![\mathbb{A} \gg \mathbb{C} \gg \mathbb{R}]\!]$ would describe a situation in which $\mathbb{R}$ is 'subject to' (i.e., outranked by) $\mathbb{C}$ while $\mathbb{A}$ is not. Satisfaction of $\mathbb{A}$ may thus lead to violation of $\mathbb{C}$, but satisfaction of $\mathbb{R}$ cannot.

In the account of Tunica, $\mathbb{C}$ is NoClash. The problem is that there are in fact no adjacent stresses on the surface in Tunica; NoClash is not violated by grammatical surface forms. This indicates that NoClash is undominated in Tunica and thus that it cannot be crucially dominated by any constraint such as $\mathbb{A}$. The absolutely obligatory internal syncope rule only produces violations of NoClash *in its immediate output*; these violations are later repaired by destressing. A full analysis of the relevant facts of Tunica thus appears to require a serial derivation.

Our Solution We recast Kisseberth's (1970b)'s analysis of Tunica in terms of Stratal OT, which provides the necessary tools to satisfy both the constraint-ranking needs and the serial derivation needs of the analysis. Specifically, we propose that internal syncope is absolutely obligatory with respect to NoClash because NoClash is crucially dominated lexically, while external syncope is relatively obligatory with respect to NoClash because NoClash is undominated postlexically.

The 'internal' vs. 'external' distinction is on its own a strong indication that the two syncope rules apply at different levels. Their basic similarity but differential behavior with respect to NoClash can be accounted for by ranking the constraint responsible for syncope above NoClash at the lexical level but below NoClash at the postlexical level, as shown in the following tableaux.

Internal syncope

L

hára+ʔáki	Sync	NoClash
a. hára+ʔáki	*!	
b. ☞ hár+ʔáki		*

P

hár+ʔáki	NoClash	Id(str)
a. hár+ʔáki	* !	
b. ☞ hár+ʔaki		*

External syncope

yúru##ʔámarʔɛhɛ	NoClash	Id(str)	Sync
a. ☞ yúru##ʔámarʔɛhɛ			*
b. yúr##ʔámarʔɛhɛ	* !		
c. yúr##ʔamarʔɛhɛ		* !	

The analysis of internal syncope is shown on the left. At the lexical ('**L**') level, the constraint responsible for syncope (here called Sync) outranks NoClash and thus forces deletion of morpheme-final vowels even between stressed vowels. The syncopated output of this level is the input to the postlexical ('**P**') level; Sync is no longer at issue, and NoClash is free to be satisfied by deletion of one of the stresses in clash, violating a lower-ranked stress faithfulness constraint (Ident(stress)). The analysis of external syncope is shown on the right, where the relevant inputs are strings of words and are therefore only evaluated at the postlexical level. At this level, NoClash and Ident(stress) both dominate Sync and so syncope is blocked between stressed vowels.

Consequences I conclude with discussion of a hypothesis stated in Kiparsky (2013), that two levels in Stratal OT may only be distinguished by the promotion of constraints to undominated status in the later level. Given that NoClash violations introduced lexically are ultimately repaired postlexically, this hypothesis appears at least not to be contradicted by the analysis proposed here.

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Adjunction and branchingness effects in Match Theory

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Match Theory (MT), an approach to the mapping from syntactic to prosodic structure couched within Optimality Theory (Selkirk 2011, Elfner 2012, Myrberg 2013), predicts that prosodic structure should closely resemble syntactic structure, and that deviations from perfect syntax-prosody isomorphism should only arise due to markedness constraints. We undertake several case studies of this theory's predictions, drawing primarily on data from phrasing in the Bantu language Kinyambo (Bickmore 1990), in order to address two theoretical issues which loom large in MT: the proper interpretation of adjunction structures, and the precise content of CON.

We employ a new JavaScript application which we have developed, allowing us to automatically generate and evaluate prosodic tree structures of arbitrary length and depth. Using a computationally rigorous methodology and taking into consideration all possible prosodic parses given by our GEN function, we conclude that high segments of XP in syntactic adjunction structures must be visible to Match (pace Selkirk 2011), and that Selkirk's (2011) treatment of adjunction makes a pathological prediction. We further find that a commonly assumed suite of constraints cannot compel well-known branchingness effects identified by Bickmore (1990) for Kinyambo.

The Adjunction Cohesion Pathology. The MT constraints MATCH(XP,ϕ) and MATCH(ϕ,XP) insist that every syntactic XP be matched by a corresponding ϕ, and vice versa. While what counts as a visible "XP" for the Match constraints is usually straightforward, a question arises in cases of adjunction. Given the segment theory of adjunction (May 1985, Chomsky 1986, Truckenbrodt 1999), the Match theorist must determine which segment(s) of a polysegmental category are "visible" to MATCH: the lowest (1a), the highest (1b), or all segments (1c) (an underlined node induces a MATCH violation if it is not mapped to a ϕ).

(1) a. $[_{\text{XP}}\ \underline{\textbf{YP}}\ \underline{\textbf{XP}}]$ b. $[_{\underline{\textbf{XP}}}\ \underline{\textbf{YP}}\ \text{XP}]$ c. $[_{\underline{\textbf{XP}}}\ \underline{\textbf{YP}}\ \underline{\textbf{XP}}]$

Following Truckenbrodt (1995, 1999), Selkirk (2011:483, fn. 38) suggests that (1a) is the correct treatment of such structures: only the lowest segment of XP is visible to the Match constraints. But this yields the wrong result for branching XPs in Kinyambo (1990), where a process of High Tone Deletion that applies only within the phonological phrase shows that a subject containing a noun and postnominal adjective is mapped to a single phrase:

(2) a. *High-Tone Deletion on non-branching subject* (Bickmore 1990)
[$_{\text{TP}}$ [$_{\text{NP}}$ abakózi] [$_{\text{VP}}$ bákajúna]] → ($_{\phi}$ abak$\underline{\text{o}}$zi b$\underline{\acute{\mathbf{a}}}kaj\underline{\acute{\mathbf{u}}}$na)
workers helped

b. *No HTD across branching subject's right boundary*
[$_{\text{TP}}$ [$_{\text{NP}}$ [$_{\text{NP}}$ abakózi] [$_{\text{AP}}$ bakúru]] [$_{\text{VP}}$ bákajúna]] → ($_{\phi}$ abak$\underline{\text{o}}$zi bak$\underline{\acute{\mathbf{u}}}$ru) ($_{\phi}$ b$\underline{\acute{\mathbf{a}}}kaj\underline{\acute{\mathbf{u}}}$na)
workers mature helped

We test sixteen distinct implementations of Match Theory, which vary in terms of three factors: (i) whether lower, higher, or all segments of XP are visible to Match, (ii) whether APs and AdvPs are visible to Match, and (iii) which of four distinct versions of CON we assume. We find that only those systems in which the **highest segment of XP is visible** can yield the correct result for the Kinyambo phrasings in (2). We further show that certain systems using Truckenbrodt's (1995,

1999) ALIGN and WRAP constraints do not have this property, and generate different and much larger typologies.

Aside from the narrow problem of failing to achieve descriptive adequacy for simple sentences in Kinyambo, our systems in which option (1a) is adopted give rise to a pathological prediction which we dub the **Adjunct Cohesion Pathology**. Such systems correctly predict languages in which BINARITY constraints force two of the three words in (2b) to phrase together. But since the maximal segment of the subject NP is invisible to the Match constraints, no constraint favors phrasing the adjective *bakúru* 'mature' with the noun *abakózi* 'workers', as opposed to with the verb *bákajúna* 'helped', as shown in (3).

(3) *A pernicious tie: neither adjunct phrasing is more harmonic*

Syntax in (2b), NP^{Max} invis.	BINMIN	BINMAX	MATCH(XP)	MATCH(ϕ)	EQSIS
((workers mature) (helped)) ∼ ((workers) (mature helped))	$e_{0\sim 0}$	$e_{0\sim 0}$	$e_{2\sim 2}$	$e_{1\sim 1}$	$e_{0\sim 0}$

The problem generalizes fully to other constructions; when full candidate sets are considered, we incorrectly predict no preference for phrasing adjuncts with their hosts. The problem does not arise when (1b) or (1c) is adopted, and the highest segment of XP counts for the Match constraints.

Branchingness Effects. Bickmore (1990) and others show that ϕ-construction can be sensitive to whether an XP is *branching*. For instance, the non-branching subject in (2a) is phrased with the verb, but the branching subject in (2b) is phrased alone. Twelve of sixteen MT systems we have tested are able to capture the effect for the simple examples in (2), thanks to BINARITY, but fail to generalize the effect to more complex syntactic structures, such as VPs with manner adverbs.

Tools for theory comparison. Rigorous work in OT approaches to the syntax-prosody interface requires generating and evaluating hundreds—sometimes thousands—of prosodic parses. Automation is therefore required. Our study of Kinyambo is designed to (i) demonstrate the importance of generating an entire candidate set and explicitly defining constraints, and (ii) provide an example of how to use our JavaScript application for interface research. Our software generates trees for every parse given a string of *n* words and an explicitly defined prosodic hierarchy. Our application implements GEN, CON, and EVAL, and provides a violation tableau which can be copied directly into OTWorkplace (Prince, Tesar, & Merchant 2013) for typological investigations.

Given the abundance of OT constraints proposed for the mapping from syntax to prosody, both in Truckenbrodt's (1995, 1999) Align/Wrap theory and in Match Theory, careful comparison of typological predictions is warranted. While our sixteen MT systems are all very similar, minor adjustments to GEN and CON are shown to yield wildly divergent typologies, underscoring the importance of such details. In sum, rather little is known regarding these theories' typological predictions, and our examination of the phrasing of Kinyambo represents a step toward developing a full understanding of the consequences of our prosodic representations and constraints.

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Formally mapping the typologies of interacting ABCD systems

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The theory of ***surface correspondence*** has been the focus of much recent work (e.g. Shih & Inkelas 2014, Faytak 2014, Akinlabi & Iacoponi 2015, etc.). Most of this work on '**ABCD**' falls along two avenues: analyzing consonant harmony as ***A****greement* ***B****y* ***C****orrespondence* (Rose & Walker 2004, Hansson 2010, etc.), and using the same mechanism to handle ***D****issimilation* (Walker 2000, Bennett 2013). Using recent advances in the understanding of formal OT typologies (Alber, et al. 2015), this talk analyzes the typologies of three ABCD systems, as a step towards a generalized solution to how any combination of ABCD systems can interact.

Surface correspondence was initially proposed to explain long-distance consonant agreement patterns (Walker 2000, Rose & Walker 2004, Hansson 2010). The guiding intuition is that non-local consonants agree because they are similar. This intuition is formalized as a correspondence relation over surface consonants. Consonants that are similar are required (by a family of CORR constraints) to correspond. Further restrictions are imposed on segments that correspond; for instance, by CC·IDENT(F) constraints that require corresponding consonants to agree with each other for [±F]. The combined effect is that consonants which have the same value on one feature are spurred to agree on another feature. The same constraints also produce dissimilation, because segments can satisfy CORR constraints by losing their essential similarity rather than undergo assimilation (Bennett 2013).

The correspondence relation at the core of surface correspondence theory has been a point of debate in some recent literature. Bennett (2013) explicitly argues for a single relation that is transitive and symmetric, in contrast to non-symmetric or non-transitive formulations used in previous analyses (e.g. Walker 2000, Hansson 2010). Also, subsequent proposals by Hansson (2014) and Walker (2015) argue that correspondence-based patterns must be indexed to the particular feature driving the correspondence – necessitating multiple SCorr relations.

The main locus of difference between various formulations of correspondence is their predictions about how ABCD patterns can interact. For example, Walker (2015) argues for multiple feature-indexed correspondence relations, on the grounds that Pasiego vowel harmony shows overlap between two harmonies in a way that isn't expected from a single-relation definition of correspondence. Previous arguments of this sort have tended to proceed in piecemeal fashion, by finding various empirical cases of interest and arguing that they are not predicted by other competing models of correspondence.

This talk approaches the same question from the other end: before comparing different formulations of the correspondence relation, we first must determine *what each one's typological predictions actually are.* We use OTWorkplace (Prince et al. 2015) to calculate and analyze the typologies of three constraint systems: **'2rt-vlessdiss'**, **'2rt-sibharm'**, and **'2rt-2f'**.

These three ABCD systems are defined with a common GEN component – a GEN which is simple enough for the candidate space to be considered exhaustively. Inputs and outputs consist of CV.CV forms, containing two Cs and a syllable boundary in between. The consonants are drawn from the set {t d s z}, allowing free combinability of two features – [±voice] and [±sibilant]. The syllable boundary approximates the effect of a domain boundary. The set of inputs consists of all possible combinations of two segments (n=16); the set of potential outputs consists of all such combinations, plus all possible surface correspondence structures for each.

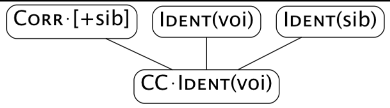
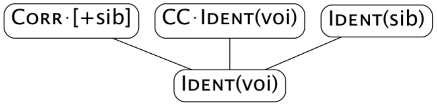
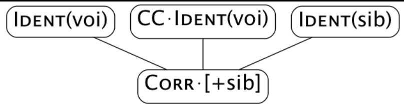
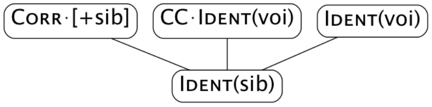
The CON components of the three systems are defined in (1). Systems 2rt-vlessdiss and 2rt-sibharm are analogs of real-world assimilation and patterns: voiceless dissimilation in Kinyarwanda (Bennett 2013), and voicing harmony between sibilants in Berber (Hansson 2010). The former contains CORR·[-voice] and a CC·EDGE constraint: a pair that can produce voiceless dissimilation across the edge of a syllable (ta.ta→[da.ta]). The latter has CORR·[+sibilant] and CC·IDENT(voice): a pair of constraints that can favor voicing harmony among [+sibilant] consonants (sa.za→[za.za]). The third system, 2rt2f, combines the other two: it tests what novel types of interactions emerge from the interaction of the constraints used in the analysis of two distinct correspondence-driven patterns.

(1) CON of the three ABCD systems considered

	2rt-vlessdiss	***2rt-sibharm***	***2rt2f***
SCorr constraints (markedness)	Corr·[–voice], CC·Edge-(σ)	Corr·[+sibilant], CC·Ident(voice)	Corr·[–voice], Corr·[+sibilant] CC·Edge-(σ), CC·Ident(voice)
Input-output faithfulness constraints	Ident(–voice)	Ident(voice), Ident(sibilant)	Ident(voice), Ident(sibilant)
Size of typology	3 lgs.	4 lgs.	16 lgs.

The typologies of systems 2rt-vlessdiss and 2rt-sibharm offer an extremely small range of choices. For example: system 2rt-sibharm has 4 constraints, and therefore 4!=24 total orders, yet these fall into only four sets producing distinct combinations of input-output mappings. These 4 languages can be characterized as a single 4-way choice, illustrated in (2).

(2) Typology of 2rt-sibharm illustrated

	Sibilants are Faithful	Unfaithful
Correspondence		
Non-correspondence		

Though these grammars share some extensional characteristics (e.g. faithfulness, or correspondence), there is no common structure between any of the rankings: none share any ERCs, because the choice of pattern is determined solely by the constraint on the bottom. ***This essential 4-way choice is a basic feature of ABCD systems in general.*** (The 2rt-vlessdiss typology make the same distinctions, modulo a gap straightforwardly due to GEN).

The more complex typology of 2rt2f contains both of its simpler progenitors. Inputs with two sibilants show precisely the same range of choices in 2rt2f as they do in 2rt-sibharm, and inputs with two voiceless Cs show exactly the same 3-way choice as in 2rt-vlessdiss. This generalizes to an important conclusion: ***if ABCD constraint systems freely interact, the distinctions from the typologies of each sub-system recur in the combined typology.***

Free combinability of the properties from 2rt-vlessdiss and 2rt-sibharm explain most of the patterns in the typology of 2rt2f. ***The novel interactions that emerge are distinguished only by differences in where the same basic 4-way choice can be made.*** For instance, CC·Edge can spur dissimilation of sibilants as well as voiceless Cs. So, while dissimilation in 2rt-sibharm can arise only between disagreeing sibilants (i.e. just where correspondence would *violate* CC·Ident), 2rt2f allows a further choice: sibilant dissimilation can apply just to disharmonic sibilants, or to any sibilants in different syllables. This interaction is formalized as the emergence of an additional intensional typological ***property*** (in the sense of Alber et al. 2015), whose values reflect a choice of which constraint drives the dissimilation.

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Long-last in language, short-last in verse

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Generative metrics has often focused on those properties of verse that are homologous to the properties of language. In this paper I will investigate an effect which at first blush appears to behave in the opposite way in verse and language: the relationship between ordering and weight. In language, heavy elements typically go last (1a,1b). In verse, the ordering is the opposite: shorter lines are placed last in couplets and stanzas (1c,1d). I will attempt to resolve this paradox.

(1) a. the good, the bad, and the ugly
b. # the ugly, the bad, and the good
c. Amazing grace! How sweet the sound / that saved a wretch like me.
d. # Amazing grace! This sound / has saved a bitter wretch like me.

The long-last effect in language is well-established in a wide variety of domains, in both phonology and syntax. Equally well-established is the opposite effect in some forms of verse, such as folk quatrains (Hayes & MacEachern 1996; Kiparsky 2006). In these corpora, there is a near-absolute preference for couplets where the second line is either equal or shorter than the first, and for quatrains where the last line is shortest. The short-last desideratum has been dubbed Saliency by these authors.

It is puzzling from a generative standpoint that verse should display opposite behavior from language. In this talk I resolve the paradox by appealing to the presence of additional constituency structure in verse, compared to language. I start with presenting some novel evidence for the short-last effect in verse. In order to test whether short-last structures are judged as more well-formed when they are rhythmical, I performed a rating study using stimuli constructed along two cross-cutting parameters: short-last vs. long-last, and rhythmic vs. unrhythmic. Participants were asked to rate on a scale of 1–7 each stimulus based on how smooth or fluent it sounds. The effect of rhythm on score is significant: sequences with 'good' rhythm get better scores ($F(1, 1918) = 112.3; p < 0.0001$). More surprisingly, there is a short-last effect: sequences ending in shorter words get higher scores ($F(1, 1918) = 60.873; p < 0.0001$). The hypothesis, however, is about the *interaction* of the two factors: does short-last give greater benefit to rhythymic than to unrhythmic lines? The interaction was indeed significant ($F(1, 1916) = 10.23; p < 0.0015$). In other words, when a well-formed rhythmic structure induces the perception of a metrical template, subjects appear to prefer stimuli with final empty beats, and/or with final short words. This confirms the existence of the end-weight paradox.

The interpretation of the paradox starts with the observation that verse, in addition to ordinary linguistic material, possesses a second layer of constituent structure that divides text into lines, feet, etc. This metrical structure must be signaled, and my argument is that the pressure to explicitly mark stanza boundaries yields the short-last effect.

The argument runs as follows. Consider a sequence of quatrains, where the goal is to induce the perception of a boundary after every fourth line. This can be accomplished by either a long-last structure or by a short-last structure. In a short-last structure, ends of lines across a quatrain boundary are further apart than ends of lines within a quatrain. In a long-last structure, beginnings of lines are further apart across a quatrain boundary than within a quatrain. (This follows similar ideas in how proximity is used to signal grouping in music, explicitly worked out by Jackendoff & Lerdahl 1983: 44).

The key is that, in addition to signaling the boundary between constituents, metrical quatrains have another well-established desideratum, Parallelism: lines prefer to have identical metrical structures. Parallelism, however, can only be satisfied by a short-last structure, not a long-last structure. This is illustrated schematically below. Each shema represents a quatrain. Each dark circle is a full beat; each light circle represents an empty beat. So, a line with four full beats is shown as ●●●●, a three-beat line as ●●●, and a four-beat line with a final empty beat as ●●●○.

As is clear from the schemas below, while different kinds of long-last structures can satisfy *either* Parallelism or signal the stanza boundary, only the short-last structure accomplishes both, and thus (in an OT sense, as I show in the talk) harmonically bounds the other two structures.

(2)

<table>
<tr><th></th><th></th><th>Parallelism</th><th>Signal boundary</th></tr>
<tr><td>4443</td><td>●●●●|●●●●|●●●●|●●●○</td><td>✓</td><td>✓</td></tr>
<tr><td>3334</td><td>●●●○|●●●○|●●●○|●●●●</td><td>✓</td><td></td></tr>
<tr><td>3334</td><td>●●●|●●●|●●●|●●●●</td><td></td><td>✓</td></tr>
</table>

Not only does this explanation resolve the paradox, it yields a prediction of the limits of the short-last effect in verse: the effect should not be observed in texts without Parallelism. I examine a number of such verse texts in both English and Russian—texts with a meter but no fixed line length, and texts with no meter. With the caveat of the weakness of arguing from absence of an effect, the prediction is confirmed: such texts do not display short-last effects.

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Abstract morphological information cued by phonotactics: Noun class disambiguation in Xhosa

Aaron Braver (Texas Tech University) and William Bennett (Rhodes University)

Introduction: While some phonologists assume that phonotactics can provide clues to abstract morphological information (Tucker et al. 1977, Moreton & Amano 1999, Gelbart 2005), this possibility has largely gone unconsidered in work on Bantu noun classes (see, e.g., Corbett 1991, Bresnan & Mchombo 1995). We present experimental evidence from Xhosa (Bantu, South Africa), showing that speakers make use of root phonotactics when assigning noun classes to nonce words. This suggests that noun class (and other abstract morphological information) is not only stored in the lexicon, but is also indicated by phonotactic cues.

Bantu languages are widely known for their complex noun class systems. A great deal of literature has explored the role of semantics in noun class assignment (Katamba 2003, Idiata 2005, etc.), under the tacit or explicit assumption that noun class is lexically stored. We show that, at least for nonce words, speakers assign noun class based in part on root phonotactics.

Xhosa noun classes: Xhosa has 15 noun classes with associated class prefixes; here we focus on the class 5 and class 9 prefixes, both of which are sometimes realized as /i-/. Because of this potential homophony, nouns of the shape *i*-CVCV could potentially belong to either class 5 or class 9. This ambiguity can be resolved by looking at the plural form of the noun: nouns of class 5 generally mark plurality by means of the *ama-* prefix (as in (1a–b)), while nouns of class 9 generally mark plurality with the *ii(N)-* prefix (as in (1c–d)).

(1) Homophony and disambiguation of class 5 and class 9 with prefix /i-/

	Singular	Plural	Gloss
a.	i-khaya	ama-khaya	‘home(s)’
b.	i-gama	ama-gama	‘name(s)’
c.	i-moto	ii-moto	‘car(s)’
d.	i-nkomo	ii-nkomo	‘cow(s)’

Historically, the class 5 and class 9 prefixes were not homophonous: class 5 nouns took the prefix **li-*, while class 9 nouns took the prefix **n(i)-*. The nasal in the historical class 9 prefix **n(i)-* induced several changes to following consonants, including de-aspiration and hardening of fricatives and /l/. (This process can be seen synchronically in forms like *–hle* [-ɬe] ‘good’ > *entle* [en-t͡ɬʼe] ‘cl.9-good’.)

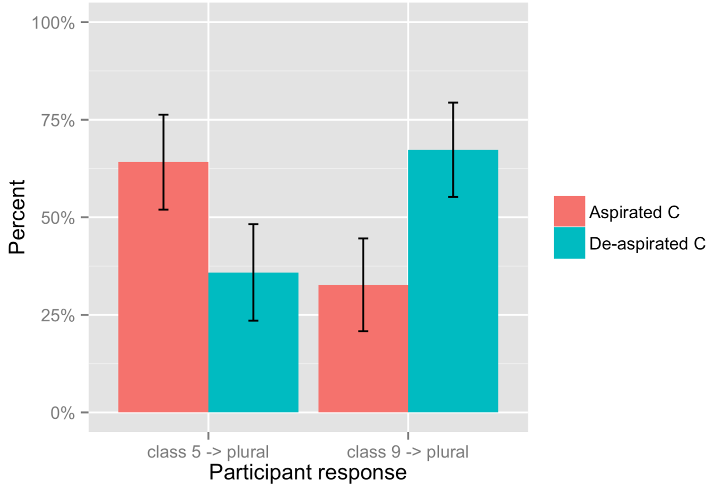
Due to the post-nasal changes that occurred historically in class 9 nouns, the first consonant of a root is a potential clue to its noun class. For example, consider the root *–khaya* in (2). If *-khaya* had received the historical class 9 nasal prefix, even if the nasal segment was subsequently lost, the synchronic form would show de-aspiration to *i-kaya*. If, however, as in the bottom branch, *-khaya* received the historical class 5 prefix **li-*, the synchronic form should not show such a change, and therefore would retain an aspirated initial stop: *i-khaya*. Speakers of modern Xhosa therefore might be able to distinguish between ambiguous class 5/9 nouns by working backwards. If the root-initial consonant is one that would *result* from de-aspiration, the noun is likely to be from class 9. Otherwise, if the root-initial consonant is one that should *undergo* de-aspiration (but has not done so), the noun is likely to be from class 5. In other words, root-initial aspirated consonants are likely to be found in class 5 nouns, whereas root-initial un-aspirated consonants are likely to be found in class 9 nouns.

(2)

i-n-khaya ⟶ i-kaya de-aspiration ↔ class 9
-khaya
i-li-khaya ⟶ i-khaya no change ↔ class 5

Experiment and results: We conducted a wug test (Berko 1958) to determine whether speakers of Xhosa do, in fact, use the phonotactic cues from post-nasal sound changes in order to classify unknown nouns. 10 native speakers of Xhosa from the Grahamstown area (Eastern Cape, South Africa) were shown nonce nouns with an *i-* class prefix, ambiguous between classes 5 and 9. Half of the nonce nouns contained root-initial consonants that could result from the post-nasal sound change (e.g., un-aspirated segments – the predictable result of de-aspiration), and half contained root-initial consonants that could have undergone this change (e.g., aspirated segments, which must not have undergone de-aspiration). Speakers were instructed to form the plural form of these nonce nouns: if they classify a given noun as class 5, they should produce the class 5 plural prefix *-ama*, whereas if they classify a given noun as class 9, they should produce the class 9 plural prefix *ii(N)*-.

As shown in the figure below, speakers were more likely to assign the nouns to class 5 (as indicated by their use of the *ama-* plural form) when the root-initial consonant was one that might have undergone a change (e.g., un-aspirated), and were more likely to assign the nouns to class 9 (as indicated by their use of the *ii(N)-* plural) when the root-initial consonant was one that might undergo a change (e.g., aspirated).



Conclusion: These findings show that speakers of Xhosa use knowledge of phonotactic patterns in determining the noun class of nonce words. More broadly, our results support the view that speakers can use low-level phonotactic cues (in addition to lexical entries) to help determine abstract morphological information.

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A foot-based Harmonic Serialism typology of Bantu bounded tone

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1 Towards a factorial typology of tone

The typology of tone is a longstanding research topic within OT (e.g. Meyers 1997; Yip 2002; Zoll 2003). Bantu bounded tone patterns have received particular attention in this respect (Bickmore 1996; Cassimjee and Kisseberth 1998; Key 2007). However, unlike analogous work on stress (Gordon 2002; Kager 2005), these works fail to investigate the full range of typological predictions that follow from their proposals. This talk presents a new approach to the typology of Bantu bounded tone, with a focus on investigating the range of predictions made.

An overview of bounded tone patterns is shown in (1). $\acute{\sigma}$ is a high-toned syllable, other syllables are low.

(1)

Pattern	**UF**	**SF**	**Example attestation**
Binary spreading	..$\acute{\sigma}\sigma$..	..$\acute{\sigma}\acute{\sigma}$..	Ekegusii (Bickmore 1996)
Ternary spreading	..$\acute{\sigma}\sigma\sigma$..	..$\acute{\sigma}\acute{\sigma}\acute{\sigma}$	Copperbelt Bemba (Bickmore and Kula 2013)
Binary shift	..$\acute{\sigma}\sigma$..	..$\sigma\acute{\sigma}$..	Kikuyu (Clements 1984)
Bin. shift + bin. spread	..$\acute{\sigma}\sigma\sigma$..	..$\sigma\acute{\sigma}\acute{\sigma}$..	Saghala (Patin 2009)
Ternary shift	..$\acute{\sigma}\sigma\sigma$..	..$\sigma\sigma\acute{\sigma}$..	Sukuma (Sietsema 1989)

The languages in (1) show a variety of spreading and shifting patterns. Crucially, this tonal mobility is restricted to a two or three-syllable domain. It is proposed that this domain is a manifestation of foot structure. The proposal fits with recent literature arguing for the organizing role of foot structure beyond stress assignment (Pearce 2006; Shimoji 2009; Bennett 2012).

2 Foot-driven tone in Harmonic Serialism

Previous research has analysed bounded tone using foot structure (see Sietsema 1989; Bickmore 1995, for overviews). There, foot edges mark the bounding domain. For example, binary shift might follow the steps in (2). Crucially, after step 2, spreading halts because the edge of the foot has been reached.

(2)

$\acute{\sigma}\sigma\sigma$	$\rightarrow$	$(\acute{\sigma}\sigma)\sigma$	$\rightarrow$	$(\acute{\sigma}\acute{\sigma})\sigma$	$\rightarrow$	$(\sigma\acute{\sigma})\sigma$
0. UF		1. Footing		2. Spreading		3. Delinking

This proposal follows Martínez-Paricio and Kager (forthcoming), hereafter 'MPK', in assuming that a binary foot and an unparsed syllable can combine to form a layered, trisyllabic foot. The typological trend of two and three-syllable bounding then follows from languages preferring either binary or ternary feet.

Derivations such as (2) require a grammar that can model seriality. This talk adopts Harmonic Serialism ('HS', Prince and Smolensky 1993/2004; McCarthy 2010) for that purpose. HS is a variation of standard OT that makes two changes. Firstly, evaluation is serial; an output is fed back into the grammar until no changes occur. Secondly, GEN can only apply one 'operation' to the input, thus restricting the candidate set. The operations considered here are tone linking and delinking, foot construction, tone split, and tone deletion.

Finally, this talk proposes a constraint set to relate feet to tone. This proposal expands on De Lacy (2002) by allowing for licensing effects. The relevant constraints are instantiated for the different foot layers of MPK, and for both left and right edges of feet. The constraint set further includes standard faithfulness and markedness constraints for tone, and syllable parsing constraints taken from MPK.

3 Investigating the full typology

To keep the computation feasible, the typological investigation of the present approach has made several limitations. Firstly, the input is a single form, $/\sigma\sigma\sigma\sigma\sigma\sigma\sigma\sigma\acute{\sigma}\sigma\sigma\sigma\sigma\sigma\sigma\sigma\sigma/$. The 17-syllable length of this form helps to distinguish between bounded and unbounded patterns, and various domain sizes. The middle syllable of the form is linked to a high tone. This way, both leftward and rightward patterns can be detected.

Secondly, a random sample of grammars is used. Specifically, 200,000 random constraint rankings were generated, and the input form was then fed to a HS grammar for each ranking. The outputs of these trials are collapsed across foot structures so that only surface tone is considered. Symmetrical results are also collapsed. Frequency counts for a selection of patterns are shown in 3.

(3)

Description	UF	SF	Frequency	Attestation
Faithful mapping	$..\acute{\sigma}..$	$..\underline{\acute{\sigma}}..$	98229	✓
Deletion	$..\acute{\sigma}..$	$..\underline{\sigma}..$	59851	✓
Bounded spread				
Binary spreading	$..\acute{\sigma}\sigma..$	$..\underline{\acute{\sigma}}\acute{\sigma}..$	26587	✓
Ternary spreading	$..\acute{\sigma}\sigma\sigma..$	$..\underline{\acute{\sigma}}\acute{\sigma}\acute{\sigma}$	3371	✓
‘Two-way’ spreading	$..\sigma\acute{\sigma}\sigma..$	$..\acute{\sigma}\underline{\acute{\sigma}}\acute{\sigma}..$	2370	✗
Quaternary spreading	$..\acute{\sigma}\sigma\sigma\sigma..$	$..\underline{\acute{\sigma}}\acute{\sigma}\acute{\sigma}\acute{\sigma}..$	67	✗
Bounded shift				
Binary shift	$..\acute{\sigma}\sigma..$	$..\underline{\sigma}\acute{\sigma}..$	88	✓
Binary shift+spread	$..\acute{\sigma}\sigma\sigma..$	$..\underline{\sigma}\acute{\sigma}\acute{\sigma}..$	31	✓
Ternary shift	$..\acute{\sigma}\sigma\sigma..$	$..\underline{\sigma}\sigma\acute{\sigma}..$	1	✓
Unbounded spread				
Unbounded to final	$..\acute{\sigma}\sigma..\sigma]$	$..\underline{\acute{\sigma}}\acute{\sigma}..\acute{\sigma}]$	221	✓
Unbounded to penult	$..\acute{\sigma}\sigma..\sigma\sigma]$	$..\underline{\acute{\sigma}}\acute{\sigma}..\acute{\sigma}\sigma]$	186	✓
Unbounded to antepenult	$..\acute{\sigma}\sigma..\sigma\sigma\sigma]$	$..\underline{\acute{\sigma}}\acute{\sigma}..\acute{\sigma}\sigma\sigma]$	8	✓

The approach correctly predicts all the attested bounded tone patterns mentioned previously in (1). There is some overgeneration: the ‘two-way’ and quaternary spreading patterns are generated, but not attested. The full talk will discuss the role of extragrammatical factors in paring down the predicted typology.

An exciting result is the unbounded spreading category; although the framework was aimed at accounting for bounded patterns, unbounded patterns are also generated. The listed patterns are attested in a.o. Copperbelt Bemba (Bickmore and Kula 2013), Shambaa (Odden 1982), and Xhosa (Downing 1990), respectively. The full talk will discuss more generated patterns, including unbounded shift and iterative tone.

4 Conclusion

This talk has presented a HS framework using layered feet to account for Bantu bounded tone patterns. For the first time in tone typology, the framework's range of predictions was investigated, using a random sample of grammars. The predictions include attested and unattested bounded patterns, as well as attested unbounded patterns. In conclusion, this talk advances our understanding of problems in tone typology, and their potential solutions.

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The Emergence of the Binary Foot in Mandarin

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While the binary foot is a common requirement across languages, formalized as a constraint, FT-BIN is violable, and predicts patterns of latent binarity in some languages. This talk outlines the prosodic behaviour of some compounds in Mandarin, which are demonstrated to yield output structures that must consist of binary tonal feet, and where otherwise additional obligatory syllables will undergo tonal deletion in order to satisfy this requirement. Finally, we tackle the problem that these feet pose: while they appear to be an emergent effect, whereby an optimal unmarked structure surfaces in specific contexts, the context here is a morphosyntactically derived form, contrary to predictions of recent approaches to constraint application.

Verbal Compounds in Mandarin

In Mandarin, [VN] compounds, which involve the merging of a verbal root with a nominal root, exhibit a process of syllable deletion. (1a) illustrates a phrasal form with disyllabic V and N, and (1b) illustrates the compounded [VN] form:

(1)	a.	ta	zai	shanli	**xunzhao**	**mogu**.
		he	in	mountain	look.for	mushroom
		‘He looked for mushrooms in the mountain.’				
	b.	ta	zai	shanli	**xun-mo**.	
		he	in	mountain	look.for-mushroom	
		‘He looked for mushrooms in the mountain.’				

Regardless of the syllable count of the individual nominal and verbal roots, the resulting structure must be two syllables in length, even if this forces the deletion of a syllable (as illustrated above). We take this to be the emergence of a disyllabic foot in derived contexts. Given that there are no stray syllables allowed in this construction, the ranking required for the compounds must be FT-BIN » MAX. We will expand on the idea of the disyllabic foot by claiming that it is actually a *tonal* foot.

Crowding in Tonal Feet

Previous works have argued for a tonal foot in Mandarin, with some claiming the foot is left-headed (Shih 1986, Yip 2004), and others that it is right-headed (Feng 1997). We remain agnostic as to whether feet are left- or right-headed in Mandarin, as there appear to be no constraints on the tonal structure of [VN] compounds; however, one phenomenon argues strongly for the resulting feet being tonal in nature, rather than syllable-based. This involves the appearance of classifiers in [VN] compounds, which surface between the verbal and nominal root, but with the citation tone changed to “neutral” tone:

(2)	a. wan (bowl CLASSIFIER)	Tone: 3
	b. he-**wan**-tang ‘drink a bowl of soup’ (drink-bowl-soup)	Tones: 1 **0** 1

Assuming that neutral-toned syllables lack a phonological tonal specification in Mandarin (Huang 2012), the existence of these structures indicates that the toneless syllable, while parsed to a tonal foot, is metrically inert in the sense that it does not count in the computation of binarity. The fact that these toneless syllables can intervene between syllables with specified tones indicates that they must belong to a single foot:

(3) a. gan-zou ‘drive somebody away’ (drive-leave) Tones: 3 3

b. gan-**bu**-zou ‘can’t drive somebody away’ (drive-not-leave) Tones: 3 **0** 3

c. gan-**de**-zou ‘can drive somebody away’ (drive-aux-leave) Tones: 3 **0** 3

Thus, the while these forms are trisyllabic, an optimal binary *tonal* foot motivates the tone deletion: since there are three morphemes, syllable deletion is not an option (as this would delete an entire morpheme); however, deleting a tone for a toneless foot achieves the optimal prosodic structure, thus Ft-Bin » Max-Tone. It is only in these contexts where the conditions on tone over-ride the disyllabicity requirement.

Implications Surrounding Ft-Bin

In recent work on English and Navajo, Martin (2011) has claimed that phonological constraints can have a categorical effect within lexical items that is expressed as a gradient effect in larger, derived contexts such as compounds (cf. also Mohanan 1993 for the idea that constraints apply more stringently to smaller domains). The problem raised by the Mandarin compound pattern is that the binary foot effect holds in [VN] compounds, but Ft-Bin is freely violable in lexical forms. For example, Zhou (2004) found that the *Xinhua New Word Dictionary* includes 2168 words, among which 1204 are disyllabic, 324 are trisyllabic, and 449 are quadrisyllabic, and that *The Contemporary Chinese Dictionary* has 58,481 words, among which 39548 are disyllabic, 4828 are trisyllabic, and 4798 are quadrisyllabic. The implication is that within lexical items, Ft-Bin is violable, but clearly emerges as a statistical preference, whereas in derived contexts, the constraint is categorically satisfied. We thus claim, based on the above patterns, that phonological constraints may in some cases apply more stringently to larger or derived domains than to lexical items (the *opposite* of Martin’s claims for English). We present further support for this view from other derived syntactic structures.

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Exploring the relationship between static and dynamic generalizations in learning

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Background: One strategy that has been suggested to aid in learning phonological alternations is the prior learning of static phonotactic generalizations. The hypothesis is not only that phonotactic learning facilitates the learning of phonological alternations, but that both sources of knowledge are derived by a shared mechanism (see Hayes 2004, Tesar & Prince 2007, Pater & Tessier 2005, Hayes & Wilson 2008). In this study, we investigate these claims using an artificial language experiment where learners are taught a language in which a static phonotactic pattern and the dynamic generalization are either matched or mismatched when a morphological decomposition is available. If learners are biased to encode these generalizations with the same mechanism, we expect to see impeded performance in alternation learning when these generalizations do not match.

Methods: American English listeners were trained on one of two artificial languages: derived-environment (DEE) and across-the-board (ATB) modeled on /t/-palatalization in Korean (e.g., Kiparsky 1993). Both artificial languages contained singular and plural words where plurality was indicated by suffixing /-i/. In both languages, stem-final [t] and [d] became [ʧ] and [ʤ] respectively before [i] at the morpheme boundary. While [ti]/[di] sequences were unattested within the singulars in the ATB language, they were attested in the DEE language. That is, in the ATB language, the dynamic generalization (ti/di→ʧi/ʤi) matches the static generalization (*ti/di), but in the DEE language, there is a mismatch (ti/di→ʧi/ʤi, but ti/di is legal).

The artificial languages were constructed using consonants [p, t, ʧ, b, d, ʤ] and vowels [a, i, u]. In the DEE language, 36 non-words, either of the form CVC (e.g., [bap]) or CVCVC (e.g., [batup]), were created as singulars. Two thirds of the items ended in the filler sounds {p, b, ʧ, ʤ} with 10 each of {p, b} and 2 each of {ʧ, ʤ}. The remaining 1/3 of the items ended in the target sounds {t, d}. Each possible CV combination, including [ti] and [di], appeared equally across all singulars. For each singular, a plural was also created. For non-words ending in {p, b, ʧ, ʤ}, plurals were created by simply suffixing the vowel [i] to the singular stem (e.g., singular [batup], plural [batupi]). For non-words ending in {t, d}, plurals were created in the same way, except that the final consonant of the stem changed to the corresponding palatoalveolar affricate [ʧ] or [ʤ] (e.g., singular [baput], plural [bapuʧi]). Non-words were randomly paired with one of 36 digital images showing singular objects and another 36 showing plural objects. The ATB language consisted of the same stimuli except that the four stems with [ti] or [di] sequences were excluded from training, resulting in a total of 32 non-words instead. All other properties of the language were kept as similar as possible to the DEE language.

Participants (currently - ATB: n=14; DEE: n=17) were recruited via the UCLA Psychology Subject Pool and tested online using Experigen (Becker & Levine, 2014). The training phase consisted of two self-paced blocks. In each block, participants heard singular and plural pairs with their respective images. Trials were randomized within each block. In the verification phase, participants performed a well-formedness judgment on both familiar and novel singulars to probe what static generalizations about stems they learned. Novel singulars were created in a similar manner as the training items. Participants were presented a singular non-word and had to decide whether what they were hearing was a possible word from the language they had just learned (two-alternative forced choice). Non-words were not paired with images in this phase. Finally, in the generalization phase, participants first saw a singular image paired with a singular non-word. When the plural image appeared on the screen, participants heard two plural options:

one changing and one non-changing plural option, the order of which was counterbalanced such that each option appeared first equally often. Participants were asked to choose the correct plural form for the image for both familiar and novel singulars.

Results: In the verification phase, participants' rate of endorsement of singulars differed by trained language (Fig.1L). In the DEE language, participants endorsed words with both [ti] and [ʧi] equally, regardless of whether the item was familiar or novel, consistent with the stem-internal static generalization in training (62% vs. 67%: β=-.42, z=-1.42, p=0.33). In contrast, in the ATB language, participants endorsed items with [ti] significantly less frequently than those with [ʧi] (64% vs. 79%: β=-1.0, z=-4.46, p<0.001). Together, this indicates that participants successfully learned the static distribution of sound sequences within stems in each language. In the generalization phase, participants in both languages chose the changed plural significantly more often with {t, d}-final singulars than {p, b, ʧ, ʤ}-final singulars, indicating that they successfully learned the phonological alternation (DEE – 55%: $\chi^2(1)$=32.55, p<0.001; ATB – 60%: $\chi^2(1)$=11.55, p<0.001; Fig.1R). Interestingly, participants in the ATB language, incorrectly chose the changed plurals for {p, b, ʧ, ʤ}-final singulars more often than in the DEE language (24% vs. 12%). This suggests that participants in the ATB language were more likely to make a product-oriented generalization (e.g. Bybee, 2001) that plurals should end with [ʧi/ʤi], regardless of the source consonant.

Discussion: Our results show that learners are able to learn the alternation pattern in both languages equally well, despite learning different static phonotactic generalizations. In fact, learners in the DEE language successfully learned both the static and dynamic generalizations despite the mismatch, keeping the domains of static and dynamic generalizations separate. This suggests that a learner need not use the same mechanism to encode both static and dynamic generalizations once they have a morphological parse of the artificial language. We are currently investigating whether learners are biased to use the same mechanism to encode both static and dynamic generalizations when morphological information is not available and phonotactic learning has to occur over unparsed forms. Together, the results from these two experiments will tell us whether learners are initially biased to maintain symmetry between static and dynamic generalizations.

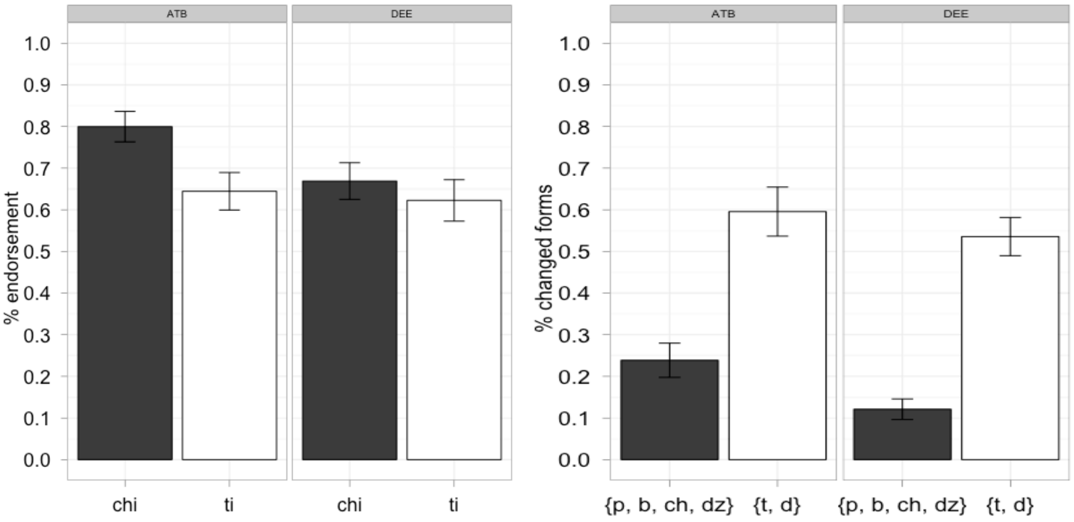

Figure 1 (L): Endorsement rate by word-type by language (Verif. phase)
(R): Proportion of changed forms selected by final consonant by language (Gen. phase).
'ch' = [ʧ] ; 'dz' = [ʤ]

"Tense" /æ/ is still lax: A phonotactics study

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Introduction: The vowel /æ/ is widely studied as a sociolinguistic variable in American English (AmE). Several dialects have both the lax [æ] allophone and an allophone [ɛə] that is described as raised and tensed, even though the vowel is historically lax. This is noteworthy because phonotactic restrictions in English apply to the classes of tense and lax vowels; for example, only lax vowels are found preceding coda clusters /sk, sp/, e.g., [lɪsp], but *[lisp]. In this paper, I ask whether the /æ/ used by Northern Cities Shift (NCS) speakers, which is realized as tense [ɛə] in all environments, still patterns as a lax vowel. I test the NCS specification through a forced-choice well-formedness judgment task, in which I look for evidence of a phonotactic restriction on the appearance of /æ/ in a lax-only /Vsk, Vsp/ environment. I compare the performances by speakers of California English (CalE) and NCS speakers. As I will show, NCS speakers treat /æ/ as a lax vowel, preferring it over tense vowels in this environment, just like CalE speakers.

AmE /æ/ systems: CalE is representative of the most common AmE /æ/ system, in which the tense allophone only occurs pre-nasally (*cat* [kæt], but *hand* [hɛənd]). The NCS system, on the other hand, tenses /æ/ in all environments (*cat* [kɛət], *hand* [hɛənd], etc.). These are two examples of several different systems attested for the vowel among American English dialects (Labov et al. 2006). In most, the tense allophone is distinguished as raised and lengthened, often diphthongized. Both the lengthening and offglide of a diphthong give the acoustic impression of tenseness.

Tense/Lax distinction: Tense (/i,e,u,o,ɔ,ɔɪ,aɪ,aʊ/) and lax (/ɪ,ɛ,ʊ,ʌ,ɑ,æ/) vowel classes are phonologically active in English. This is evidenced both in morphophonological processes like trisyllabic laxing (Lee 1996) and in phonotactic distribution. Tense vowels are permitted word-finally (*she* [ʃi], *die* [daɪ], etc.), preceding word-final /ð/ (*bathe* [beð], *loathe* [loð], etc.), and preceding a vowel (*riot* [raɪ.ət], *react* [ri.ækt], etc.). Lax vowels may not occur in these environments (*[dɪ], *[bɪð], *[rɛ.ot]). On the other hand, lax vowels may occur preceding /ŋ/ (*hung* [hʌŋ], *sing* [sɪŋ], etc.), and in monomorphemes, lax vowels may precede consonant clusters containing a noncoronal (*wisp* [wɪsp], *mask* [mæsk], etc.). Tense vowels are not found in these environments (*[toŋ], *[tosp]) (Green 2001). The latter restriction, particularly /Vsk, Vsp/, is the focus of this experiment. As seen, the lack of tense/lax vowels in a given environment represents a systematic gap in the language.

Methods: This experiment relies on CalE speakers having a restriction in the phonotactic grammar on tense vowels in /Vsk, Vsp/. If this were the case, a comparison of NCS and CalE responses would indicate the tenseness of NCS /æ/. CalE speakers are expected to treat /æ/ as lax, preferring it and other lax vowels to tense vowels in the experiment; if NCS speakers treat /æ/ as lax, they should do the same. If they treat it as tense, they should instead significantly prefer other lax vowels over /æ/.

Speakers have been found to distinguish between systematic and accidental gaps in experimental conditions eliciting well-formedness judgments (Frisch and Zawaydeh 2001, Kager and Pater 2012, inter alia). In order to obtain these, a forced-choice experiment was designed using Experigen (Becker and Levine 2014), in which nonce minimal pairs (e.g., [desp] vs. [dɪsp]) were presented to participants, who were then asked to indicate which of the pair sounded more like a possible word of English. The nonce word pairs differed only in vowel, while the onset and coda were the same for each trial. Each test trial used the codas /sk, sp/, which are lax-only environments. All front vowels /i, ɪ, e, ɛ, æ/ were used in this experiment. Only frames which yielded nonce words for each front vowel were used (i.e., /dVsp/ could be used: /dæsp, dɛsp, dɪsp, disp, desp/ are all nonce words. However, /rVsk/ could not: /ræsk, rɛsk, risk, resk/ are nonce words, but /rɪsk/ is an attested word). As test conditions, /æ/ was compared to each of /i, ɪ, e, ɛ/, while /i-e, i-ɛ, ɪ-e, ɪ-ɛ/ comparisons were used to control for the tense/lax distinction in general, as well as potential effects of height. Fillers were created using the same vowels and codas /b, g, p, k/. CalE speakers comprised a control group that did not engage in /æ/ tensing, while NCS speakers formed the test group that did. Stimuli were recorded such that participants heard their variant of /æ/. This meant CalE heard a lax [æ], while NCS speakers heard tense [ɛə]. Participants saw 120 trials in total: 80 test, 32 filler, and 8 practice. In total, 11 CalE and 9 NCS speakers comprise the data reported here, making for 1600 test items.

Results: For a given pair of vowels, if there is a phonotactic restriction, we would expect the licit one to be chosen at a rate well above chance, that is, well above 50%. Bonferroni corrected binomial tests show that this is the case for CalE speakers: in conditions that pit a tense vowel against a lax vowel, where we would expect a phonotactic restriction to be visible, we find that the lax vowel is chosen at a rate significantly above chance ($p<0.0015625$). CalE speakers do not choose a vowel significantly above chance in conditions that compare two lax or two tense vowels. NCS speakers behave similarly: /æ/ is favored over /e,i/, while /ɛ/ is favored over /i/. A logistic mixed effects regression model (Bates et al. 2014) of conditions that compare an attested vowel /æ, ɛ, ɪ/ to an unattested vowel /e, i/ shows that the attested vowel is significantly favored over the unattested vowel ($p<.001$). Additionally, /æ/ is treated no differently than /ɛ/, with both groups disfavoring /ɪ/ ($p<.05$). There was no main effect for dialect. In sum, there appears to be no phonotactic restriction on /æ/ in /Vsk, Vsp/ environments for either set of speakers.

Discussion: Both the binomial tests and logistic regression model point to CalE having a restriction on tense vowels in /Vsk, Vsp/ environments, with /æ/ patterning as lax. Because NCS speakers do not differ from CalE speakers in treatment of /æ/, the results also indicate that NCS /æ/ is phonologically lax, regardless of its phonetic characteristics. This serves to support an emergentist view of phonologically active classes (Mielke 2008). It appears NCS participants generalized their phonotactic grammar from attested lexical items, rather than from phonetic characteristics. That is, being long and a diphthong does not make /æ/ inherently tense, even though the other long vowels and diphthongs are tense. Instead, being attested in positions in which only lax vowels appear makes NCS /æ/ lax.

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Learning generalisations in the face of ambiguous data

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Background There is little experimental work probing how learners extract phonological generalisations from input that is ambiguous between multiple generalisations. It is unclear if they learn: (i) the most specific generalisation that accounts for the data - *Subset Principle* (**SP**; Berwick 1985; Hale and Reiss 2003), (ii) the simplest (most general) generalisation that accounts for the data - *Simplest Generalisation* (**SG**; Chomsky and Halle 1968), (iii) multiple (simple) generalisations, all of which are consistent with the data - *Multiple Simple Generalisations* (**MSG**; Hayes and Wilson 2008). The little experimental work there is on the issue suggests that learners use SP (Gerken 2006). We provide evidence that learners use SP when there is a smaller set of environments, and MSG with more variegated environments.

Experiment 1 The experiment had two phases: *training* and *test*. In the training phase, participants listened to and silently mouthed 100 CVCV nonce words [C=/p,b,t,d,f,v,s,z/, V=/a,i,u/], where the consonants obeyed both voicing and stop harmony simultaneously (e.g., ✓[tipa, bida, fisa], *[tisa,bipa,fida]). In the test phase, participants heard CVCV nonce words of the following types: (a) 12 words they heard during training (OldStims), (b) 12 words they did not hear during training but that obeyed exactly the same pattern (NewStims), (c) 12 words that had only a voicing harmony pattern (OnlyVoicing), (d) 12 words that had only a stop harmony pattern (OnlyStop), and (e) 12 words that did not have either a stop or voicing harmony pattern (NoPattern). The participants were asked if the the word they heard was possible in the "language" they had learned during training. 14 English-speaking undergraduates participated in the experiment for extra-credit.

Hypotheses SP predicts that learners will prefer NewStims and OldStims over the other three, which should be undifferentiated. This is because NewStims have exactly the same pattern as OldStims (stop and voicing harmony). SG predicts that some learners will prefer OnlyVoicing stimuli, while others will prefer the OnlyStop stimuli, and that they will find NewStims as acceptable as either. Thus, they might be equally good with all three. Finally, MSG predicts that learners will prefer both OnlyVoicing and OnlyStop equally, and this would potentially have an additive effect on the NewStims, which would be accepted at a higher rate since they are consistent with both generalisations.

Results A logistic mixed-effects model was fitted to the Yes-No responses with random intercepts for participants and stimuli. The independent variable was the generalisation type of each stimulus (Type). The NoPattern stimuli were the baseline. Results indicate that all of the test types were recognised as possible more so than the NoPattern stimuli; however, the Yes-responses for the NewStims were as high as for OldStims (Table 1 left, Fig. 1 left). The results are most consistent with MSG.

Experiment 2 There was a potential confound in Exp. 1: the NewStims had consonantal sequences that learners heard during training. Therefore, learners might have performed so well on them simply because they kept track of the consonantal sequences. So, in Exp. 2, during training, participants heard a list of nonce words similar to Exp. 1, except that a particular combination of consonants (in both orders) was withheld for testing (e.g., no words with the patterns dVbV or bVdV were presented to the participant). The excluded consonant pair was randomised for each subject. The combinations that were withheld were used exclusively for the NewStims in the test phase of Exp. 2. 20 English-speaking undergraduates participated in the experiment for extra-credit.

Hypotheses Same as in Exp. 1.

Results A logistic mixed-effects model (similar to Exp. 1) indicated that *only* the NewStims and the OldStims were significantly different from the NoPattern responses (Table 1 right, Fig. 1 right). The results suggest that only the NewStims were acceptable beyond the NoPattern levels, thereby supporting SP.

Overall Discussion The only difference between Exp. 1 and Exp. 2 was that the test set for NewStims of the latter contained new consonantal sequences not observed during training. As a consequence, there were fewer different consonantal combinations (environments) in Exp. 2 during training, than in Exp. 1. Overall, the results suggest that, initially, learners learn generalisations according to the SP, and as more evidence from different environments gathers, listeners attempt to move towards accounting for the patterns using simpler generalisations (MSG).

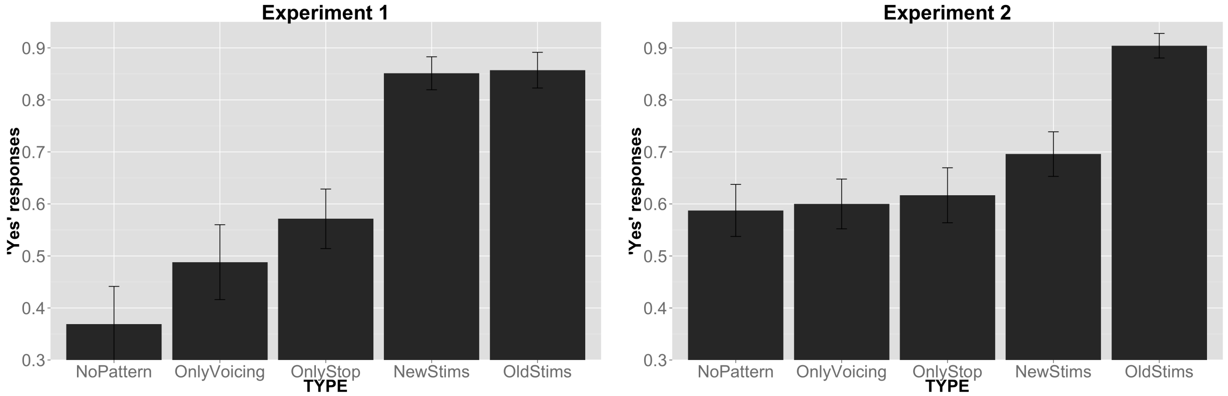

Figure 1: 'Yes' responses for Experiment 1 (left) & Experiment 2 (right).

	Experiment 1			Experiment 2		
Fixed Effect	Estimate	z value	Pr(>|z|)	Estimate	z value	Pr(>|z|)
(Intercept)	-0.60	-1.76	0.078	0.43	1.87	0.06
Type: OldStims	2.77	8.09	<**0.001**	2.06	7.63	<**0.001**
Type: OnlyVoicing	0.62	2.33	**0.02**	0.06	0.28	0.78
Type: OnlyStop	1.04	3.81	<**0.001**	0.14	0.67	0.5
Type: NewStims	2.73	7.95	<**0.001**	0.53	2.55	**0.01**

Table 1: Logistic mixed-effects models for Experiment 1 (left) & Experiment 2 (right).

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Articulatory retiming: investigations from cross-modal linguistic evidence

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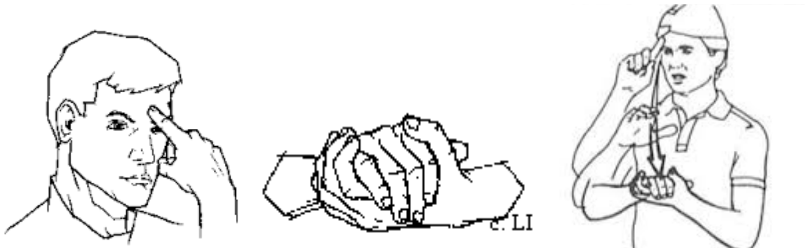
The study of phonological assimilation processes has long been a window into the organization and coordination of articulatory units of spoken language. Within the framework of Articulatory Phonology, assimilation is motivated by the retiming of articulations such that there is gestural overlap in the production of sequences of phonological segments (Browman & Goldstein, 1992). Quantitative evidence from cross-linguistic comparison shows common strong tendencies toward anticipatory retiming in consonant-to-vowel assimilation, in which the gestures associated with a following vowel are anticipated and retimed to start during the articulation of a consonant (Bybee & Easterday under review). Despite these robust findings, linguists have yet to compare these tendencies across modalities. Though some scholars have applied the Articulatory Phonology framework to the analysis of signed languages (Wilcox, 1988; Keane, 2013), to our knowledge, no research currently exists on gestural retiming in signed languages.

In the present study, we compare retiming tendencies in signed and spoken modalities. Our data on assimilation in spoken languages comes from Allophon, a database of 820 allophonic processes extracted from a sample of 82 languages selected to maximize genetic and geographic diversity (Bybee & Easterday under review). For each allophonic process, the articulatory gestures associated with the input segment, the output segment, and the conditioning environments were coded, and all retimings analyzed. Our analysis shows that gestural retiming was involved in 371 of the 820 processes; that is, the output segment was produced as an effect of the overlap of an articulatory gesture associated with the conditioning environment. Of these processes, 253 (68%) involve anticipatory retiming, while 118 (32%) involve carry-over retiming. A typical example of anticipatory retiming is represented by the following process in Margi (Chadic, Nigeria): Consonants become palatalized preceding a high front vowel (Hoffman 1963: 40). Here during articulation of the consonant, the tongue body moves into the high front position associated with the following high front vowel.

Our data on retiming processes in signed languages comes from phonological analyses of what have been traditionally called compounds. Signed compounds are formed when two signs become fused phonologically. In addition to rampant reduction at these sign boundaries, there is often evidence of articulatory retiming among segments of the two signs as they merge. A pilot study of signs from American Sign Language (ASL) analyzed 50 compounds to determine whether signed languages follow a similar preference for anticipatory retiming. Examples of such compounds include BELIEVE, which is a compound of the signs THINK and MARRY in which the orientation of the 1-handshape in THINK assimilates to match the orientation of the handshape in MARRY (fig. 1).

Of 50 tokens, we observed 25 examples of assimilation. Of these 25 instances of assimilation, 19 (76%) were found to be anticipatory while only four (16%) were instances of carry-over retiming. Additionally, two tokens within our set showed evidence of both anticipatory and carry-over retiming, each in different features of the sign. These preliminary analyses suggest that signed languages, like spoken languages, have a preference for anticipatory retiming.

Here we suggest that like spoken language, retiming in signed languages is governed by domain-general modality non-specific processes related to motor routines. Neuromotor research suggests that even non-human primates plan subsequent motor routines during their current motor program (Miyashita et al. 1996; Rand et al. 1998; Rhodes et al. 2004.) Furthermore, as Bybee (2015) states, "producing a word or a phrase containing a sequence of articulatory gestures can be seen as analogous to other repeated behaviors, such as starting your car or tying your shoes, (p. 47)." Thus assimilation arises from the repetition and entrenchment of frequent and practiced neuromotor activity. Findings from spoken and now signed languages support the view that anticipatory retiming is an important domain-general cognitive tendency in organisms occurring within repeated motor routines that are processed as chunks.



THINK MARRY BELIEVE

Fig.1) ASL signs THINK and MARRY versus the ASL compound BELIEVE

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Generalization Beyond Similarity: Support for Abstract Phonology

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Summary: One of the major questions in phonology is how speakers form representations for novel items. In traditional, generative phonology, rules and constraints govern the formation of novel words. For example, an abstract, general rule of voicing assimilation (e.g., [-Son] → [+Voi] / _ [+Voi]) predicts that speakers will voice any obstruent, as long as it is adjacent to a voiced segment, no matter how 'different' the word is from other forms in the language. However, exemplar theories of phonological processing propose that measures of similarity best determine whether a novel form will conform to a phonological pattern; the more similar an item is to known lexical items that conform to the pattern, the more likely it will undergo a phonological pattern (Johnson, 1997). However, it is unclear whether speakers apply similarity when distinguishing between grammatical and ungrammatical items. To tease this apart, learners of a novel vowel harmony language made direct similarity judgments in addition to two-alternative forced choice (2AFC) comparisons directly distinguishing between grammatical and ungrammatical items. In order to test the extent of similarity-based judgments for novel forms, items contained familiar and novel stems as well as novel affixes. Learners used similarity to distinguish grammatical and ungrammatical items for items containing familiar suffixes, but not for items containing novel prefixes. However, learners successfully selected grammatical over ungrammatical items for novel prefix items, supporting abstract models of phonological representations.

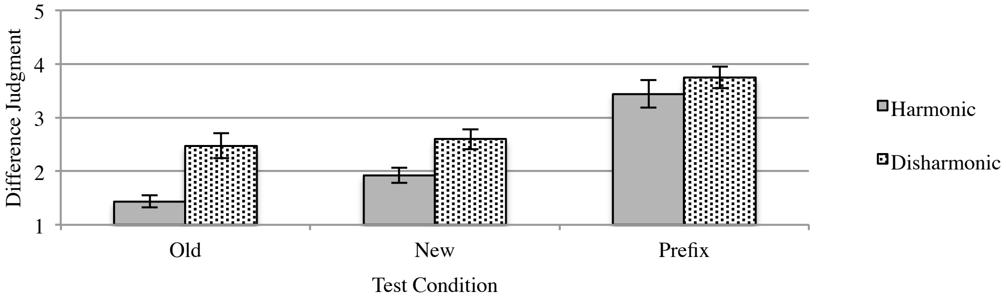
Participants: Thirteen speakers, fluent in American English (with no knowledge of vowel harmony), participated in the present experiment for course credit.

Exposure: Participants were trained on a novel vowel harmony pattern, following the design of Finley and Badecker (2009), who trained English speaking participants on a novel language in which CVCV stems alternated with suffixed CVCV-mi/mu forms, where the suffix [-mi] appeared with stems containing front/unround vowels [i, e], and [-mu] appeared with stems containing back/round vowels [o, u]. The exposure to 24 sets of stem+suffix pairs (e.g., mobo-mobomu, [piki-pikimi], was repeated five times in a randomized order.

Test: Participants were given two different tests: 2AFC and Distance Judgments. The 2AFC test was identical to the test in Finley and Badecker (2009). Each test item compared a grammatical (harmonic) item to an ungrammatical (disharmonic) item; each item differing only in the affix vowel. Old Items contained stems and affixes that appeared in the exposure phase. New Items contained stems that did not appear in the exposure phase, but the same suffix from the exposure phase. Prefix items contained stems that appeared in the exposure phase, but the affix was a novel prefix that alternated between /gi/ and /gu/ (e.g., *gi-mubu vs. gu-mubu). In the Distance Judgment test, participants were asked to rate, on a scale from 1 to 5, how similar each item was to the items that were heard during the exposure phase, where 1 was identical, and 5 was extremely different. The same 36 items from the 2AFC test were used for the Difference Judgment task, counterbalanced for order effects.

Results: Overall, participants rated Harmonic items as more similar than Disharmonic items (*ß*=1.04, z =6.88, p<0.001), as shown in Figure 1. However, this difference was not significant for Prefix items (*ß*=.31, t =1.96, p=0.57), (but significant for New items (*ß*=.71, t =4.54, p<0.0023)). This suggests that learners only used similarity as a metric for grammaticality when the structure of the word was similar to trained items. The 2AFC items were compared to 50% chance (via an intercept only mixed effects model), which showed significant effects for New (M = 0.66,*ß*=.84, z =2.19, p=0.029) and Prefix (M = 0.68,*ß*=.88, z =2.24 p=0.025) items, and a marginally significant effect for Old items (M = 0.63,*ß*=.66, z =1.74, p=0.087). This suggests that participants were able to differentiate between grammatical and ungrammatical items, even for items ranked as highly dissimilar to the training items.

Figure 1: Difference Judgment Results (Means and Standard Errors)



Discussion and Conclusions: The present results replicated Finley and Badecker (2009), demonstrating that in a 2AFC task, participants can generalize vowel harmony in a suffixing language to a prefixing language. However, when asked to rate the same items based on similarity, participants rated prefixed items as highly dissimilar, and showed no significant distinction between grammatical and ungrammatical items. This suggests that metrics of similarity, as suggested by exemplar models of phonology, cannot account for the ability to distinguish between grammatical and ungrammatical items when the structure of the novel item differs significantly from familiar items. While metrics of similarity may be useful in determining grammaticality for known and similar novel lexical items, it cannot account for learners' ability to generalize to novel items in an abstract manner, as rule/constraint based models predict. Future research will work to explore the role of similarity in constructing abstract models of phonological processing.

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Vowel height and dorsals: allophonic differences cue contrasts

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***Overview*:** A phonemic contrast between uvular and velar consonants in Quechua is often additionally cued by allophonic differences in surrounding vowel height: uvulars trigger lowering of a surrounding high vowel, e.g., [**ki**ru] ‘tooth’ but [**qe**ru] ‘vase’. An identification task finds that allophonic vowel height is used as a strong cue to consonant place, but that mid vowels cue uvular place more strongly than high vowels cue velar place. This is interpreted as showing that the more limited distribution of mid vowels makes these vowels more informative.

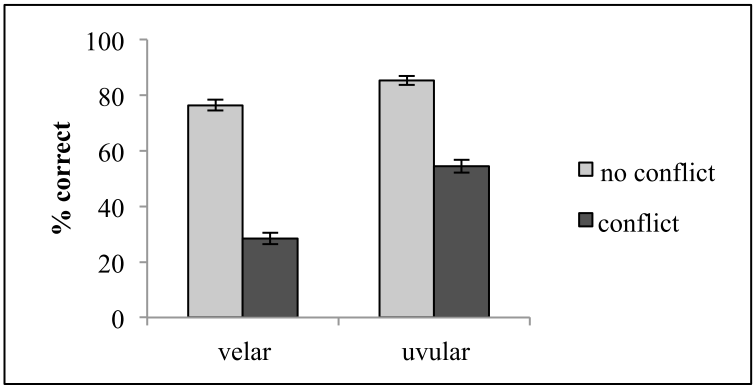
***Vowel height*:** Cochabamba Quechua has three phonemic vowels /i u a/. The high vowels /i u/ surface as mid [e o] when a uvular [q q’ q^h] precedes or follows (Bills et al. 1969), e.g., [**ku**sa] ‘good’ but [**qo**sa] ‘husband’. An acoustic study confirmed this lowering effect root internally, and also documented lowering from a suffixal uvular onto a root vowel, contra previous claims that lowering only applies morpheme internally (Molina Vital 2014). Root internally, vowels are lower (higher F1) when preceded by a uvular consonant than when preceded by a velar or labial, e.g., [ha**p’i-**ni] ‘I grab’, [p’a**ki-**ni] ‘I break’ but [sa**qe-**ni] ‘I leave’. Across a morpheme boundary, a suffixal uvular consonant lowers a preceding stem vowel, e.g., [hap’**i**-ni] ‘I grab’ but [hap’**e-rq**a] ‘he grabbed’. This pattern holds of both front and back vowels, and comes from data collected from 10 near-monolingual speakers.

A result of vowel allophony is that the contrast between uvular and velar consonants is often cued by differences in surrounding vowels as well as in the consonants themselves. Interestingly, then, root vowels following velars, [p’a**ke**-r**q**a] ‘he broke’, were found to lower just as much as vowels following labials, [ha**p’e**-r**q**a] ‘he grabbed’ in the presence of a suffixal uvular consonant, indicating no blocking effect of the root velar. Vowel height, then, is not a wholly reliable cue to whether a preceding consonant is uvular or velar: high vowels are a reliable cue that a preceding consonant is velar, but mid vowels may be preceded by either a velar or uvular.

***Perception study*:** A perception study was designed to test how Quechua speakers use consonantal and vocalic cues in distinguishing uvular and velar categories. In an identification task, 16 native speakers (Spanish bilinguals) labeled 120 stimuli as containing either a velar or uvular ejective (represented orthographically as <k’> and <q’>). Ejectives were chosen for the study because they differ only in place; plain and uvular uvulars often spirantize (/q/ → [ʁ] and /q^h/ → [χ]) and thus contrast with their velar counterparts for manner as well place. Nonce word stimuli were made by cross-splicing the burst from a uvular and velar ejective with high and mid front vowels, creating quadruplets like [was**k’i**ni] ~ [was**q’e**ni] ~ [was**k’e**ni] ~ [was**q’i**ni]. Ejectives allowed for easy cross-splicing because the burst is followed by a period of silence, and the glottal closure in the ejective minimizes place cues from formant transitions in the following vowel. Closure and VOT duration were normalized across all stimuli to a value intermediate between uvulars and velars.

There are two hypotheses. First, it could be that high vowels are used as a more reliable cue than mid vowels, since speakers have practice perceiving velars before mid vowels (as in [p’a**ke**rqa]) but no practice perceiving uvulars before high vowels. Second, mid vowels may be used as a more reliable cue than high vowels, since mid vowels occur in a more restricted range of environments, and, under traditional analyses, are derived. Under the first hypothesis, [was**q'i**ni] should be misidentified more often than [was**k'e**ni]; under the second hypothesis, [was**k'e**ni] should be misidentified more often than [was**q'i**ni].

Participants were more accurate at perceiving consonantal place when the consonantal and vowel cues were consistent, as in [was**k'i**ni] and [was**q'e**ni], than when they conflicted, as in [was**k'e**ni] and [was**q'i**ni], as can be seen in the figure below. A significant interaction between cue consistency and place ($p < 0.01$) was found in a Mixed Logit Model, indicating that conflicting cues had a stronger negative effect on accurate perception of velar place than uvular place. Stimuli like [was**k'e**ni] were incorrectly identified as containing [q'] 72% of the time, while stimuli like [was**q'i**ni] were incorrectly identified as containing [k'] only 54% of the time.



Discussion: The identification study shows that Quechua listerners use allophonic vowel height as a strong cue to consonantal place: when consonantal and vocalic cues conflict, accurate identification of consonant place decreases. Mid and high vowels are not used to the same degree, however. The mid vowel [e] is interpreted as indicative of a preceding uvular [q'] more frequently than the high vowel [i] is interpreted as indicative of a preceding velar [k'].

These results support the second hypothesis, that the mid vowel [e], which occurs in a more limited set of environments and may be analyzed as derived, is used as a stronger predictor of consonant place than the high vowel [i]. This finding is interesting in light of forms like [p'a**ke**rqa] 'he broke', where a velar consonant may be followed by a mid vowel. Given that both preceding and following uvulars trigger lowering, Quechua speakers are likely quite good at identifying the position of the trigger of lowering. While mid vowels aren't necessarily a reliable cue to a *preceding* uvular, they are a reliable cue that a uvular is present. In the current task, the most likely position for this uvular was the preceding consonant. An interesting follow-up would be to compare identification rates for nonce words like [was**k'erq**a], where the mid vowel can be attributed to the following consonant and thus should be factored out in determining the place of the preceding consonant.

Conclusion: The results here show that allophonic vowel height differences are used as a strong cue to preceding consonantal place, but asymmetrically so. Vowels that are derived by an allophonic rule (here, the mid vowel [e]), and thus have a more limited distribution in the language as a whole, are used as a stronger cue than default vowels (here, the high vowel [i]).

Extrametricality and second language acquisition

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Word-level stress a challenging task for second language learners (L2ers). Languages differ on several dimensions, such as whether (i) syllable shape (weight) affects stress and (ii) word-final syllables are extrametrical. As well, we find a rich cross-linguistic variation regarding the phonetic correlates of stress. This is especially difficult to adult L2ers, given the critical period hypothesis [2]. Such L2ers may have native-like syntax and morphology, but their prosody often reveals traces of their L1 patterns. In this paper, I investigate the second language acquisition of stress in Portuguese by native English speakers, and show that despite these difficulties, late L2ers are indeed capable of converging to a target-like grammar with respect to stress patterns—even when that requires resetting their L1 parameters [3] and acquiring subtle patterns in the L2.

PORTUGUESE stress in nouns and adjectives (non-verbs) favours final syllables (no extrametricality) when such syllables are heavy (closed), and penult syllables otherwise (1). Antepenult stress is irregular/unpredictable in the language, and is avoided in novel words [1]. ENGLISH non-verbs, on the other hand, avoid final stress (extrametricality). Penult stress is preferred when the penult syllable is heavy, and antepenult stress is preferred otherwise (1). Native English speakers (L2ers) acquiring Portuguese need to learn that the final syllable is not avoided in the language. This requires resetting extrametricality from YES to NO. As a result, as L2ers learn that stress assignment should not skip the final syllable, antepenult stress (common in the L1) should be dispreferred in the L2 (assuming binary feet), thus matching what is observed in native Portuguese speakers (2).

This study involves forced-choice judgment tasks with real (*n*=30, pre-test) and nonce Portuguese words (*n*=225). Natives (*n*=20) and L2ers (*n*=10) were shown pairs of words with different stress patterns and different syllabic profiles. They were then asked to rate (1-7) which word in the pair sounded more natural in Portuguese (3). The data were modelled with mixed-effects Ordinal Regressions (by-speaker and by-item random effects and intercepts).

L2ers' judgments were not significantly different from natives' judgments ($\hat{\beta} = -0.01, p = 0.95$)), but their responses were significantly affected by proficiency level (significant effect among near-native speakers ($\hat{\beta} - 0.90, p < 0.001$)). Extrametricality was clearly reset by more native-like L2ers, and the predicted consequence (penult stress as default) was observed in the data. Importantly, L2ers have a gradient pattern according to their proficiency level (Fig. 1), and some learners mirror native speakers even when the patterns are considerably subtle.

Examples and figures

(1) Regular stress patterns in English (L1) and Portuguese (L2) non-verbs

a. L1: penult if penult syllable is heavy → *agénda*. Antepenult otherwise → *cítizen*.
b. L2: final if final syllable is heavy → *papél* ‘paper’. Penult stress otherwise → *páto* ‘duck’.

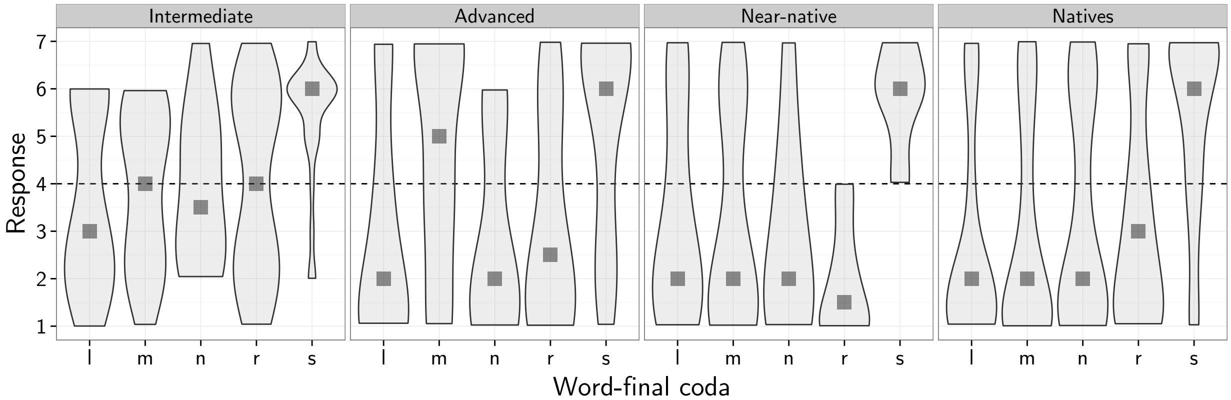
(2) Extrametricality $\langle\rangle$ in English (L1) and Portuguese (L2) words (] = word edge)

a. L1: extrametricality → $\sigma\sigma\langle\sigma\rangle]$ Preferred stress positions: Penult and antepenult
b. L2: no extrametricality → $\sigma\sigma\sigma]$ Preferred stress positions: Final and penult
c. L1 → L2: L2ers need to *include* the final σ

(3) Sample question (capital letters = stressed syllable). Different tasks controlled for different variables.
Which word sounds more natural?

`gamoDOR` `gaMOdor`
○ ○ ○ ○ ○ ○ ○

Figure 1: y-axis = speakers’ responses/judgments (nonce words): 7 = penult stress; 1 = final stress; 4 = undecided/neutral. x-axis = different word-final codas in the stimuli. Squares represent median values. All nonce words in this particular task contained a heavy word-final syllable (CVC; expected: final stress). Note that L2ers mirror natives not only quantitatively, but also qualitatively. Statistical models (mixed-effects Ordinal Regression) confirm the significance of the patterns observed below.



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Shift happens! Shifting in Harmonic Serialism

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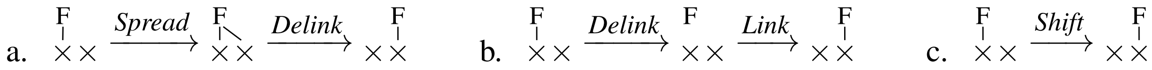
Phonological theory has attributed stress, tone, and segmental shift to unrelated mechanisms. This paper looks at shift in Harmonic Serialism (HS) and proposes a unified analysis. We argue that shift must be a possible Gen operation. We back this up with cross-linguistic and typological evidence, tested using OT-Help 2.0 (Staubs et al. 2010).

Shift has been considered a two-step phenomenon in Autosegmental Phonology (Goldsmith 1976): spreading and delinking (1-a), or delinking and linking (b). The distinction between the two is irrelevant in OT (Myers 1997; Yip 2002), but it does matter in serial variants of OT, such as HS. McCarthy (2006) and McCarthy et al. (2012) use a two-step analysis. We argue that the evidence instead suggests that Gen must be able to shift features and stress in a single step (1-c).

(1)



Despite no detailed study, stress shift has been standardly considered a possible Gen operation in HS. In Ukrainian, for instance, stress shifts in the plural. Alderete (1999) attributes stress shift to anti-faithfulness constraints, which require morphologically related forms to be dissimilar. Along these lines, Yanovich & Steriade (2010) propose constraints that favor paradigmatic contrast (2).

(2) SINGULAR≠PLURAL (henceforth, SG≠PL)
Assign a violation mark for each pair of stems with identical stress grids whose morphological feature matrices differ in [singular/plural].

While SG≠PL can be satisfied by shifting stress in the plural (3-a), it can also be satisfied by adding (b) or removing stress (c), which are possible Gen operations (McCarthy 2008, 2010). If stress shift is not a possible operation—and (3-a) would not be generated—then we predict that related forms may surface as unstressed or doubly stressed. We know of no languages in which only some members of the paradigm would lack stress or have double stress. If, however, shift is possible, then the pathological candidates (3-b-c) are harmonically bounded by the shifting candidate (a).

(3) Ukrainian shifting grammar: Step 1 (singular: kóles-o)

/kóles-a/	SG≠PL	IDENT(stress)	CULMINATIVITY	HAVESTRESS
a. ☞ kolésa		*		
b. kólésa		*	*!	
c. kolesa		*		*!
d. kólesa	*!			

Tone-shifting patterns often involve a prominent target (σ́ or edge) that may be several Tone Bearing Units (TBUs) away. Consider a language like Chizigula (Kenstowicz & Kisseberth 1990), where a High tone shifts to the penultimate TBU. Shift (4-a) violates more faithfulness constraints than spreading (c), which violates the constraint against branching. At each of the following steps, tone shifts to the following TBU until it reaches the penult position. Now consider the alternative non-shifting grammar, in which tone is spread and delinked, as in (1-a). At step 1, candidate (4-c) would win, which means that ALIGN-R must outrank *BRANCH. At step 2, delinking wins (6-a). Further spreading (6-c) must be ruled out, which requires *TERNARY (5).

(4) Pseudo-Chizigula shifting grammar: Step 1

/ $\mu\ \overset{H}{\mu}\ \mu\ \mu\ \mu\ \mu$ /	*Branch	NonFin	Align-R	MaxLink	DepLink
a. ☞ $\mu\ \mu\ \overset{H}{\mu}\ \mu\ \mu\ \mu$			***	*	*
b. $\mu\ \overset{H}{\mu}\ \mu\ \mu\ \mu\ \mu$			****!		
c. $\mu\ \overset{H}{\overbrace{\mu\ \mu}}\ \mu\ \mu\ \mu$	*!		***		*

(5) *Ternary (after Uffmann 2005; Topintzi & van Oostendorp 2009)
T must not be linked to more than two Tone Bearing Units.

(6) Pseudo-Chizigula non-shifting grammar: Step 2

/ $\mu\ \overset{H}{\overbrace{\mu\ \mu}}\ \mu\ \mu\ \mu$ /	NonFin	*Ternary	Align-R	*Branch	MaxLink	DepLink
a. ☞ $\mu\ \mu\ \overset{H}{\mu}\ \mu\ \mu\ \mu$			***		*	
b. $\mu\ \overset{H}{\overbrace{\mu\ \mu}}\ \mu\ \mu\ \mu$			***	*!		
c. $\mu\ \overset{H}{\overbrace{\mu\ \mu\ \mu}}\ \mu\ \mu$		*!	**	*		*

The non-shifting analysis relies on *Ternary which penalizes sequences of multiple constituents. Such constraints are known to cause pathologies in HS. For instance, FootBinarity causes pathological local weight sensitivity as a function of the number of syllables in the whole word (Pruitt 2012). The shifting grammar does not require *Ternary, thus avoiding such pathologies.

The final piece of evidence comes from segmental shift. Consider shifting in Halkomelem (Hukari & Peter 1995), which exhibits lowering of stressed /é/ when followed by an /a/, which subsequently reduces to [ə]: /néts’-θat/ → ná̱ts’-θat → [náts’-θə̱t] ‘change’. This process can be analyzed as shifting of the feature [+low]. If shifting is allowed in a single step, both faithfulness constraints can be ranked below the reduction constraint *Unstressed/a (7). If shifting is *not* allowed by Gen, spreading (b) must obtain at step 1, which requires that Max[+low] crucially outranks *Unstressed/a. This ranking creates a paradox, in which forms with multiple /a/’s fail to display reduction: /páj-θat/ → *[páj-θat], [páj-θə̱t] ‘curved’. This problem does not obtain in the shifting grammar, because the reduction constraint is undominated, as in (7).

(7) Halkomelem shifting grammar: Step 1

/ n é ts’ - θ $\overset{[+l]}{\text{a}}$ t /	*Unstressed/a	Max[+low]	MaxLink[+low]	*éC$_0$a
a. ☞ n $\overset{[+l]}{\text{á}}$ ts’ θ ə t			*	
b. n $\overset{[+l]}{\overbrace{\text{á ts’ θ a}}}$ t	*!			
c. n é ts’ θ $\overset{[+l]}{\text{a}}$ t	*!			*
d. n é ts’ θ ə t		*!		

Segmental shift is an underreported, but attested pattern. We document 15 cases which include rounding (Gitksan), place (Kinyarwanda), nasality (Karajá), and laryngeal features (Ayutla Mixe).

The representations of stress, tone, and segmental features differ in phonological theory, yet HS offers a framework to unify shift as one phenomenon. Shift is a single operation in HS.

Hyperhypervoicing in Crow

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Voicing is difficult to maintain in oral stops because the pressure differential above and below the glottis evens out as air flows from the lungs into the oral cavity; as the pressure equalizes, airflow over the glottis ceases, preventing voicing during oral closure. Some languages have tricks to make voiced stops more possible. These include imploding the stop by lowering the larynx, which increases the size of the oral cavity and decreases supralaryngeal air pressure (Ladefoged & Maddieson 1996:78); this occurs with and without preglottalization (eg, Vietnamese, Nguyen 1987:84). The other trick is prenasalizing the stop, as found in Mixtec (Iverson & Salmons 1996); prenasalizing voiced stops opens up the nasopharyngeal port and lets air leak into the nasal cavity, which again reduces supralaryngeal air pressure and allows air to pass over the glottis to maintain voicing (Lisker & Abramson 1971:775). 'Prenasalization appears most often with voiced stops, and, in the many languages where no plain voiced stops contrast with the prenasalized series, may be thought of as a way to facilitate the maintenance of voicing on stops' (Henton et al 1992:71).

I argue here that Crow (Missouri River Siouxan) has a similar but more radical process that nasalizes phonologically long stops more fully; rather than just prenasalizing them, Crow turns them into full nasals *m* and *n*. Hypervoicing prenasalizes singleton voiced stops in onsets in Mixtec, but in Crow we find *full* nasalization of voiced stops and only when they are geminated or occur in the coda, i.e. when they are phonologically long and bear a mora. I call this phenomenon *hyperhypervoicing* since nasalization is full rather than partial and since it takes place only when the sound is moraic. If this analysis is correct, nasalization promotes voicing in two ways across languages: *hypervoicing* turns voiced stops into prenasalized stops when they are phonologically short (Mixtec) and *hyperhyper-voicing* turns them into nasals when they are phonologically long (Crow). The reasoning: if voicing is hard to maintain in phonologically short (nonmoraic) stops and results in partial nasalization (Mixtec), then voicing should be more difficult to maintain in phonologically long (moraic) stops and should result in more complete nasalization (Crow).

Crow has (in traditional terms), two phonemes that alternate between a voiced stop, nasal, and voiced approximant (Kaschube 1967, Martin 1989, Graczyk 2007, my own fieldwork). The labial sound in (1) has three allophones, hilariously [b, m, w]; the coronal sound in (2) has corresponding allophones [d, n, l]. In both cases the voiced stops (b, d) and nasals (m, n) are in complementary distribution with each other and with the approximants (w, l); there is no morphological conditioning (it isn't consonant mutation) and the alternations are surface true and fully productive. Assuming that codas and geminates are both moraic (Hayes 1989), we can characterize the basic distribution as follows (where 'onset' excludes *intervocalic* onsets):

(1)	onset [b]:	[baapá]	'day'	[išbúupči]	'his ball'
	moraic [m]:	[bačeém]	'a man'	[baammáxi]	'buckskin'
	intervocalic [w]:	[awá]	'earth'		

(2)	onset [d]:	[dáawii]	'three'	[áapdaxči]	'hang'
	moraic [n]:	[koón]	'there'	[annissúu]	'dance hall'
	intervocalic [l]:	[balí]	'water'		

(3) pitɚ-lak ʤan-nak ʤemz-dak Ø-áxp-ak daá-u-k
Peter-and John-and James-and 3sg-with-SS go-PL-DECL
'Peter, John, and James went with him.' (Luke 9:28, Graczyk 2007:191)

Following underlying *h* the situation is slightly different: the stop still geminates and nasalizes but the first half is voiceless, retaining the aspiration of the *h* (Graczyk 2007:14):

(3) [dám̥miia] ‘three times’
[an̥n̳uuší] ‘eat a lot’

The facts in (1-3) are internal to the phonological phrase: word-initial voiced stops often turned to *w* and *l* when the preceding word ends in a vowel.

My analysis is that the voiced stops *b* and *d* lenite to *w* and *l* intervocalically; a similar process is found in the Djapu dialect of Yolngu where intervocalic *b* and *g* surface intervocalically as [w] and *d̪* and *ɟ* surface there as [j] (Morphy 1983:29; Gurevich 2011:1563). And, as discussed above, I propose that *b* and *d* nasalize when they are moraic (geminate or in the coda) to avoid phonologically long voiced stops. Avoidance of long voiced geminates is well-known and found in languages like Japanese (Kawahara 2005).

The traditional analysis is that the approximants *w* and *l* are underlying (Kaschube 1967), but Martin (1989) and Graczyk (2007) argue for underlying nasals (*m, n*). Kaschube requires occlusivization of approximants in onsets and occlusivization *cum* nasalization of glides when long or in the coda; neither process is phonetically or phonologically motivated. Martin/Graczyk requires denasalization in onsets and denasalization *cum* lenition intervocalically; denasalization is unmotivated in either case, though denasalization of voiced stops *does* occur word-initially in Korean (Kim 2011). Both approaches require that underlying sounds can’t surface in the onset, which goes against expectations of markedness, since onsets are usually the best licensers of consonantal contrasts.

In terms of consonant inventory, all three analyses are weird. Kaschube requires a language with no underlying nasals, Martin/Graczyk require one with no liquids or glides. The present analysis requires one with no liquids, glides *or* nasals. An OT perspective mollifies this a little bit, as richness of the base helps us look away from underlying forms, but it doesn’t ultimately help explain the oddity of the situation we find in Crow.

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Nasal-lateral interactions: typology and structure

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Processes of assimilatory nasalization and lateralization across heterosyllabic nasal-lateral (NL) and lateral-nasal (LN) clusters may be present in a language along with other sonorant-related assimilatory phenomena: non-exhaustively, see cases in Korean (Iverson & Kim 1987, Iverson & Sohn 1994, Davis & Shin 1999), Toba Batak (Hayes 1986; Rice & Avery 1991), Ponapean (Davis 2000, Blevins and Garrett 1993), and Klamath. In this paper, I argue that these phenomena display some coherent typological properties which are particularly problematic when considered alongside 'syllable contact' discussions. I also suggest that nasal-lateral interactions in Korean and Sakha/Yakut are demonstrably distinct in operation from other assimilatory phenomena in these languages, despite the fact that syllable contact has previously been argued to underlie both cases (Davis & Shin 1999, Baertsch 2002). Broadly, then, we may desire a formalism in which nasal- and lateral- assimilations might be derived as an independent class, and subsequently be permitted to interact with other, more general constraints on shared structure or sonority contour.

What is the typological range of the co-occurrence of LN and NL repairs, and of the possible rescue mechanisms involved? A partial review follows:

	Nasalize LN	Lateralize LN	'Ignore' LN
Nasalize NL			Korean non-coronals, Meitei non-coronals (Chelliah 1997), Syrian Arabic non-coronals (Cowell 1964), ...
Lateralize NL	Moroccan Arabic coronals (Harrell 1962, Seo 2003)	Korean coronals, Leti coronals (van Engelenhoven 1995), Toba Batak coronals	Klamath coronals (Barker 1964), Meitei coronals, Syrian Arabic coronals, Ponapean coronals (Goodman 1995), Selayarese (Blevins 1994), Uyghur ...
Ignore NL			

Sonority considerations would predict that NL is more likely to be targeted for repair than LN; in fact, we do find that every language that appears to repair LN also repairs NL. However, a comparison with stop-lateral (TL) sequences is instructive: in languages like Korean or Leti, NL and TL are both repaired, but in the patterns in Klamath, Selayarese, or Moroccan Arabic, NL is repaired while TL is ignored; and I am unaware of cases in which TL repairs arise in the absence of NL repairs. This is precisely the inverse of the typological prediction made by 'syllable contact' formalizations, in which the sonority drop across an NL sequence is expected to be less poor than that across a TL sequence. Nasalization is the preferred repair in non-coronal (in these cases equivalently: non-homorganic) sequences, and lateralization is the preferred repair in coronal sequences. The existence of LN repairs (always coronal) implies repair of *coronal* NL, and the existence of *non-coronal* NL repairs implies the repair of *coronal* NL, but it is possible for languages to display either pair without the third type of repair.

In Korean, the well-known patterns of sonorant-sonorant assimilation and obstruent sonorization given in (1) have previously been analyzed in terms of syllable contact: indeed, avoidance of rising sonority across the syllable boundary predicts the repairs in (1a). The data in (1b) and in (2) are, however, problematic in an account predicated solely on sonority:

(1) Korean obstruent sonorization and nasal-lateral assimilation (Iverson & Sohn 1994)

a. /han-kuk+mal/	[haŋ.guŋ.mal]	'Korean lg.'	/sam-lju/	[sam.nju]	'third-rate'
/patʰ+noŋsa/	[pan.noŋ.sa]		/jəŋ-lak/	[jəŋ.nak]	
/pəp-ljul/	[pəm.njul]		/han+ljaŋ/	[hal.ljaŋ]	
b. /səl-nal/	[səl.lal]				
/pul+nɨŋ/	[pul.lɨŋ]				

(2) Stop-fricative non-assimilation in Korean

/guk+su/	[guk.su]	'noodle'
/sam+gjəp+sal/	[sam.gjəp.sal]	'pork belly'

A syllable contact account of Korean assimilation, in requiring that rising sonority be repaired, suggests correctly that stop-nasal/stop-liquid and nasal-liquid clusters must undergo some repair, and predicts that liquid-stop and nasal-stop should be acceptable. As (1b), NL and LN are repaired *symmetrically* in Korean, which cannot be predicted by syllable contact: there is no prima facie reason that constraints forcing falling sonority should disprefer LN without also rendering the flat sonority in NN and LL problematic, and some additional account is needed. In (2), although outside the strict ambit of assimilation involving nasality or laterality, the non-alteration of stop-fricative clusters (despite rising sonority) poses additional difficulties for 'straightforward' syllable contact in Korean. In a model of syllable contact phenomena in which markedness constraints explicitly reference sonority distance (*DIST-X, Gouskova 2004), we might suggest a partial model of Korean in which *mild* rising sonority is tolerated (*DIST+2 > FAITH > *DIST+1): this would allow [p.s], and would also leave both NL and LN unrepaired – forcing the alternation in nasal/lateral contexts to derive from some other operation. In Sakha (also Yakut; Turkic), affix onsets are always desonorized after glides, rhotics and obstruents, as in (3a). If preceded by a lateral, coronals are lateralized while non-coronals undergo no effect, as in (3b); if preceded by a nasal, any consonantal onset is nasalized, as (3c).

(3) Sakha affix onsets (Krueger 1962; Odden 2013)

a. /ubaj-lar/	[ubaj.dar]	'elder brothers'
/køtør-lar/	[køtør.dør]	'birds'
/at-lar/	[at.tar]	'horses'
b. /kuul-lar/	[kuul.lar]	'sacks'
/uol-taɣar/	[uol.laɣar]	'son-comparative'
/uol-ka/	[uol.ga]	'son-dative'
c. /olom-ta/	[olom.no]	'ford-partitive'
/oron-lar/	[oron.nor]	'beds'
/aan-ka/	[aaŋ.ŋa]	'door-dative'

The data given in (3a) broadly suggest – analogous to the Kyrgyz pattern described in Davis 1998 and Gouskova 2004 – a 'syllable contact'/sonority-motivated alternation in which a simple sonority drop is insufficient in itself, and repair must be made to force the largest possible sonority drop across the syllable boundary (*DIST–3 > FAITH > *DIST–4) – hence desonorization after high-sonority codas. This is, however, inconsistent with (3b) and (3c): in (3b), lateralization creates flat sonority, *and* destroys the steep sonority drop in /l.t/ in favor of [l.l], and in (3c) nasalization outranks sonority considerations. In both Korean and Sakha, then, the genesis of NL and LN patterns is under question; what may ultimately be required is, at least in part, a constraint specifically banning NL sequences, possibly motivated by attested positional restrictions on /l/ in both languages.

Stress and Grades in the Creek Stem: a Consequence of Cyclic Structure

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Overview: The Stem is roughly the domain of regular iambic stress in Creek verbs. However, a final regular stress can occur on a non-Stem syllable following the Stem. In the morphological context of “graded” (internally changed) verbs, the final Stem syllable is always heavy, and receives the final, primary regular stress; a non-Stem syllable never has regular stress in graded verbs. I propose that while non-graded verbs are built in one cycle, graded verbs are built in two cycles, which causes the final syllable always to receive stress and be heavy.

Data—Non-Graded Verbs: Verbs in Creek consist of the root, prefixes, inner suffixes (forming the Stem) and outer suffixes (data from Martin (2011)). The Stem is parsed into left-to-right iambic Feet: (L'L), ('H) and (L'H). Outer suffixes can be inherently either stressed or unstressed. High tone /H/ extends from the first to last regular stress, which is primary (Haas 1977). In a non-graded verb, if a Stem ends in a heavy syllable or an even sequence of light syllables, the final syllable receives the final regular stress. If a Stem in a non-graded verb ends in an odd sequence of light syllables, the first syllable in the outer suffixes receives the final regular stress.

Table 1. Regular Stress in Non-Graded Verbs

Input	/homp=as/ ‘eat=IMP’	/wanay=as/ ‘tie=IMP’	/a-wanay=as/ ‘to-tie=IMP’
Surface Form	[(ˈho^{H}m).p=as]	[(wa.ˈna^{H}).y=as]	[(a.ˈwa^{H}).(na.ˈy=a^{H}s)]
Stem Prosody	Heavy (ˈH)=…	Even Light (LˈL)=…	Odd Light (LˈL)(L=ˈ…)

Data—Graded Verbs: Creek verbs undergo a series of internal changes known as “grades” (Haas 1940) that affect the right edge of the Stem; grades encode the natural syntactic class of aspect. Creek has four grades: lengthened (LGR), aspirated (HGR), falling (FGR), and nasalized (NGR) (terminology from Martin 2011). LGR involves lengthening of the final Stem vowel and a right-spreading high tone /H*/, which gets downstepped if there is a previous stress. The other three grades are mostly identical in Foot structure to LGR, but add different autosegmental content. Table (2) shows the grade system for Stems ending in a light syllable in non-graded verbs.

Table 2. Paradigm of Grade System

Grade	LL Stem /wanay=/	LLL Stem /a-wanay=/
No Grade	[(wa.ˈna^{H}).y=as]	[(a.ˈwa^{H}).(na.ˈy=a^{H}s)]
LGR /^{H*}/	[(wa.ˈna:^{H}).y=i^{H}s]	[(a.ˈwa^{H}).(ˈna:$^{H-}$).y=i^{H-}s]
HGR /h/	[(wa.ˈna^{H}h).y=is]	[(a.ˈwa^{H}).(ˈna^{H}h).y=is]
FGR /^{HL}/	[(wa.ˈna:^{HL}).y=is]	[(a.ˈwa^{H}).(ˈna:^{HL}).y=is]
NGR /~, $^{HH+}$/	[(wa.ˈnã:$^{HH+}$).y=is]	[(a.ˈwa^{H}).(ˈnã:$^{HH+}$).y=is]

Generalizations: Graded verbs display three key differences from non-graded verbs. First, a Stem-final syllable can be short in non-graded verbs, but must be long in graded verbs. Second, the final regular stress can occur outside of the Stem in non-graded verbs, but must be always Stem-final in graded verbs. Lastly, graded verbs all have autosegmental content that docks to the Stem-final syllable. The different aspectual morphemes are distinguished only by these autosegments, and have no independent morphs.

Account: I account for these differences between non-graded and graded verbs as a consequence of their cyclic structures: graded verbs are constructed in two cycles, while non-graded verbs are constructed in one cycle. The Stem of a graded verb thus must form a prosodically isolable intermediate representation, while the Stem of a non-graded verb is parsed together with its outer suffixes. This distinction is what allows the final regular Foot to extend beyond the Stem in non-graded verbs, but forces this Foot to be right-aligned with the Stem in graded verbs, causing final vowel lengthening. This right-aligned iambic Foot is the head Foot in Creek, so that the final Stem syllable has primary stress in graded verbs. Primary stress attracts autosegments, certain of which (tone and nasalization) also result in vowel lengthening.

I demonstrate this account for the graded and non-graded forms of the LLL Stem /a-wanay=/. In the derivation of the graded form, /a-wanay=/ goes through a first cycle by itself (1), while in the derivation of the non-graded form, it goes through a cycle with the outer suffix /as/ (2).

(1) Graded Derivation: /a-wanay=/ → [(a.ˈwa^{H}).(ˈna:$^{H-}$)y]=/is/ → [(a.ˈwa^{H}).(ˈna:$^{H-}$).y=i^{H-}s]

(2) Non-graded Derivation: /a-wanay=as/ → [(a.ˈwa^{H}).(na.ˈy=a^{H}s)]

The analysis requires three constraints: FtBin (e.g., McCarthy and Prince 1986), demanding that Feet be binary either in morae or syllables; Parse-σ(Stem) (e.g., McCarthy and Prince 1993; see Zoll (1996) for indexing markedness constraints to privileged positions), demanding that every syllable affiliated with the Stem be parsed into a Foot; and, Ident-V(Long) (e.g., McCarthy 2000), demanding that input and output vowels be the same length. FtBin and Parse-σ(Stem) are high-ranked, eliminating candidates with (ˈL) Feet and unfooted Stem syllables, respectively. Low-ranked Ident-V(Long) eliminates the lengthening candidate in Table (3), which does not beat the other candidates on the higher-ranked constraints, but not the one in Table (4), which does so.

Table 3. LLL Stem, Non-Graded Verb: Stress on Outer Suffix

/LLL=L/	FtBin	Parse-σ(Stem)	Ident-V(Long)
→ (LˈL)(L=ˈL)			
(LˈL)(ˈH)=L			* W
(LˈL)L=L		* W	
(LˈL)(ˈL)=L	* W		

Table 4. LLL Stem, Graded Verb: Stress on Lengthened Final Stem Syllable

/LLL=/	FtBin	Parse-σ(Stem)	Ident-V(Long)
→ (LˈL)(ˈH)			*
(LˈL)L		* W	L
(LˈL)(ˈL)	* W		L

When the Stem is parsed in an early cycle in graded verbs, the final Stem syllable always has primary, final stress (as in Table (4)). Primary stress attracts the autosegments that encode the aspectual material associated with the grades, whose docking can result in lengthening in LL Stems.

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Sahaptin: Between stress and tone

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Hyman 2009 notes that the term ‘‘pitch-accent…is frequently adopted to refer to a defective tone system whose tone is obligatory, culminative, privative, metrical, and/or restricted in distribution”, also suggesting that “we would do well to avoid using the term pitch accent as a catch-all in favor of direct reference to the properties of…a diverse collection of intermediate word-prosodic systems”. The Yakima dialect of Sahaptin (ykm) (YS) has been described as a pitch accent language (Hargus and Beavert 2005, Hargus and Beavert 2014). However, a closer look at the properties of YS prosody indicates that Hyman is right, that YS does indeed have properties of both stress and tone languages.

Background on YS lexical prosody. The primary phonetic correlates of YS accent are higher pitch and greater energy (Hargus and Beavert 2005, Jacobs 1931). By the definition of tone language (Hyman 2006) as “one in which an indication of pitch enters into the lexical realisation of at least some morphemes,” the following data suggest that YS might be a privative (H vs. 0) tone language: [kú] ‘do, make’ vs. [ku] ‘and’; [náʃ] ‘carry inside’ vs. [naʃ] 1SG; [táʃtaʃ] ‘merganser’ vs. [taʃ] 1PL.EXCL; [újt] ‘first’ vs. [uː] ‘or’. However, [ku] ‘and’, [uː] ‘or’, [naʃ] 1SG, and [taʃ] 1PL.EXCL are function morphemes, in contrast to the accented content morphemes above. Thus YS arguably displays one of the defining characteristics of a stress language (Hyman 2006): “Obligatoriness (every lexical word has at least one syllable marked for the highest degree of metrical prominence (primary stress))”. In YS every lexical word must have an accent. (Obligatoriness also holds of roots.) YS also displays Hyman’s second property of a stress language, “Culminativity (every lexical word has at most one syllable marked for the highest degree of metrical prominence)”. In YS, one and only one syllable is the most prominent. Although roots must have an accent, its locastion is unpredictable within roots ([ałá] ‘claw, finger, toe’ vs. [ála] ‘paternal grandfather’). Affixes are either accented or not (-[mí] GEN vs. –[ki] INST; [pa]- 3PL.NOM vs. [pá]- INV; [pápa]- RECP vs. [piná]- REFL.SG). As evidence of Culminativity in YS, accent shifts from root to (outermost) affix obligatorily (Hargus and Beavert 2002), except for a small set of “strong roots” (Hargus and Beavert 2006) which fail to shift accent to prefixes.

Interaction of lexical prosody with intonation. Is YS simply a stress system with a phonetic correlate of stress as pitch (like Turkish, Levi 2005)? One impediment to this view, in favor of the pitch accent analysis, is that word accent interacts with intonation. Declarative sentences are marked by a sentence-final boundary tone L, but this L does not occur when the sentence-final word ends in an accented syllable like [tkwalá] ‘freshwater fish’ (Hargus and Beavert 2014). Also, there are no L intonational pitch accents in YS: intonational pitch accents are extra-high (for focus of emphasis), extra-high optionally on rightmost word accent (in yes/no questions) or downstepped high (optionally deaccented monosyllables) (Hargus and Beavert 2009). Hayes 1995 has suggested this as a characteristic of pitch accent languages: they ‘must satisfy the criterion of having invariant tonal contours on accented syllables, since tone is a lexical property’.

Secondary stress. On the other hand, in texts we have observed a prosodic phenomenon which can only be described as secondary stress. Jacobs 1931:117 wrote that in the northwest Sahaptin dialects (which include YS) ‘ordinary words have only one syllable accented and no secondary stress...whereas in the Umatilla reservation dialects there may be two, three or four accented syllables to a word'. In our work with texts in YS we have observed a secondary stress in certain reduplicated forms (verbal iteratives); e.g. [pánakwɨʃawàjkwɨʃawàjkʃana] 'he kept rowing them across' (pá- INVERSE, nák- 'with', wɨshá- 'row, -wájk 'cross' (a bound root), -ʃa IMPF, -na PST). (Recall that all roots obey Obligatoriness, and are underlyingly accented.) The secondary stresses observed on the root(s) is not a pitch peak; its phonetic correlate appears to be extra energy.

Implications. When we take an in-depth look at a "pitch accent" language like Sahaptin, we see that it displays properties of both stress (Culminativity, Obligatoriness, and if we are right in our interpretation of texts, secondary stress) and tone languages (lexical accent blocks with intonational L). We suggest that recent prosodic typologies which abandon the notion of pitch accent in favor of a decompositional approach to prosody are on the right track.

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Onset weight with branchingness constraints: The case of Pirahã

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One of the central claims of Hayes' classical theory of the syllable is that onsets cannot add to a syllable's weight because they are not moraic (Hayes 1989). After Hayes's publication, however, it has been shown repeatedly that this prediction is incorrect: in some languages onsets do add to weight. The standard approach is to say that, in those cases where onsets are weight adding, they are moraic (Topintzy 2006). This is illustrated in (1).

(1) Weight vs. non-weight adding onsets (Topintzy 2006)

Technically this approach works, but its fundamental problem is that it cannot reconcile a very important property of onsets with a very important property of moras; preferred onsets are those with low sonority (Smith 2003) and moras tend to dominate segments of high sonority (Zec 2007). Strictly speaking Topintzy's approach predicts that the first mora in (1a) tends to contain a segment of higher sonority. Faced with the fact that this is not true at all (Smith 2003), one could say that a mora tends to dominate a segment of higher sonority unless the segment is located in onset position. But this is entirely *ad hoc*.

Our goal is to give a more insightful analysis of weight adding onsets. It takes as its point of departure the well-established fact that consonants in onset position tend to have lower sonority. In that sense we claim to come closer to answering the question why onset consonants of lower sonority can be weight adding more readily than onset consonants of higher sonority. The language we will be dealing with is Pirahã (Everett and Everett 1984), the most complex system known so far in which onsets are weight adding.

In Pirahã the heaviest syllable in a tree-syllable window at the right edge of words is stressed. In words with syllables of equal weight, stress is final. Which syllable is the heaviest is determined by the weight scale in (2) (Hayes 1995). Some examples are given in (3).

(2) Weight scale for Pirahã (Hayes 1995:286)
PVV > BVV > VV > PV > BV > V
(where P = voiceless consonant; B = voiced obstruent; VV = long vowel)

(3)

(3)	PVV > BVV	'kao.ba.bai	'almost fell'
	BVV > VV	poo.'gai.hi.ai	'banana'
	VV > PV	pia.hao.gi.so.'ai.pi	'cooking bananas'
	PV > BV	a.ba.'pa	city name

Our analysis contains the following ingredients:

I. *The Hyman-onset and the Hayes-onset*. We propose that there are two types of onsets: in one type the prevocalic consonant is a dependent of the mora, which is the syllable's head (Hyman-onset). In the second type the prevocalic consonant is adjoined directly to the syllable node (Hayes-onset). These two structures are illustrated in (4).

(4) Hyman-onset vs. Hayes-onset

In principle the Hyman-onset is the default onset due to a constraint requiring that the head of a syllable (i.e. the mora) must branch. This branchingness constraint is an instance of a whole family of similar constraints requiring (among others) that the stressed syllable must be heavy (the head of a foot must branch) and that the main stressed foot must be bisyllabic.

II. *Exclusion of low sonority segments from the Hyman-onset*. Consonants of lower sonority, voiceless consonants in the case of Pirahã, are not allowed in the dependent of a head mora. Thus, in Pirahã the constraint *[-voice]/$\mu_{\text{Dependent}}$ is ranked above the constraint requiring that the head of a syllable (i.e. the mora) must branch.

III. *Branchingness constraints*. Weight sensitivity is expressed with branchingness constraints (as in Hayes 1980 and Hammond 1986). We propose two such constraints, the first penalizing branchingness at the syllable level, the mora level, and the melody level, and the second only at the syllable level. Their formulation is given in (5).

(5) Branchingness constraints

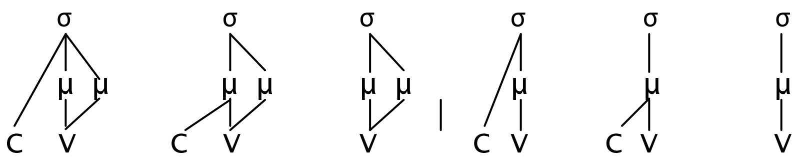
a. α *BRANCHING-FOOT'SDEPENDENT: A dependent of a foot must not branch.

b. β *BRANCHING-HIGHEST FOOT'SDEPENDENT: The highest dependent of a foot must not branch.

These two constraints are in a stringency relation: β is more specific than α. Therefore, if β is violated, then α is also violated. Consider now how the weight scale in (2) is mapped onto the violation profiles in (6) (marked with digits). The violation profiles express the fact that the heavier a syllable is, the more violations it receives when occupying a foot's dependent and the greater its inclination to avoid this position.

(6) Violation profiles of foot's dependent syllables

PVV > BVV > VV > PV > BV > V



3	3	2	1	1	0	Constraint α
2	1	1	1	0	0	Constraint β

Consider, for example, a BVV-syllable. This syllable type receives three violations from the general constraint α: one for the branching syllable, one for the branching first mora, and one for the branching vowel which also occupies a foot's dependent position. As for the constraint β, only one violation mark is assigned to the branching syllable, which is the highest foot's dependent.

So far nobody has paid much attention to the question where to parse prevocalic consonants. This was almost exclusively determined by the analyst's taste. We propose that both options can be correct, and which option is preferred is exclusively determined by linguistic arguments. If a language makes a distinction between the two types, we claim, it will always be the case that consonants of lower sonority prefer the Hayes-onset, not the Hyman-onset. In this way, we predict that if in a language onsets add to weight, then it will always be the case that the Hayes-onset adds more weight than the Hyman-onset. This follows from the fact that the two relevant constraints are in a stringency relation, which penalize twice a Hayes-onset: once by the general constraint α, and once by the more specific constraint β. The fact that onset consonants of lower sonority have a greater tendency to add to weight than onset consonants of higher sonority is not a problem for us at all, as it is for Topintzy (2006). Far from being a problem for our approach, this is in fact predicted by it. We can this not only describe how onset consonants contribute to weight, but we come also closer to answering the question why onset consonants of lower sonority contribute to weight more readily than onset consonants of higher sonority.

The Prosodic Effects of VP and Embedded CP Boundaries in Japanese

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Research on the syntax-phonology interface (e.g., Selkirk 1984, Truckenbrodt 1995, et seq) has suggested that syntactic information (constituents or operations) is visible in phonology. E.g., Selkirk and Tateishi (1991), looking at patterns in downstep in Japanese, propose that the left edges of maximal projections of syntactic categories (XPs) are mapped onto the left edges of the Major Phrase boundaries. Kubozono (1989) shows that the prosody is different between phrases in left-branching and right-branching structures. Ishihara (2003) argues that each time there is syntactic Spell-Out at certain phrases (e.g., CP), the prosody is derived, and this operation is repeated cyclically until the last Spell-Out. Sugiyama (2012) argues that syntactic movements result in different prosodic phrasing than structures without movement. All these works support the hypothesis that if the syntax is different, the prosody may be different as well.

In this study, we investigate this hypothesis in (Tokyo) Japanese with two nodes that are relatively high in the clausal syntax, i.e., (a) an embedded CP and (b) a boundary between the subject NP and predicate VP. Our results suggest that the former does not affect the prosody, while the latter does. Thus, while the syntax actually matters to the prosody, not all types of syntactic information are relevant. Furthermore, we test the perception of these production results and find that the prosodic differences are not noticeable to listeners.

In testing whether the presence of an embedded CP affects prosody, we used three pairs of sentences, (1)-(3). Each pair has the same phonological lengths (counted by moras) and word accent patterns (apostrophes indicate word accent), but they differ in their syntax: sentences in (a) have an embedded CP with the complementizer *-to* (Saito 1987), while those in (b) do not.

(1) a. [a'ni-wa [hana'-to]$_{CP}$ itta.] b. [a'ni-wa hana'-o utta.]
brother-TOP flower-COMP say-PAST brother-TOP flower-ACC sell-PAST
'My brother said flower.' 'My brother sold flowers.'
(2) a. [a'ni-wa [hana-to]$_{CP}$ itta.] (hana 'nose') b. [a'ni-wa hana-o utta.]
(3) a. [a'ni-wa [kariforunia-to]$_{CP}$ itta.] (kariforunia 'California') b.[a'ni-wa kariforunia-o utta.]

(1) and (2) differ in terms of the accentuation on the second noun; in (1), *hana'* 'flower' has accent on the last syllable, while in (2), *hana* 'nose' is unaccented. We also consider the word length: (1) and (2) have the two-mora words *hana'/hana*, while (3) has a longer (six moras) word, *kariforunia* 'California'. According to Ishihara's (2003) proposal, the items in each pair are expected to have different prosodies, since he proposes that once a CP is generated, the prosody applies to that phrase; our pair sentences are expected to be pronounced differently.

In order to test about the boundary between the subject NP and predicate VP, we used (4), the *ooba* pair: (4a) does not have any syntactic boundary within the six-mora window in *kariforunia*, whereas (4b) has a boundary between the subject NP (*kore*-ga) and predicate VP (*ooba*).

(4) a. [a'ni-wa [[ ]$_{NP}$ [kariforunia]$_{VP}$-to] itta.] (=(3a))
b. [a'ni-wa [[kore-ga]$_{NP}$ [ooba]$_{VP}$-to] itta.]
brother-TOP this-NOM ooba herb-COMP said 'My brother said this was ooba herb.'

Again, if it is only the phonological length and word accentuation that are important in the phonological phrasing, the prosody in this pair would be the same, since the accentual representation is the same (unaccented during the six-mora window; the initial lowering would be, and in fact was among our speakers, blocked in *ooba* as the first syllable is heavy, in which case the word would begin with a H tone); if this particular syntactic boundary should be realized in the prosody, these sentences would be pronounced with different prosodies.

Six speakers pronounced the above seven sentences eight times. In examining the prosody, we used the pitch of three vowel portions that occurred in the same position in the pair and compared (e.g., [a'ni-wa [hana'-to]$_{CP}$ itta.] vs. [a'ni-wa hana'-o utta.]; [a'ni-wa [kariforunia-to]$_{CP}$ itta.] vs. [a'ni-wa kariforunia-o utta.]). We took the means of the fundamental frequencies (f0) to represent the pitch. We compared the f0s of the three vowel portions in each pair by performing liner mixed-effects analyses, using R (ver. 3.1.2) and *lme4* and *lmerTest* packages. We entered the speaker and repetition into the model as random effects and vowels as fixed effects.

The pairs in (1), (2), and (3) did not differ in terms of the pitch, but the pairs in (4) did differ. Figures 1 to 4 give the mean f0s as estimated from the linear analyses for (1) to (4) respectively: the lines in each pair run almost identically in Figures 1 to 3, but are farther apart in Figure 4.

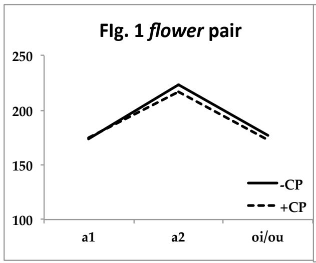
FIg. 1 *flower* pair

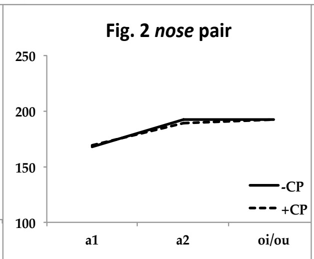
Fig. 2 *nose* pair

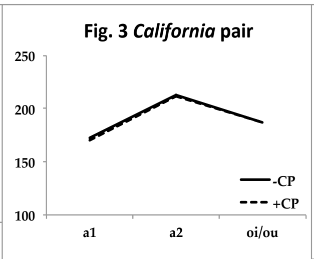
Fig. 3 *California* pair

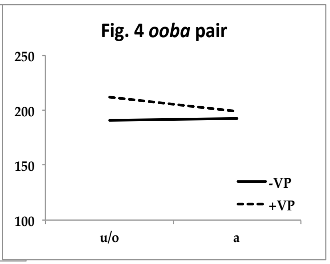
Fig. 4 *ooba* pair

These results in Figures 1 to 3 show that regardless of the presence or absence of the embedded CP, the pitch as examined in this study did not differ so long as the phonological information, in particular the word accentuation and the length, is the same in the sentences. This indicates that a CP boundary (and other syntactic boundaries that may differ in the pairs) may not be interpreted to surface prosodically. Recall that this is not expected from Ishihara's (2003) proposal.

On the other hand, the boundary between the subject NP and predicate VP is explicitly reflected in prosody. In Figure 4, the f0 declines from the vowel *u* to *a* in *kariforunia*, which can be interpreted as the natural lowering in the pitch, i.e., declination, whereas in the *ooba* sentence, f0 slightly ascends from the vowel *o* to *a* in *kore-ga ooba*, with a boundary between the subject NP and predicate VP before *o*. We propose that this particular syntactic boundary is strong and unavoidable in prosody, unlike the other XP boundaries, and thus the declination cannot continue across it. This result is along the lines of Selkirk and Tateishi (1991), who propose that in Japanese, a Major Phrase boundary is inserted at the left edge of an XP. *Kariforunia* does not have an XP boundary before *ru* and thus the declination continues throughout the word, whereas *korega ooba* does have the boundary before *o* and so such declination cannot continue across the boundary.

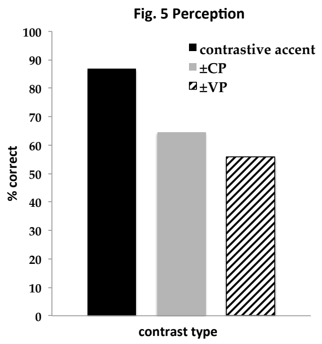
Fig. 5 Perception

We next tested if the pairs in (1) to (4) are distinguishable to the listeners. For each pair, we extracted the pitch, removing the segmental information, and asked 60 participants to choose which item in the pair they heard. We also included control pairs where the syntactic structure is the same but they differ in the accent (e.g., (1a) vs. (2a)). The results (Fig. 5) show that pairs in (1), (2), and (3) are not identifiable; the listeners answered at nearly chance level (middle bar); this is expected, since the pitch curves do not differ in the stimuli (Figs. 1-3). However, they could not distinguish the *ooba* pair either, in which the pitch curves do reflect the syntactic differences (Fig. 4). This indicates that the syntactic differences that the speakers encode in pitch may not be noticeable for the listeners.

Exploring the syntax-phonology interface: the effect of freestanding form

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One prevalent theory of syntax-phonology interface postulates a prosodic level that is distinct from syntax and phonology and that mediates between these two (Selkirk 1986, Selkirk 2011). For this postulation, two questions need to be answered: how do syntactic and prosodic structures correspond; is there enough evidence to postulate an additional level rather than claiming that there is a mismatch between syntax and phonology, presumably due to competing constraints/rules? Mandarin Tone 3 Sandhi (T3S), of which the domain is often analyzed as prosodic, provides some insight into these questions. This study, by investigating T3S, shows that (i) T3S domain corresponds to the syntactic constituency, inherited by the prosodic component of the grammar, if and only if the syntactic constituents are freestanding; otherwise (ii) the prosody can act as an independent structure which intervenes and reconfigures the domain.

T3S is the phenomenon where Tone 3 (T3) changes to Tone 2 (T2) when it precedes another T3 (T3 → T2/___ T3). The sandhi application is believed to be cyclic (Chen 2000, Duanmu 2007, a.o.). For example, if the syntactic structure is a right-branching one, e.g.{*xiao*{*yu san*}} ("small umbrella"), and if the prosodic structure aligns with the syntactic structure, i.e. *(xiao(yu san))*, the output should be *(xiao3(yu2 san3))* (where 2 means T2 and 3 means T3). The first T3S domain is the innermost constituent *(yu san)*; after the first cycle of sandhi application, the result is *(xiao3(yu2 san3))*. There is no environment for T3S to apply again. This prediction is consistent with native speakers' judgment. However, there are some systematic exceptions with certain syntactic configurations such as in the following example: for {*liang*{*ba san*}} ("two Classifier umbrella") the output is *liang2 ba2 san3*.

Those exceptions are traditionally explained by a cliticization rule (Poteet, 1985). In Poteet's (1985) original example, *mai ba san* ("to buy an umbrella"), the verb and the classifier form a prosodic word. It is not clear whether this account can be extended to all syntactic categories, such as numeral phrases e.g. *liang ba san* ("two umbrellas"). The rule also needs to explain why the clitic attaches to the left not the right constituent which is syntactically closer to it. A traditional alignment constraint (McCarthy and Prince, 1993) in an Optimality Theoretical account cannot explain the difference between *xiao yu san* and *liang ba san* either. Since *xiao yu san* and *liang ba san* have exactly the same syntactic structure, if the prosodic and syntactic boundaries are matched by alignment constraints, the prosodic structure for the two examples will be the same. However, as shown above, they have different sandhi patterns. There is one difference between the two phrases that is overlooked by alignment constraints: *ba san* is not a freestanding constituent, but *yu san* is. This study thus argues that in the case of T3S, syntactic constituents that are not freestanding are not visible to prosody; in other words, alignment constraints can only match prosodic boundaries with the syntactic boundaries of freestanding structures. Therefore, the syntactic structure of {*liang*{*ba san*}} is not relevant to the prosody component of the grammar, because of the non-freestanding status of *ba san*. This phrase is interpreted as {*liang ba san*} by the prosody.

The above hypothesis (stated earlier as hypothesis (i)) comes from the effect of isolation forms (Kenstowicz 1996; or Lexical Conservatism by Steriade 2000). Such an effect is derived from correspondence between bases and derivatives: if there are outputs for both the base and the derivative, there is an output-output correspondence between the two; if there is no freestanding base, meaning no output of base to be evaluated against the output of the derivative, the correspondence constraint is mute. Hypothesis (i) follows a similar logic: the alignment constraint can only see a constituent when the constituent is a freestanding form. Otherwise, it is mute. What it says about the interface between syntax and phonology at Spell-out is that, when the constituent is a freestanding form, it can enter phonological evaluation, and its boundaries can be matched to prosodic boundary by alignment. If the constituent is not freestanding, it cannot have a phonological form and consequently cannot enter the phonological evaluation. In fact, it has to wait until a later cycle when the constituent becomes a freestanding form to be spelled out. This is the case with *liang ba san*.

This leads us to another question: since there is no syntactic component that determines the hierarchy of the prosodic structure, does this mean that the prosody is not hierarchical at all? To answer this question, the author of this study has conducted an acoustic analysis on three-syllable chains that have no visible internal syntactic structure. This experiment controls for syllable structure by using identical syllables. The results show that the boundary between the second and third syllables is significantly larger than the boundary between the first and second syllables ($t = 3.73$, $p<0.001$). Thus, three-syllable units have the prosodic structure ((σσ)σ). This structure predicts its sandhi pattern to be ((22)3) which is consistent with native speakers' judgment. It is shown that, even without any syntactic information, prosodic structure must be organized in a hierarchy. So, *liang ba san* has *((liang ba)san)* as its prosodic structure, and *xiao yu san* has a prosodic structure of the form *(xiao(yu san))*. The fact that they have different prosodic structures explains why different sandhi results are expected, hence hypothesis (ii).

To sum up, this study shows a case where constituents with the same syntactic tree structure can have different prosodic correspondents. It is argued that (i) the freestanding status of some syntactic constituent is relevant to its visibility to the prosodic structure. T3S, as a case of cyclic application, shows the correspondence between syntax and prosody in each derivation cycle. It therefore sheds some light on the nature of Spell-out; that is, only freestanding constituents can be spelled out in T3S domain. In addition, it was shown that (ii) prosodic hierarchy can be created independently of syntactic structure. This supports the postulation of a prosodic level, and explains why constituents with the same syntactic structure can have different prosodic structures.

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To epenthesize or not? Adaptations of English coda [m] in Standard Mandarin loanwords

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This paper examines when and why English [m] is or is not adapted with an epenthetic vowel in Standard Mandarin (SM) loanwords (e.g. *Beckham* → *[pei.k*^{h}*ɤː.han.muː]*, *Walmsley* → [wei.*muː*.sɤː.liː] vs. *Columbia* → *[ke.lun.piː.jaː]*). [m] is illicit in coda position in SM, but in order to to fulfill the SM phonotactic constraints, SM speakers have three possible repair strategies: [m]→[n]/[ŋ] place of articulation alternation (POA), [m] deletion, and vowel epenthesis. We propose an analysis based on SM speakers' perception and their native phonology to account for the following three cases of SM loanword adaptation of English [m] in different phonological environments: a) when the English [m] is adapted with vowel epenthesis, b) when it is adapted with [m] POA, and c) when it is variable. We identify the conditioning factors are based on the syllable position and phonological environment of [m] in English.

Data & Generalizations By looking at English [m] in two corpora (an English-Chinese dictionary and Google Maps) consisting of more than 4500 proper nouns, including American and British given names, surnames, and place names, we identify that vowel epenthesis appears in SM loanwords when [m] is in word-medial and word-final coda positions or in monosyllabic words in English (in (1)). However, there are exceptions. When English coda [m] is in a homorganic environment such as [m.b] or [m.p] vowel epenthesis never occurs. Instead, [m] POA occurs. This happens to word-medial codas and syllable final consonant clusters (in (2)). In addition, when the pre-[m] vowel is long or a diphthong, even in a homorganic environment, [m] is adapted with vowel epenthesis (in (3)). Variable adaptation occurs when [m] is adjacent to other stops (in (4)).

(1) Vowel epenthesis: word-medial, word-final coda, and monosyllabic words.
Camrose→ *[k*^{h}*aː.muː.l*^{w}*oː.sɤː]*
Plimsoll→ *[p*^{h}*iː.liːmuː.s*^{w}*oː.ər]*
Tom→ *[t*^{h}*aŋ.muː]*
(2) [m] POA: [m] in a homorganic environment.
Columbia→ *[ke.lun.piː.jaː]* (word-medial coda)
Olympia→ *[ao.lin.p*^{h}*iː.jaː]* (word-medial coda)
Camp→ *[k*^{h}*an.puː]* (word-final consonant cluster)
(3) Vowel epenthesis: [m] in a homorganic environment when the previous vowel is long.
Shaumberg→*[ʂau.muː.pau]*
Bloomfield→ *[puː.luːmuːfei.ər.tə]*
(4) Variable adaptation: [m] in non-homorganic environment.
Camden→ *[k*^{h}*aː.muː.təŋ]~[k*^{h}*ən.tun]*
Binghamton→ *[pin.han.muː.tun]~[pin.han.tun]*

In the corpora, we also find that when [m] in English is ambisyllabic, nasal insertion occurs, e.g. *Sammy* → *[ʂan.miː], sauna* → *[saŋ.naː]* and the place of the inserted nasal, in most cases, agrees on the backness with its preceding vowel in English (cf. Hsieh, Kenstowicz & Mou 2009). Moreover, the epenthetic vowels are all [+round], [u] in most cases, and [o] in only two words.

Proposed Analysis Vowel epenthesis after [m] in SM loanwords is motivated by SM phonology to fix the illicit [m] in coda position in SM. In addition, vowel epenthesis improves the perceptual similarity between the English inputs and the SM loanword outputs. We proposed that among the three possible repair strategies, deletion is not chosen due to the need for segment preservation (Paradis and LaCharité 1997). The reason [m] POA change is not adopted in most coda positions is that the produced outputs are less phonetically similar to forms repaired with vowel epenthesis. We argue that vowel epenthesis after [m] is used to match the perceived consonant release (Kang 2003, Peperkamp, Vendelin & Nakamura 2008) in word-medial and word-final positions, given the fact that they are acoustically similar. In English, a sequence of stops is produced with a gestural overlap (i.e. [m.p]/[m.b]), such that there is no audible release for the first stop (Henderson & Repp 1982, Browman & Goldstein 1990). Hence, vowel epenthesis never occurs in a homorganic environment when the preceding vowel is not long.

However, when the pre-[m] vowel is long or a diphthong, epenthesis still occurs, despite satisfying the homorganic condition. We propose that SM speakers tend to keep the vowel duration to fulfill the μμ-syllable constraint (Duanmu 2007) and resyllabify the English coda [m] with an epenthetic vowel. In these cases, vowel epenthesis does not fix the illicit coda but fixes the illicit onset clusters or illicit consonant sequences in SM.

Variable adaptations occur due to the weak release or no audible release after the coda consonant in consonant sequences. Coda consonants may or may not be released (Malécot 1958, Selkirk 1982, Crystal & House 1988), or depending on the following consonant, have various degree of release in English (Davidson 2011). Hence, speakers are indeterminate with the release cue. When the input is perceived with different degrees of consonant release, the SM loanwords are produced in two ways—with and/or without vowel epenthesis ([m] POA).

We have also run three experiments, online adaptation, rating, and ABX tasks, on monolingual Mandarin speakers to verify the proposed analysis. With a full analysis pending, the preliminary findings suggest the trend in the right direction.

Conclusion The proposed analysis captures the important generalizations from the current corpora. Vowel epenthesis is adopted for syllable repair/phonological reasons. However, we also propose that the appearance of the epenthetic vowel is due to the fine phonetic cue in English and speakers' perception, i.e. the vocalic-like release after English coda [m] is perceived as a vowel. To promote the perceptual similarity between the English input and the SM loanword output, vowel epenthesis is adopted as a syllable repair. [m] POA in homorganic cases is also motivated to improve perceptual similarity as well as repairing the illicit syllables.

This study provides additional evidence that loanword adaptations originate in perceptual assimilation that maps the non-native sounds and structures at the perceptual level onto the phonetically closest native sounds while involving speakers' native phonological knowledge.

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Perceptually Weak and Strong Unmarked Patterns: A Message-based Approach

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Perceptual factors have been drawn on to provide insight into sound patterns (e.g. Ohala 1981; Lindblom 1990; Flemming 1995; Jun 1995; Hume 1998; Steriade 2008) and commonly serves as a diagnostic for markedness (e.g. Hamilton 1996, Boersma 1998). However, a puzzling situation has emerged: patterns associated with strong perceptual distinctiveness and those with weak distinctiveness are both described as unmarked. For example, it is widely assumed that the unmarked position for most consonants is in prevocalic/onset position (e.g. [**t**a]), a pattern commonly associated with multiple inherent and/or contextual phonetic cues (Wright 1996). Yet, unmarkedness is also associated with weak cues, as in positions of neutralization (Silverman 2012). In coda position, for example, Korean plain voiceless, aspirated and tense consonants (e.g. [t tʰ t']) surface as the plain consonant (Cho 1990), the unmarked member of the opposition (Trubetzkoy 1939, Rice 1999). Context is important in understanding why strong and weak cues can both be unmarked: prevocalic/onset position hosts unmarked consonants with strong cues and postvocalic/coda position hosts unmarked consonants with weak cues. Yet *why* should the unmarked sound in coda position be commonly associated with weak cues while the unmarked consonant in onset position be associated with strong cues? Or, more fundamentally, what does it mean for a pattern to be unmarked?

We suggest that insight into the unmarked nature of the patterns and into markedness more generally can be gained when we take seriously the view of language as a system of communication. Like all communication systems, language involves transmitting messages (i.e. morphemes, words or higher levels of meaning) from one person/place/thing to another. Building on recent work by *[withheld]*, unmarked patterns are those that effectively balance two competing pressures: (a) contribution of the phonological unit in context (PUc) to accurate message transmission, and (b) resource cost of the PUc to identifying the signal (Figure 1).

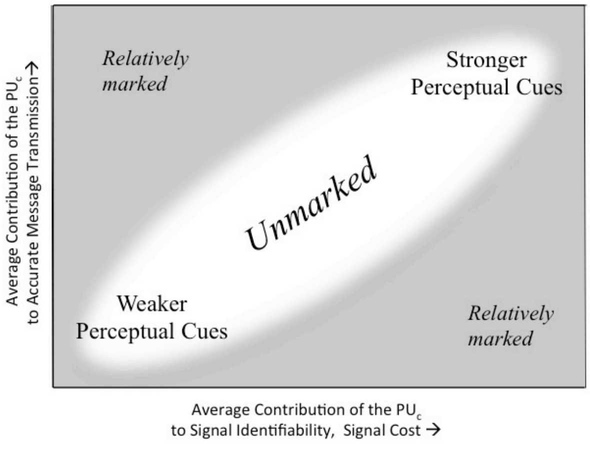

Figure 1. Communicative effectiveness and its relation to phonological patterns

The space delimited by the axes in Figure 1 can be thought of as the abstract space occupied by different possible signals (phonetic signals, in the present case) used to communicate messages. The horizontal axis represents the amount of redundancy present in a particular signal, with less-redundant signals to the left and more redundant signals to the right. Less redundant signals are lower in cost, yet at the same time associated with a lower likelihood of accurate signal identification and message transmission (Shannon 1948). The vertical axis represents the possible contribution that a particular signal makes toward achieving error-free communication, with less important signals near the bottom and more important signals near the top. Thus, signals can have different overall potential contributions to the robustness of message transmission; that is, they are more or less important for communicating the message.

Communicative effectiveness is optimized when resource cost is allocated to positions in the message that make a greater contribution to the message's identification and minimized in positions that contribute little. This region is labeled 'unmarked' along the diagonal in Figure 1. Framed in this way, we are able to predict the conditions under which sound patterns are likely to be considered unmarked. Specifically, patterns with strong perceptual cues should typically occur toward the top right quadrant of Figure 1; that is, in contexts which contribute more to message identifiability, i.e. toward the beginning of the word, or in segmentally and/or prosodically prominent contexts. For consonants, this includes prevocalic/onset position. Similarly, patterns with weak perceptual cues are predicted to occur in contexts that provide little benefit to message identification, such as toward the end of the word or in segmentally and/or prosodically non-prominent contexts, e.g. for consonants: postvocalic/coda position. Thus, what have emerged in the literature as "unmarked" values are unified by the observation that they optimally balance the competing pressures of resource cost and accuracy when it comes to communicating messages. In some cases this balance corresponds to being phonetically weak and in others, to being phonetically strong.

Evidence from perceptual distinctiveness suggests that sound patterns emerge as a result of pressures on higher-level units of meaning. Thus, while linguistic structure provides the conditioning context for sounds at a sub-lexical level, the role of phonology within a communication system strongly influences the shape of sound patterns in a phonological system.

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Learnability of Two Vowel Harmony Patterns with Neutral Vowels

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The relationship between the complexity of a phonological pattern and its learnability is one of the noteworthy questions in phonological theory. The Complexity Hypothesis in (1) states that a less complex pattern is easier to learn than a more complex pattern.

(1) *Complexity Hypothesis*
If $x <_{complex} y$ then $x <_{learn} y$:
If x is less complex than y, then x is easier to learn than y.

In this study, the Complexity Hypothesis is instantiated as the *Subregular Hypothesis*, which measures complexity in terms of the Subregular Hierarchy. The Subregular Hierarchy classsifies logically possible phonotactic patterns into different classes (Heinz, 2010; Heinz et al., 2011; Rogers and Pullum, 2011; Rogers et al., 2013). Since higher classes in the Subregular Hierarchy are deemed more complex than the lower classes, patterns in the higher classes are predicted to be more difficult to learn than the lower classes. The Subregular Hypothesis has been shown to successfully capture differences in learning (Lai, 2012, 2015). Lai's (2012; 2015) studies showed that participants in an artificial language learning experiment showed more difficulty in learning a pattern in a higher class in the Subregular Hierarchy than the one in a lower class. Like Lai's research, this study reports results from artificial language learning experiments which support the Subregular Hypothesis (though the patterns under investigation here compare different classes than the ones investigated by Lai).

Specifically, this study investigates the learning of vowel harmony patterns with neutral vowels that belong to different classes in the Subregular Hierarchy. An artificial language learning experiment was conducted to test the hypothesis. In Finley (2015), artificial language learning experiments were conducted to compare the learning of vowel harmony patterns with opaque vowels and with transparent vowels. The result of the study showed that participants were better at learning the pattern with opaque vowels than the one with transparent vowels. (However, participants could learn the transparent vowel pattern with more exposure.) In this study, two vowel harmony patterns with transparent vowels were tested. The two vowel harmony patterns belonged to different subregular classes. One pattern was in the Star-free class, and the other was in the lower Locally Testable class. In both patterns, there were five vowels [i, e, a, u, o], and a suffix which alternated between [-se/-so].

The pattern in the Star-free class is called the Rightmost pattern. In the Rightmost pattern, the suffix agrees with the frontness of the rightmost non-neutral vowel of the word. The neutral vowel in the Rightmost pattern is the low vowel [a]. If the rightmost non-neutral vowel is the front vowel [i] or [e], then the word selects the suffix [-se], and if the rightmost non-neutral vowel is the back vowel [u] or [o], then the word selects the suffix [-so]. For example, a word like *'pukina'* selects the suffix [-se] because the rightmost non-neutral vowel is the front vowel, and a word like *'pikuna'* selects the suffix [-so] because the rightmost non-neutral vowel is the back vowel.

The other pattern in the Locally Testable class is called the At Least One (ALO) pattern. In this pattern, if there is at least one front vowel in the word then the suffix agrees in frontness with it. Since the suffix agrees only with the front vowels, the back vowels [u] and [o] behave as if they were neutral vowels in this pattern, like the low vowel [a]. For example, both of the words *'pukina'* and *'pikuna'* select the suffix [-se] because there is a front vowel [i] in the word. Notice that the word *'pikuna'* selects a different suffix depending on whether it follows the Rightmost pattern or the ALO pattern.

The experiment were composed of two sessions: training and test. Participants were trained in one of the patterns depending on the condition. The test session was the same across all conditions. There were three conditions: Rightmost, At Least One, and Control condition. The Rightmost condition and ALO condition were based on the vowel harmony patterns discussed above. The critical stem type of interest was FBL type, where F refers to the front vowels, B to the back vowels, and L to the low vowel. In the Rightmost condition, the FBL word types take the suffix [-so] since the rightmost non-neutral vowel is the back vowel. In the ALO condition, the FBL word types take the suffix [-se] because there is a front vowel in the stem. In the training of the Control condition, half of the words took the suffix [-se] and the other half of the words took the suffix [-so]. So half of the FBL training words took [-se] and half took [-so]. The Control condition can be used as a reference level for the other two conditions.

A total of 79 students (26 each in the Rightmost and Control conditions, and 27 in the At Least One condition) from University of Delaware participated in the study. In the test session, participants were asked to choose a word with the suffix that they think belongs to the language that they were trained on during the training session. There were 60 randomized test items and the suffixes were counter-balanced.

The results were analyzed by selection of the suffix [-se] in each condition. When the Rightmost condition and the ALO condition were compared directly, the difference between the two conditions in selecting the suffix [-se] was statistically significant ($p = 0.000462$) in the expected direction. When the two conditions were compared to the Control condition, the difference between the ALO condition and the Control condition was statistically significant ($p = 0.000178$), but the Rightmost condition and the Control condition were not ($p = 0.127639$). The results show that participants were better at learning the ALO pattern than the Rightmost pattern. In other words, participants were better at learning the less complex pattern than the more complex pattern, where complexity is measured by the Subregular Hierarchy. Hence, these results provide additional support for the Subregular Hypothesis. The results for other word types, how these results fare with other potential explanations and how they bear on other complexity hypotheses will also be discussed.

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Prosodic Subcategorization, Infixation, and Relation-Specific Alignment

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In Yu's (2007) prosodic subcategorization approach to infixation, a Generalized Alignment (GA; McCarthy and Prince 1993) constraint is used to position an infix with respect to its "pivot", the prosodic category to which the infix appears to be anchored. The basic pattern of Tagalog *-um-* infixation provides a simple illustration. As (1) indicates, the affix *-um-* anchors at the right edge of the stem-initial onset. The stem-initial onset is the pivot.

(1) Stem: sulat Infixed form: sumulat, *umsulat, *sulumat, *sulatum 'to write'

To account for the basic Tagalog pattern, the prosodic subcategorization account uses a constraint like ALIGN(*-um-*, L, ONS$_1$, R), given in (2), to align the left edge of *-um-* with the right edge of a stem's initial onset, as in (3a) below.

(2) ALIGN(*-um-*, L, ONS$_1$, R): The left edge of every *-um-* affix corresponds with the right edge of some stem-initial onset.

The use of GA constraints presents two difficulties, however, one general and one specific to the prosodic subcategorization account. First, GA constraints in general are capable of producing a well-known pathology, the "Midpoint Pathology", where one of the aligned categories can seek out the center of a form regardless of the form's length (Eisner 1997, Hyde 2015). GA's Midpoint Pathology effect is sufficiently problematic to warrant abandoning GA constraints in general, including in the context of prosodic subcategorization. Second, the particular GA constraints employed in the prosodic subcategorization approach are more complex than standard GA constraints in that they almost always require special stipulations about the position of the pivot category. ALIGN(*-um-*, L, ONS$_1$, R) does not merely require alignment with *some* onset, for example, the situation that would be found under the standard formulation, but it requires alignment with a particular onset: the *first* onset of the base. Without the special stipulation concerning the onset's position, ALIGN(*-um-*, L, ONS$_1$, R) could be satisfied by alignment with *any* onset, as in (3b), and the analysis would fail.

(3a)

um + sulat	ALIGN(*-um-*, L)
a. um-sulat	*!
☞b. s-um-ulat	
c. sul-um-at	*!*
d. sulat-um	*!***

(3b)

um + sulat	ALIGN(*-um-*, L) *without stipulation*
a. um-sulat	*!
☞b. s-um-ulat	
☞c. sul-um-at	
☞d. sulat-um	

Replacing GA constraints with Relation-Specific Alignment (RSA; Hyde 2012) constraints avoids these problems. RSA constraints do not produce Midpoint Pathology effects (Hyde 2012, 2015), and they can capture prosodic subcategorization effects without a special stipulation concerning the position of the pivot. The facts of Tagalog *-um-* infixation can be captured by ranking the RSA constraint *um*-INFIX-DEPTH, given in (4a), above the RSA constraint ALIGN-*um*-RIGHT, given in (4b).

(4) a. *um*-INFIX-DEPTH: *⟨*ons*, *-um-*, *seg*⟩ / *ons* … *seg* … *-um-*
'Assess a violation mark for every *⟨c*ons*, *um*, *seg*⟩ such that an *onset* precedes *-um-* with *segment* intervening.'

b. ALIGN-*um*-RIGHT: *⟨*um*, *S, stem*⟩/ […*um*…*segment*…]$_{stem}$
'Assess a violation mark for every *⟨*um*, *seg, stem*⟩ such that *um-* precedes a *segment* within a *stem*.'

As (5) demonstrates, *um*-INFIX-DEPTH determines the pivot category. The affix *-um-* is one of the aligned categories, and the pivot, *onset*, is simply the other aligned category. Though *um*-INFIX-DEPTH restricts the affix to a position near the initial onset, the position of the relevant onset is not stipulated in the constraint. Since the constraint prohibits an onset from preceding the affix with a segment intervening, a candidate only satisfies the constraint when *-um-* precedes the initial onset, as in (5a), or occurs at its right edge, as in (5b). If *-um-* occurs any further to the right, as in (5c,d), a segment will intervene between the affix and a preceding onset. The decision to locate -*um*- immediately after the initial consonant, rather than before it, is made by the second RSA constraint, Align-*um*-Right. Since the prefix position violates Align-*um*-Right more than the infix position, the infix position is optimal.

(5)

um + sulat	*um*-Infix-Depth	Align-*um*-Right
a. um-sulat		*****!
☞b. s-um-ulat		****
c. sul-um-at	*!*	**
d. sulat-um	*!*** **	

Using RSA constraints has the advantages of avoiding Midpoint Pathology effects and avoiding special stipulations about the position of the pivot, but it also has the advantage of providing a general, uniform analysis for infixation and seemingly unrelated phenomena such as accent windows. RSA constraints similar to those used to position the -*um*- affix in (5) have been shown to play a key role in creating trisyllabic accent windows and positioning accents within those windows (Hyde 2012, Hyde 2015).

Ranking the RSA constraint Initial-Window, (6a), above the RSA constraint Accent-Right, (6b), for example, produces post-peninitial accent, a configuration that arises in Kashaya (Buckley 1994) and Azkoitia Basque (Hualde 1998).

(6) a. Initial-Window: $*\langle A, F, \sigma\rangle \,/\, F \ldots\, \sigma \ldots\, X_{\omega}$
'Assess a violation mark for every $\langle A, F, \sigma\rangle$ such that a *foot* precedes an *accent* with a *syllable* intervening.'

b. Accent-Right: $*\langle A, \sigma, \omega\rangle \,/\, [\ldots A \ldots \sigma \ldots]_{\omega}$
'Assess a violation mark for every $*\langle A, \sigma, \omega\rangle$ such that an *accent* precedes a *syllable* within a *prosodic word*.'

As (7) demonstrates, Initial-Window causes an initial foot to act as sort of pivot for accents. Initial-Window is satisfied when the accent occurs within the initial foot, (7a,b), or on the syllable adjacent to the initial foot, (7c). The lower ranked Accent-Right insists that the accent occur in the rightmost of these positions, resulting in post-peninitial accent.

(7)

	Initial-Window	Accent-Right
a. (σ́σ)(σσ)		**!*
b. (σσ́)(σσ)		**!
☞c. (σσ)(σ́σ)		*
d. (σσ)(σσ́)	*!	

The extension the RSA approach to both accent windows and infixation has the advantage of providing a general, uniform analysis of both, and it suggests that it may be possible to extend the approach to other, potentially related phenomena, such as second position clitics and second position verbs, where a peripheral word or phrase acts as pivot.

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The typology of Headed Agreement By Correspondence

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This paper proposes the new concept that correspondence relations hold between heads and correspondents (HD-Correspondence) rather than between segments with the same status. It therefore extends Agreement By Correspondence theory (ABC, Walker 2000, 2001; Rose & Walker 2004; Hansson 2010; Bennett, 2013). The structure of its basic factorial typology is discussed in the paper. The theory provides an account of directional harmony without targeted constraints, and predicts under general premises a type of attested harmony where directional and dominant harmony interact. Other advantages not this discussed in this paper are the elimination of some majority rule effects, and the account of known Derived Environment Effects in harmony (e.g. Basque, Slovenian).

Akin to ABC, in Headed Agreement By Correspondence (HABC), surface correspondence is established among segments that share a specific feature. However, in HABC, one of such segments is a consonant head (c-head), and as such, it is the target of specific constraints. Figure (1) illustrates the difference between the two correspondence relations.

(1) HD, CC and IO correspondence

a. HD-Correspondence b. original CC-Correspondence

For the factorial typology, GEN is defined as follows. For the input, it generates all combinations of two segments /s/, /ʃ/ and /t. The first two segments /s, ʃ/ represent the segments with the correspondence feature [+sib], but with a different value of the harmonizing feature [ant]. For example, a possible input is /s…t/.

Each segment in the input can be mapped to [s], [ʃ] or [t]. Only 1 to 1 I/O mappings are generated (no epenthesis, deletion, splitting or coalescence), and the order of the segments is maintained (no metathesis). Since only two segments can appear in the output, there are only two possibilities in terms of correspondence: either the two segments correspond, or they do not. Correspondence is indicated by using a shared index $_{x\ldots x}$ if the segments correspond, or $_{x\ldots y}$ if they do not. For example, a possible candidate with the sibilants in correspondence is: /s…ʃ/ → [ʃ$_x$…ʃ$_x$].

CON consists of seven constraints, informally defined in (2). In addition to the three faithfulness constraints Ident-IO(+sib), Ident-IO(-ant) and Ident-IO(+ant), CON includes four HD-Correspondence constraints. Corr-HD(+sib) and Ident-HD(ant) are an adaptation of Corr and Ident-CC/VV constraints in ABC. The two constraints on c-heads are original. Notice that the Ident-IO constraints that refer to the harmonizing feature are in the fixed ranking Ident-IO(-ant) ≫ Ident-IO(+ant) to simplify the typology and to reflect an empirical generalization not discussed in this paper.

(2) CON$_{\text{C-Hea}}$

Corr-HD(+sib): "One violation for each [+sib] segment that does not correspond to a [+sib] segment "
Ident-HD(ant): "One violation for each segment in HD-correspondence that have a different feature value for the feature [anterior] from its head"
Align(c-head, R): "For each c-head H, assign a violation for each segment D in correspondence with H which is between H and the right edge of the prosodic word" *H…D}$_\omega$
Ident-IO(c-head): "One violation for each unfaithful feature mapping of a c-head segment"

The support for the typology includes the two disharmonic inputs /ʃasa/ and /saʃa/. The nine languages in (3) are generated. In addition to the expected dominant-recessive, directional, dissimilation and faithful languages, the typology also includes a previously unreported – but attested (e.g. Pengo, Kera) - type of language, which I call dominant-directional. In dominant-directional harmony, disharmonic roots harmonize only when the rightmost segment in the correspondence domain has the dominant feature value. Another language is predicted that is a combination of the dissimilation type and the dominant-directional one. In this grammar, disharmonic roots harmonize when the rightmost segment in the correspondence domain is marked, otherwise disharmonic roots dissimilate.

Inputs →	*ʃasa*	*saʃa*	*Language description*	*Possibly attested in...*
Dom.Hright	**(ʃ)**$_x$aʃ$_x$a	ʃ$_x$a**(ʃ)**$_x$a	**Dominant harmony.** Harmonize to the marked segment	Malto, Basque (Moroccan Arabic)
Dom.Hfaith	ʃ$_x$a(ʃ)$_x$a	ʃ$_x$a**(ʃ)**$_x$a		
Pure Dir	s$_x$a**(s)**$_x$a	ʃ$_x$a**(ʃ)**$_x$a	**Direction harmony.** Harmonize to the rightmost segment	Tsilhqot’in, Chumash, Saisiyat, Thao
Dom-Dir.noCor	ʃ$_x$as$_y$a	ʃ$_x$a**(ʃ)**$_x$a	**Dominant-Directional harmony.** Harm. only if rightmost segment is dominant	Ngizim, Pengo, Kera
Dom-Dir.Cor	ʃ$_x$a**(s)**$_x$a	ʃ$_x$a**(ʃ)**$_x$a		
Diss-Dir	ʃ$_x$at$_y$a t$_x$as$_y$a	ʃ$_x$a**(ʃ)**$_x$a	**Dominant-Directional dissimilation.** If rightmost marked harmony, diss. otherwise	(Javanese)/unattested?
Diss.	ʃ$_x$at$_y$a, t$_x$as$_y$a	ʃ$_x$at$_y$, t$_x$as$_y$a	**Dissimilation** Dissimilation everywhere	Chol
Faith.noCor	ʃ$_x$as$_y$a	s$_X$aʃ$_y$a	**Faithful** No harmony/dissimilation	Lgs without harmony
Faith.Cor	ʃ$_x$a**(s)**$_x$a	s$_x$a**(ʃ)**$_x$a		

Structurally, the typology is similar to the typology of ABC. Four constraint classes (Alber and Prince, ms.) used to describe its structure are listed below. The typology was calculated using OTWorkplace 71.

- **F = {**f.+ant, f.-ant**} -** Ident-IO constraints that refer to the harmonizing feature
- **Agr = {**corr-sib, m.HD, f-sib**} -** Constraints that conspire to give agreement
- **HPos** = {Al, f.HD} **-** Constraints that refer to c-heads
- **U** = {**Agr**, **F**}**-** Non-c-head constraints

The first split partitions the typology into harmonic and non-harmonic languages based on the ranking of the dominated constraint in the classes U and F (**USub(ordinate)** <> **FSub(ordinate)**). The dissimilation and the faithful languages belong to the latter group, while the rest of the languages have at least one harmonic output. Harmonic languages are divided into dominant and directional by **USub** <> **HPSub**.

Another property splits the typology into symmetric (pure directional only), and non-symmetric grammars, depending on the treatment of the two disharmonic inputs (**FDom** <> **AgrSub**). Non-symmetric languages have at least one disharmonic input wherein harmony is not achieved. These languages are distinguished on the treatment of this input, which can be mapped to an output that is faithful with correspondence, faithful without correspondence (as in ABC), or dissimilatory when f.-sib is dominated.

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Well-formed tone mappings with local, inviolable surface constraints

Adam Jardine and Jeffrey Heinz, University of Delaware

A problem which has long avoided a satisfying solution is how to capture cross-linguistic variation in 'tone-mapping' phenomena, or how tone melodies are realized over strings of tone-bearing units (TBUs). Early autosegmental work (Goldsmith 1976, Clements and Ford 1979, Pulleyblank 1986), which made directional association a primitive of the theory, was criticized by Zoll (2003) for failing to capture tone-specific association behavior. Zoll (2003) instead argues for violable, toneme-specific constraints evaluated globally over candidates in OT, at the cost of naturally capturing directionality. Both miss the generalization that language-specific tone-mapping well-formedness constraints (WFCs) over the surface structures are fundamentally *local*. The current proposal captures locality by characterizing tone-mapping patterns with a restricted set of *inviolable, language-specific* constraints. These constraints capture *both* directionality and tone-specific association behavior within the same framework while maintaining a restrictive typology.

To start, in Kukuya, HL-melody words have a L plateau on the right, suggesting left-to-right association. However, LH-melody words have a L plateau on the left.

(1) Kukuya word tone patterns (Zoll, 2003)

a. kâ 'to pick'	H-L	b. sámà 'conversation'	HL	c. káràgà 'to be entangled'	HLL
d. sǎ 'knot'	L-H	e. kàrá 'paralytic'	LH	f. mʷàrə̀gí 'brother'	LLH (*LHH)
g. bá 'palms'	H	h. bágá 'show knives'	HH	i. bálágá 'fence'	HHH

As Zoll (2003) observes, directional analyses require ad-hoc rules to capture the LLH forms. She instead analyzes them with a highly-ranked CLASH constraint against adjacent H-toned TBUs.

However, directionality cannot be entirely abandoned. Take, for example, Type α words in Wan Japanese (Breteler, 2013; Kubozono, 2011), in which all TBUs (in the *bunsetsu*, a domain including certain suffixes) are H-toned, save for a penultimate L tone.

(2) Wan Japanese (all words with '-nga' NOMINATIVE suffix) (Breteler, 2013)

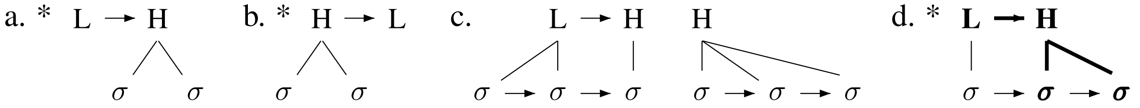
a. ká-ngà 'child'	LH	b. mídù-ngá 'water'	HLH
c. tátámì-ngá '*tatami* mat'	HHLH	d. mídúkúmì-ngá 'glutinous rice'	HHHLH

Kubozono (2011) analyzes Wan autosegmentally with right-to-left tone association, as the initial H consistently plateaus, whereas the L and second H are assigned one TBU each. In contrast, Zoll (2003)'s theory cannot distinguish between HHLH and *HLHH, as both violate CLASH equally. It would thus require an ad-hoc accentual analysis in which L is underlyingly associated to exactly where right-to-left directionality would assign it. Either that, or it would need to adopt some sort of ALIGN constraint (Yip 2002), which are problematic typologically (Eisner 1997, McCarthy 2003), partly because they are evaluated *globally*.

What both analyses miss is that language-specific WFCs are, on the surface, fundamentally *local* over autosegmental structures. The current proposal captures this by characterizing directionality and toneme-specific association with inviolable, language-specific *banned substructure* constraints. Such constraints have been posited for string-based phonotactics (Heinz, 2010; Heinz et al., 2011; McMullin and Hansson, to appear), and are attractive for multiple reasons. For one, they provide a restrictive theory of phonotactics. Two, they have a straightforward cognitive interpretation of well-formedness being evaluated locally over individual substructures (Rogers et al., 2013). Additionally, their theoretical learning properties are well-understood (Heinz, 2010; Jardine, in press).

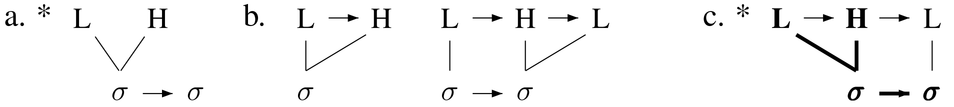
We can interpret banned substructure constraints over autosegmental representations (ARs) as banned *subgraphs*, as ARs are graphs (Goldsmith, 1976). For example, Zoll (2003)'s CLASH constraint can be reanalyzed as two inviolable constraints, one banning multiple association of a nonfinal H tone (3a), and one banning multiple association of a noninitial H tone (3b). Licit forms (3c) in Kukuya do not contain these structures as subgraphs, whereas the illicit AR corresponding to *LHH (3d) contains (3a) (highlighted in bold). In the following, adjacency is explicitly marked with arrows in the representation; the absence of an arrow between units on a tier means they may be nonadjacent. Full specification of TBUs to tones is assumed, as is the OCP (i.e., no adjacent, identical melody autosegments). Without loss of generality, σ will be assumed to be the TBU.

(3)



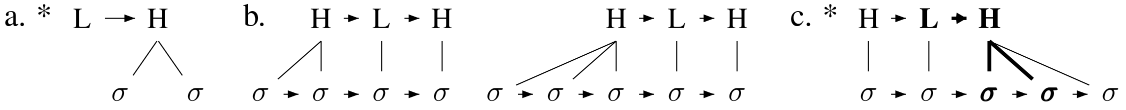
That contours in Kukuya only surface on the left edge can also be captured in this way:

(4)



The analysis of the restriction on H spread as two separate constraints in (3) makes the prediction that these constraints may appear independently. This is exactly the analysis for Wan Japanese, as only the nonfinal H is allowed to spread. Thus, (3a), but not (b), is present in Wan:

(5)



Thus, banned substructure constraints over ARs offer a unified analysis of both directional and quality-based conditions on tone mapping. They do so *locally,* as well-formedness is decided by a form's constituent substructures. Future work can explore how this property can be preserved when studying transformations from underlying to surface forms (c.f. Chandlee 2014). Additionally, future work can develop a theory of learning these constraints based on results in learning banned substructure constraints over strings (Heinz, 2010) and learning local graphs (López et al., 2012).

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LEARNING OPAQUE AND TRANSPARENT INTERACTIONS IN HARMONIC SERIALISM

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It has long been hypothesized that opaque process interactions are less natural and more difficult to learn than transparent interactions (Kiparsky 1968). However, the potential impact on phonological theory of these central debates has been limited by a lack of explicit computational models capable of learning opaque interactions and making precise and testable predictions for language acquisition and change. Building on recent developments in phonological theory and learnability that enable the modeling of opaque interactions in Harmonic Serialism (HS) and the learning of hidden structure in phonology, respectively, this paper presents initial modeling results comparing the relative learnability of four basic types of process interactions: bleeding, feeding, counterfeeding and counterbleeding. The overall findings support an inherent learning bias against opaque interactions; however, the specific patterns of preference depend substantially on the framework and choice of constraints.

The language system used for modeling is a hypothetical system involving potential interactions between a palatalization process (s → ʃ / _i) and a vowel deletion process (V → ∅ / _V). In the transparent interaction (1), vowel deletion applies first and palatalization second, resulting in bleeding (1c) and feeding (1d) interactions, depending on input. In the opaque interaction, palatalization applies before vowel deletion, leading to counterbleeding (2c) and counterfeeding (2d), depending on input.

1) Transparent Interaction

	a. Deletion	b. Palatalization	c. Bleeding	d. Feeding
Underlying	/sa-a /	/si/	/si-a/	/sa-i/
Deletion	sa	—	sa	si
Palatalization	—	ʃi	—	ʃi
Surface	[sa]	[ʃi]	[sa]	[ʃi]

2) Opaque Interaction

	a. Deletion	b. Palatalization	c. Counterbleeding	d. Counterfeeding
Underlying	/sa-a/	/si/	/si-a/	/sa-i/
Palatalization	—	ʃi	ʃia	—
Deletion	sa	—	ʃa	si
Surface	[sa]	[ʃi]	[ʃa]	[si]

The theoretical framework used for modeling these four interactions is a variant of HS called Serial Markedness Reduction (SMR; Jarosz 2014b). In SMR, candidates encode newly satisfied markedness constraints in a list called *mseq* that is initially empty <> and is updated on each pass. As shown in 3, deletion requires *VV ≫ MAX, while Palatalization requires *SI ≫ IDENT. Unlike in OT, in HS, potential feeding interactions (4) require *VV ≫ *SI because the required step of deletion creates a violation of *SI.

3) Crucial Rankings for Individual Processes in HS: Iteration 1

/sa-a/ <>	*VV	MAX		/si/ <>	*SI	IDENT
a. sa-a < >	W*	L		a. si < >	W*	L
☞ b. sa <*VV>		*		☞ b. ʃi <*SI>		*

4) Feeding / Counterfeeding: Iteration 1

/sa-i/ <>	*VV	MAX	*SI	IDENT
a. sa-i < >	W*	L	L	
☞ b. si <*VV>		*	*	

The SMR constraint SM(*SI, *VV), which assigns a violation to an *mseq* in which *SI follows or occurs simultaneously with *VV, is necessary to favor opaque interactions. With these rankings established, on the second iteration of the potential feeding interaction (5), SM(*si, *VV) ≫ *si results in counterfeeding, while the opposite ranking results in feeding. In the potential bleeding interaction (6), the choice between transparency and opacity is made on the first iteration: bleeding occurs unless SM(*si, *VV) ≫ *VV.

5) Feeding / Counterfeeding: Iteration 2

/si/ <*VV>		*VV	Max	*si	Ident	SM(*si, *VV)
counterfeeding	a. si <*VV>			*		
feeding	b. ʃi <*VV,*si>				*	*

6) Bleeding / Counterbleeding: Iteration 1

/si-a/ <>		*VV	Max	*si	Ident	SM(*si, *VV)
faithful	b. si-a < >	*		*		
bleeding	a. sa <*VV + *si >		*			*
counterbleeding	b. ʃi-a <*si>	*			*	

To model learning in this system, the general approach to hidden structure learning developed by Jarosz (2014a) is adapted to an HS framework. In this approach, the grammar is represented in terms of pairwise ranking probabilities (e.g. P(A≫B), P(A≫C), etc.), and it is these parameters that are updated during learning. To compute the update, each pairwise ranking A≫B is tested by sampling the predicted outputs from a temporary grammar that is just like the current grammar except with A≫B categorically set. Updates reward pairwise rankings that succeed in correctly generating the observed output form. In this way, hidden structure is irrelevant to the mechanics of learning, and adapting the approach to HS requires only implementing an HS, iterative EVAL production module – everything else is identical.

The initial grammar for all simulations ranks all constraints equally. The languages in 1 and in 2 were both learned correctly on all runs, confirming that the model is capable of learning both opaque and transparent interactions in SMR. Additionally, to compare the relative learnability of the four process interaction types, learning was examined on four test sets that included only 1a and 1b, plus exactly one of the interaction types (1c, 1d, 2c, or 2d). The number of learning iterations required for the model to converge on the correct grammar on average (out of 20 runs) was used as a proxy for learning difficulty. As shown in 7, bleeding was learned most quickly, feeding next most quickly, and the opaque interactions were learned most slowly and did not differ significantly from one another.

7) Ave (s.d.) of 20 runs	*Bleeding*	*Feeding*	*Counterbleeding*	*Counterfeeding*
Iterations till convergence	56.0 (9.9)	90 (17.2)	153.5 (25.6)	150.5 (30.9)

The results depend only on the ranking requirements of the above SMR analysis: no prior biases of any kind are assumed. Feeding is harder than bleeding because feeding requires an extra crucial ranking (4) be learned. Opaque interactions are harder because they require SM constraints rank above markedness, which must be above faithfulness, requiring more 'spread out' rankings. The paper discusses alternative analyses that result in different predictions. For example, under different constraint formulations, bleeding and feeding become equally easy. In general, predictions for learning difficulty can hinge on minute details of the theory, and a great deal of careful modeling work is needed before any general conclusions can be reached.

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On the Relationship between Learning Sequence and Rate of Acquisition

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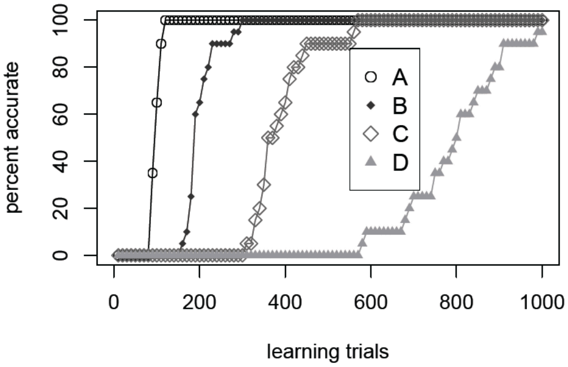
Overview: The Gradual Learning Algorithm (GLA; Boersma 1998, Boersma & Hayes 2001) predicts that more frequent input forms will be acquired earlier than less frequent input forms – a fact that has been commonly taken as a virtue of the model (e.g., Boersma & Levelt 2003, Curtin & Zuraw 2002, Jarosz 2010). The GLA also predicts, however, that the *rate* of learning for more frequent input forms should be *faster* than the rate of learning for less frequent input forms. In other words, the model predicts that sequence and rate of acquisition are related; structures acquired earlier in the course of learning will be acquired more rapidly, while those that are acquired relatively later will be acquired more slowly. This paper explicates these predictions and argues that they are not consistently supported by child language data.

Predictions of the learning model: The relationship between sequence and rate of acquisition in the GLA stems from two key properties of the model: the learner is error driven, and, in common implementations, target forms are sampled in accordance with their probability in the target language. As a result, the ranking values of constraints associated with more frequent target forms are adjusted more often than are those associated with less frequent target forms. This means that more frequent forms are mastered earlier *and* that the progression from the first accurate realizations to 100% accuracy occurs more rapidly for more frequent forms.

Figure 1: Results of GLA learning simulations



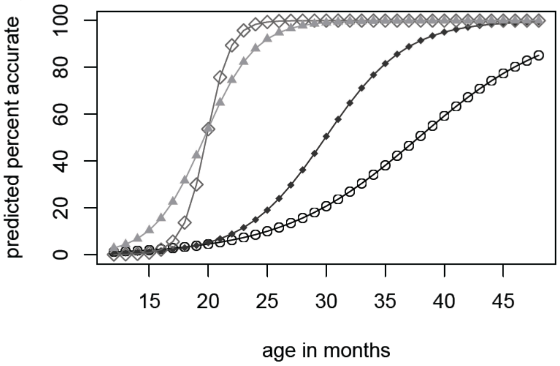
To illustrate this effect I constructed a toy language with the four forms /A/, /B/, /C/ and /D/, each of which provides evidence about the ranking of a markedness constraint (*A, *B, etc.) and a conflicting faithfulness constraint (FAITH-A, FAITH-B, etc.). An initial M >> F ranking was assumed. Figure 1 shows the mean results of 10 GLA simulations conducted in Praat (Boersma & Weenink 2014) based on an input distribution where the probability of /A/ was twice the probability of /B/, the probability of /B/ was twice the probability of /C/, etc. Mappings for each input form were sampled after every ten pieces of learning data. As expected, the most frequent input form, /A/, began to be realized accurately first, while the least frequent input form, /D/, was the last to begin to be realized accurately. Furthermore, it took an average of only 40 learning trials for input /A/ to shift from less than 10% accurate realization to over 90% accurate realization, while it took 320 learning trials for input /D/ to make the same transition. Inputs /B/ and /C/ fell between inputs /A/ and /D/ in terms of both sequence and rate of learning.

Child language data: Longitudinal corpus data allows us to test whether the predicted relationship between sequence and rate of acquisition holds consistently in child language. Data from two English-acquiring children are considered here: Trevor (Compton & Streeter 1977, Pater 1997) and Amahl (Smith 1973). For each child all target utterance-initial onset clusters and utterance-final coda clusters were extracted from the corpus. Target clusters found in unstressed syllables and those formed through morphological concatenation were excluded. For Trevor this yielded a total of 1633 tokens distributed across 40 cluster types (rhotic dialect), while for Amahl it yielded a total of 1496 tokens distributed across 51 cluster types (non-rhotic dialect). Target clusters were coded as accurate if they were produced as a sequence of two consonants, regardless of segmental changes. Additional details are given in the table on page 2.

For both Trevor and Amahl, the probability of all clusters being realized accurately increased significantly with age. In both cases, however, a logistic regression model with the factors age, syllable position, and sonority fully crossed provided a better fit to the data than any simpler model (Trevor: $p < .01$, Amahl: $p < .001$). This indicates that the *rate* of acquisition varied across cluster position and sonority profile.

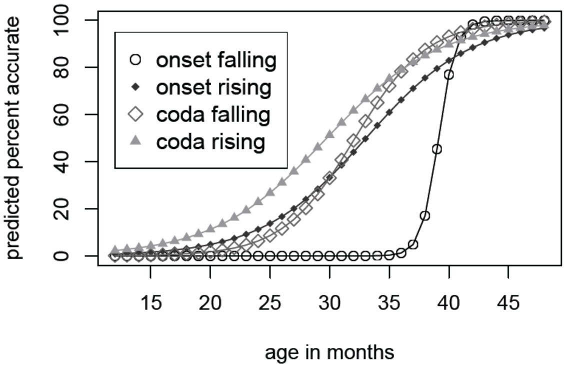
	Trevor (0;11-3;1)		Amahl (2;2-3;9)	
	onset	coda	onset	coda
rising sonority	877	63	845	44
falling sonority	120	573	199	408
total	997	636	1044	452

Figure 2: Trevor's accurate cluster realization



Figures 2 and 3 plot the predicted probability of accurate realization for the different cluster types based on the fitted logistic regression models. For Trevor, the overall pattern largely mirrors that predicted by the GLA. The cluster types that Trevor begins to produce earliest – rising and falling sonority coda clusters – reach a high level of accuracy at a faster rate than the later-acquired cluster types. For Amahl, on the other hand, the pattern directly contradicts the predictions of the GLA. As Figure 3 shows, falling sonority onset clusters are the last cluster type that Amahl begins to realize accurately, but his rate of acquisition for this cluster type is more rapid than for any other type.

Figure 3: Amahl's accurate cluster realization



Implications: The predictions of the GLA outlined here extend to all gradual error-driven learning models that sample based on frequency (e.g., Noisy Harmonic Grammar – Boersma & Pater to appear, MaxEnt-OT – Goldwater & Johnson 2003). Comparisons with child data, however, indicate that the relationship between sequence and rate of acquisition is not as straightforward as these models predict. This points to the necessity of incorporating other factors, such as input restructuring and lexical growth, into models of phonological learning.

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Long-Distance Licensing in Harmonic Grammar

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This paper examines positional licensing's ability under Harmonic Grammar (HG) to model the typology of assimilation patterns that target prominent positions. In the Romance variety of Central Veneto, e.g., a post-tonic high vowel triggers raising of the stressed vowel and any vowels between it and the stressed syllable: /ó̲rde̲n-i/ → [ú̲rdi̲n-i] 'order (2sg. pres. ind.)' (Walker 2011). Under Walker's (2011) OT-based theory of such systems, a positional licensing constraint License(λ,π) outranks Ident and requires the element λ (e.g. [+high]) to appear in position π (e.g. the stressed syllable). I argue that the typology of Veneto-like systems is produced in HG only if a significant change to licensing constraints is made: they must penalize not just the failure of λ to appear in π, but also the failure of λ to appear in intervening positions, too. This change necessitates the adoption of other recent theoretical proposals (see below) that ensure proper behavior of the constraints, thus providing further support for those proposals.

Under HG, standard positional licensing is pathological. Assimilation in [úrdin-i] requires w(License) $>$ w(Ident). While failure to assimilate violates License once, spreading to n segments violates Ident n times. Increasing the distance between trigger and target leads to a greater penalty from Ident, so for any weights, eventually $n(w(\text{Ident})) > w(\text{License})$: spreading to sufficiently many positions is less harmonic than failure to spread; see (1). Under the weights shown in (1), spreading to two positions is permitted (/ée-i/ → [íi-i]), but spreading to three is not (/éee-i/ → [éee-i]). In both cases, failure to spread incurs a penalty of -5 (from one License violation). Assimilation has a penalty of -4 in the first case (two Ident violations) and -6 in the second case (three violations). By manipulating the constraint weights we can arbitrarily designate an upper bound for the distance spreading can cross. This kind of pattern is unattested. While the presence or quality of intervening segments can affect assimilation in Veneto-like systems, the number of intervening segments does not (Walker 2011).

The problem arises because License assigns a static penalty to the faithful form, and therefore the motivation for harmony does not keep up with Ident's increasing penalty. The solution developed here reformulates positional licensing so that it assigns violations for failure to spread to the intervening positions. Thus as the distance between trigger and target increases, License penalizes failure to spread to the same extent that Ident penalizes its occurrence. Such distance-sensitive harmony constraints suffer from well-known defects (e.g. Wilson 2006): for example, they can motivate deletion of material instead of triggering harmony as a means of eliminating violations (2). Kimper (2011) shows that this is remedied by reinterpreting these constraints as positive constraints that reward spreading instead of penalizing its absence. With positive distance-sensitive positional licensing, the reward for spreading increases with the number of intervening positions, countering Ident's increasing penalties (3). For assimilation to n positions, License gives a reward of $n(w(\text{License}))$, and Ident a penalty of $-n(w(\text{Ident}))$. As shown in (3), under $w(\text{License}) > w(\text{Ident})$, assimilation always receives a positive score and emerges as most harmonic because the no-spreading candidate has a score of 0 (no penalty/reward from Ident or License). The no-distant-licensing pathology is eliminated.

One final move is necessary. Positive constraints invite runaway derivations (e.g. unbounded epenthesis to increase License's reward) unless Serial HG is employed (Kimper 2011). Therefore, the necessity of positive License argues for Serial HG. Once this framework is adopted, distance-sensitive positional licensing produces Veneto-like harmony systems without the no-distant-licensing pathology, the pathologies that gradient constraints can invite, or runaway derivations.

This result provides support for recent theoretical developments, namely positively formulated constraints and a serialist implementation of HG. More broadly, this result reinforces the conclusion that HG and OT can require very different constraints, and it lays the foundation for building a sound theory of positional licensing in HG that can produce the full range of licensing-based phonological phenomena.

(1) a.

/ée-i/	License 5	Ident 2	*H*
a. ée-i	−1		−5
☞ b. íi-i		−2	−4

b.

/éee-i/	License 5	Ident 2	*H*
☞ a. éee-i	−1		−5
b. íii-i		−3	−6

(2)

/órdeni/	License 5	Ident 2	Max 1	*H*
a. órdeni	−2			−10
(☞) b. úrdini		−2		−4
💣 c. úrdni		−1	−1	−3

(3) a.

/ée-i/	Lic 5	Ident 2	*H*
a. ée-i			0
☞ b. íi-i	2	−2	6

b.

/éee-i/	Lic 5	Ident 2	*H*
a. éee-i			0
☞ b. íii-i	3	−3	9

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Stratal OT and underspecification. Evidence from Tundra Nenets

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The process of final debuccalization in Tundra Nenets presents both a famous descriptive problem (Tereshchenko 1956; Janhunen 1986; Salminen 1997; Nikolaeva 2014) and a serious theoretical challenge, because the opaque interactions of this process seem to not match its domain of application (Kavitskaya & Staroverov 2010). This paper proposes a new autosegmental account of Tundra Nenets glottal stop, framed within Stratal OT and building in particular on the proposals in Bermúdez-Otero (2001, 2012) and Ramsammy (2012). Our account relies on the assumption that both nasals and obstruents lose their place finally at the word level, but nasals may regain place specification due to postlexical assimilation. Our account thus solves a problem for Stratal OT by postulating an underspecified output at an intermediate step.

Problem. The Tundra Nenets data in this paper come from the authors' original fieldwork. In Nenets, phrase-final /t d s n ŋ/ change to a glottal stop. While obstruent debuccalization is fully compatible with our proposal, the problem is best illustrated with debuccalization of nasals in (1a). Phrase and word-medially, nasals undergo place assimilation, with concomitant voicing of a following obstruent (1b,c).

(1) Alternations of Tundra Nenets underlying nasals

a. Debuccalization phrase-finally (in isolation): /sʲin#/ → [sʲiʔ] 'lid'

b. Assimilation word-medially: /sʲin-ta/ → [sʲinda] 'his lid'

c. Assimilation across word boundary:
/nʲe-n xʌnʌ/ 'woman-GEN.SG sledge' → [nʲeŋ gʌn] 'a woman's sledge'

Phrase-finally, the vowel /ʌ/ is deleted, and final /ʌ/-deletion counterfeeds debuccalization (1c, 2b). Interestingly, a final-syllable /ʌ/ is also deleted before [ʔ], thus debuccalization triggers (or feeds) pre-final vowel loss.

(2) Vowel deletion in Tundra Nenets: phrase-finally or before a phrase-final [ʔ]

a. /xʌnʌ#/ → [xʌn] 'sledge'; b. /nʲenʲetsʲʌn#/ → [nʲenʲetsʲʔ] 'man'

These data present several problems for Stratal OT and in fact for any OT framework. Debuccalization must be post-lexical since it only applies phrase-finally (1), but at the same time debuccalization must precede final /ʌ/-deletion (2). Attributing debuccalization to a stratum earlier than that of apocope would predict that there is a cyclic phrasal domain where debuccalization applies but apocope does not. Yet, such a phrasing is not possible. For example /nʲenʲetsʲʌn sawa/ 'the man is good' can be pronounced [nʲenʲetsʲʌn zawa] (alternating as in 1b-c) or [nʲenʲetsʲʔ sawa] (alternating as in 2b) but not *[nʲenʲetsʲʌʔ sawa].

Analysis. On our analysis, final /ʌ/-deletion only applies post-lexically, while place loss is only active lexically. We analyze nasal debuccalization as a two-step process. At the lexical level final /n ŋ/ lose their place features (*C-PLACE]$_{\mathrm{Wd}}$ >> MAX-[place], *ʌ]$_{\mathrm{Phr}}$) but retain their nasality, thus /n ŋ/ → [N] (see also McCarthy 2008; Ramsammy 2012).

Post-lexically a previously created placeless nasal /N/ may either lose its nasality (phrase-finally: [sʲiʔ#] 'lid') or assimilate to a first consonant of a following word (phrase-medially: [nʲeŋ gʌn] 'woman's sledge'), since surface [N] is disallowed (*N >> IDENT-[nas]). Post-lexical /ʌ/-deletion exposes new place-bearing consonants to phrase-final position: [xʌn#] 'sledge', (3a). On the other hand, the final nasal which lost its place at the word level may now change to [ʔ] and trigger deletion of a preceding /ʌ/: [nʲenʲetsʲʔ#] 'man', (3b).

(3) Feeding and counterfeeding in TN post-lexical phonology

a. Post-lexical counterfeeding: /xʌnʌ/ → [xʌn] (phrase-final)

	xʌnʌ	*ʌ]$_{Phr}$	MAX-[place]	MAX-seg	*C-PLACE]$_{Wd}$
☞ a.	xʌn			1	1
b.	xʌnʌ	W1		L	L
c.	xʌʔ		W1	1	L

b. Post-lexical feeding: /nʲenʲetsʲʌN/ → [nʲenʲetsʲʔ] (phrase-final)

	nʲenʲetsʲʌN	*ʌ]$_{Phr}$	*N	MAX-seg	IDENT-[nas]	*C-PLACE]$_{Wd}$
☞ a.	nʲenʲetsʲʔ			1	1	
b.	nʲenʲetsʲʌN	W1	W1	L	L	
c.	nʲenʲetsʲ			W2	L	W1
d.	nʲenʲetsʲʌʔ	W1		L	1	

On this analysis, only the output of lexical level shows place loss but no apocope (intermediate |nʲenʲetsʲʌN sawa| 'the man is good'). The subsequent post-lexical alternations ensure that the final syllable vowel only gets deleted if the intermediate /N/ loses its nasality.

Alternatives. Any treatment of the Nenets data, including the autosegmental approach sketched above, is not directly compatible with Harmonic Serialism or OT-CC (McCarthy 2007; Kavitskaya & Staroverov 2010; Jarosz 2014). Place loss (/nʲenʲetsʲʌn/ → [nʲenʲetsʲʌN]) and apocope (/xʌnʌ/ → [xʌn]) require the opposite rankings of *C-PLACE]$_{Wd}$ and *ʌ]$_{Phr}$, and hence no single constraint hierarchy can derive both processes. The paper will also show that previous-step constraints, which could solve this problem (Kavitskaya & Staroverov 2010), encounter a difficulty in accounting for the typology of coda place loss.

Conclusion. Our account solves the descriptive problem of dual behavior of Tundra Nenets glottal stop, and assumes only one [ʔ] on the surface. We reconcile Tundra Nenets data with Stratal OT at the cost of assuming an intermediate output nasal unspecified for place /N/. Thus Stratal OT has to rely on underspecified representations (Keating 1988; Cohn 1990, 1993; Bermúdez-Otero 2001), and in particular our account relies on nasals unspecified for place (see also Ramsammy 2012).

Asymmetrical Generalisation of Harmony Triggers

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In vowel harmony systems, certain classes of segments may be preferred as triggers — Kaun (1995) notes that rounding harmony is preferentially triggered by non-high segments. In Yakut, for example, both high and non-high vowels can spread rounding to high targets, but only non-high vowels can spread to non-high targets. Both language-internally (as in Yakut) and across languages, there is an implicational relationship between high and non-high triggers in rounding harmony: **high-vowel triggers imply non-high triggers, but not vice versa**. Kaun (1995) and others argue that this is phonetically grounded — non-high vowels manifest F_2 contrasts less prominently (Linker, 1982; Terbeek, 1977) and therefore benefit more from the boost in perceptual salience that harmony may provide.

Wilson (2006) proposes that phonetic grounding makes its way into the grammar via biases in learning — while both substantively grounded and arbitrary processes are learnable, the learner assigns a higher prior probability to the former. Moreton and Pater (2012a,b), in their review of artificial grammar learning experiments, find robust evidence for inductive biases based on structural complexity, but mixed and inconclusive evidence where substantive bias is concerned. Following in that line of inquiry, the present study investigates the possibility of substantive inductive bias favouring non-high triggers in rounding harmony. **Hypothesis:** If the implicational relationship described above is encoded as a substantive bias, naïve learners exposed to a harmony pattern triggered by *high* vowels should tend to form *broad generalisations* (including all vowels), while those exposed to *non-high* triggers should show a greater tendency to form *restricted generalisations* (limited to exposed triggers).

Methods: 67 native speakers of British English were trained on a novel suffix alternation involving stem-controlled back/rounding harmony; 33 subjects were trained with stems containing only mid vowels (*mid group*) while 34 were trained on stems containing only high vowels (*high group*). Training included both passive listening and testing with feedback (yes/no well-formedness judgements). In the final test phase (with no feedback) subjects were asked to judge *old* forms (specific items seen in training), *new* forms (new items of the same type seen in training) and *novel* forms (items of a new type — high-vowel stems for the mid group, and mid-vowel stems for the high group). 18 mid-group and 22 high-group subjects did not perform better than chance on old items and were excluded.

Results: Overall, mid learners showed higher performance than high learners ($p < 0.01$). As predicted, there was an interaction between group and item type — high learners showed no difference between new and novel items ($p > 0.05$), while mid learners showed greater generalisation to new items than novel items ($p < 0.001$). **Figure 1** (left) shows that this effect interacted with subjects' overall performance — proficient learners showed a *greater* asymmetry than less proficient learners ($p < 0.001$). Figure 1 (right) shows that non-learners, analysed separately, showed no asymmetry ($p > 0.05$). **Figure 2** shows that the asymmetry is also somewhat modulated by response time — while the interaction did not reach significance ($p > 0.05$), late responses show a greater asymmetry than early responses.

Discussion: The divergent generalisation behaviour of mid-vowel-trained and high-vowel-trained subjects seems to provide some support for a substantive bias. The interaction between this effect and subjects' overall performance suggests, contra van de Vijver and Baer-Henney (2014), that this distinction can emerge late in learning, and that substantive biases may perhaps be involved in *explicit* (rather than implicit; see e.g. Moreton and Pertsova 2015) concept learning.

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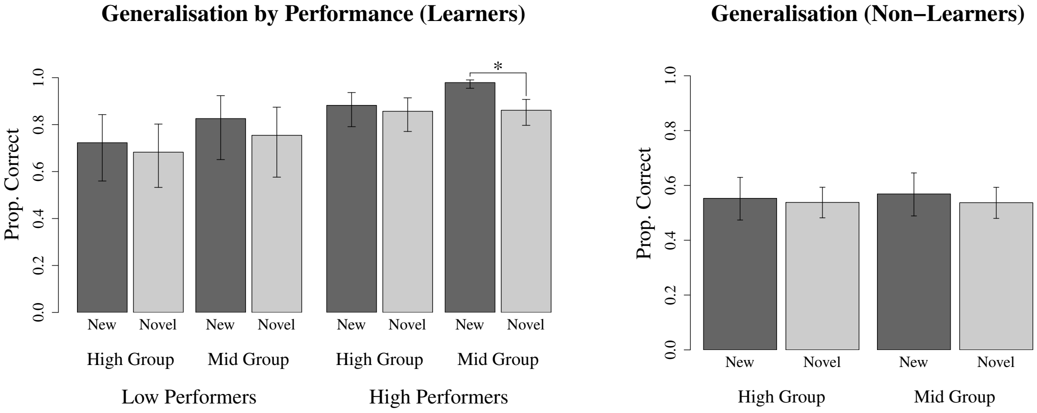

Figure 1: Generalisation by performance, for learners (left) and non-learners (right). 'Correct' responses were consistent with vowel harmony. Error bars are 95% CIs.

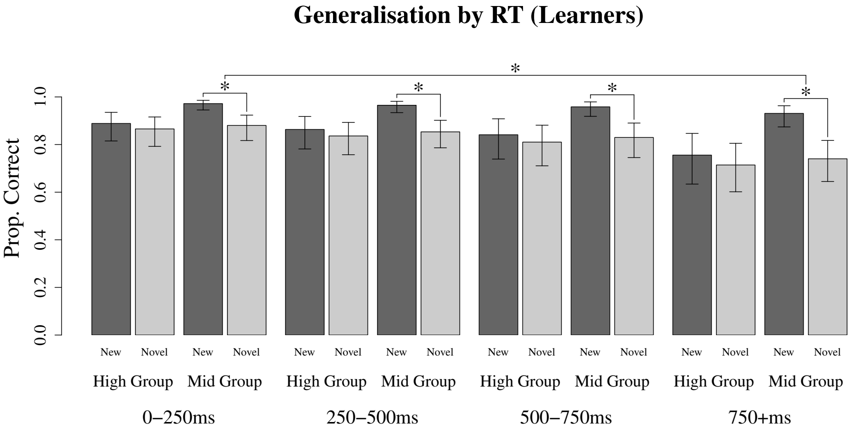

Figure 2: Asymmetrical generalisation as a function of response time.

Resolving the Issue of the Target of Vowel Copy in Fijian Loanwords

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►Introduction: Vowel copy is an option for determining epenthetic vowel quality in loanword adaptation. English loanwords into Fijian undergo vowel epenthesis because Fijian disallows coda consonants and consonant clusters. Some of the loanwords exhibit vowel copy (Schütz 1978). In the Fijian loanwords, the target of vowel copy seems either the preceding or following vowel of the epenthetic site. However, the choice of the target vowel is indeterminate because there is no vowel copy in Fijian native phonology.

This study proposes three conditions on the target of vowel copy in Fijian loanwords by adopting an expanded version of prosodic projection theory (Martínez-Paricio 2012) based on Itô & Mester's works (2007 et seq., 2013). I argue that the domain where vowel copy applies can be circumscribed by Foot[±max/±min], and that not only minimal feet ([+min]) but also maximal feet ([-min]) play a decisive role in opting for the target of vowel copy.

►Proposal: I propose three conditions on the target of vowel copy in Fijian loanwords. First, interacting segments must be as close as possible (Adjacency Condition). Given that a $\underline{v}$ is inserted in a hypothetical form $CV_2CV_1C\underline{v}CV_1CV_2$, the condition favors the copy with V_1 over that with V_2 since $\underline{v}$ is closer to V_1 than V_2. Second, an epenthetic vowel copies an inherited vowel from English (Base Condition). Third, an epenthetic vowel is required to show copy the vowel within the foot where it belongs (Foot Condition). While Adjacency and Base Conditions are never violated, Foot Condition is sometimes violated.

In Fijian, bimoraic trochee feet are formed from the right edge of the word, except that degenerate feet would be formed (Kenstowicz 2007). In addition, I assume that feet can be recursive in Fijian, and that an unparsed syllable is incorporated into a recursive foot (e.g., σ(σ́σ) → <σ(σ́σ)>). Recursive feet invariably contain a light syllable on the left hand and a minimal foot on the right hand.

►Analysis: This analysis depends on the data compiled from Schütz (1978). I show three types of vowel copy in Fijian loanwords. Type I enforces all the conditions presented above, and allows vowel copy to occur in the minimal foot. Illustrative examples are presented in (1). The (highlighted) epenthetic vowel copies the preceding or following vowel within the minimal foot to which it belongs.

v (bold) = relevant epenthetic vowels; (   ) = minimal feet; < > = maximal feet

(1) Type I

English	→	Fijian	English	→	Fijian
cake	→	(kék**e**)	Píng-Pong	→	(pì̱gi)(pog**o**)
mark	→	(mák**a**)	Hòng Kóng	→	(ògo)(kóg**o**)
bill	→	(bíl**i**)	Octóber	→	(òk**o**)(tóva)
ball	→	(pól**o**)	Fébruary	→	(fèp**e**)<ru(éri)>
block	→	<bu(lók**o**)>	décimal	→	(dèsi)(mól**o**)
clock	→	<ka(lók**o**)>	Mìcronésia	→	(mài)(k**ò**ro)<ne(sía)>
táxi	→	(tèk**e**)(síː)	nítrogen	→	(nài)(t**ò**ro)(jíni)
vélvet	→	(vèl**e**)(véti)	Métropole	→	(mèː)(t**ò**ro)(pólo)

In Type II, Foot Condition is violated while Adjacency and Base Conditions are enforced. The data listed in (2) show that the (highlighted) epenthetic vowel does not copy the vowel within the foot which it belongs because the target of vowel copy is also an epenthetic vowel, which would violate Base Condition. In this case, the (highlighted) epenthetic vowel copies the adjacent non-epenthetic vowel at the expense of violating Foot Condition.

(2) Type II

v (bold) = relevant epenthetic vowels; (   ) = minimal feet; < > = maximal feet

English	→	Fijian	English	→	Fijian
strike	→	(sìt**a**)(ráke)	belt	→	(bèː)(l**é**ti)
spring	→	(sìv**i**)(rígi)	table	→	(tèː)(p**é**li)
screw	→	(sùk**u**)(rúː)	cable	→	(kèː)(v**é**li)
			Óxford	→	(òː)(k**ò**si)(vóte)

Type III allows vowel copy to take place within the maximal feet while enforcing all the three conditions presented above. The (highlighted) epenthetic vowel in (3a) copies the following vowel, indicating that the vowel copy takes place within the maximal foot. The data (3b) highlights the present proposal with recursive feet. Though the (highlighted) epenthetic vowel in (3b) has two options to determine the target of the vowel copy (i.e. the preceding or following vowel), it copies the following rather than the preceding vowel because Foot Condition requires that vowel copy occur within the foot. The data (3b) show that maximal feet help to circumscribe the domain where vowel copy applies.

(3) Type III

v (bold) = relevant epenthetic vowels; (   ) = minimal feet; < > = maximal feet

(a)			(b)		
English	→	Fijian	English	→	Fijian
bróther	→	<b**a**(ráca)>	télegram	→	(tàli)<k**a**(rámu)>
plan	→	<p**e**(léni)>	geógraphy	→	(jòː)<k**a**(rávi)>
trump	→	<t**a**(rábu)>	télegraph	→	(tàle)<k**a**(rávu)>
train	→	<t**e**(réni)>	prógram	→	<pa(ròː)><k**a**(rámu)>
cross	→	<k**o**(lósi)>	páragraph	→	(pàra)<k**a**(rávu)>

►Conclusion: This study can resolve the issue of the target of vowel copy in Fijian loanwords by proposing three conditions (Adjacency, Base, and Foot Conditions). The proposal of Foot Condition suggests that not only minimal feet but also maximal feet can play a role in determining the choice of the target of vowel copy.

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An Acoustic and Theoretical Analysis of the Nasal Vowels of Mẽbêngôkre and Panará

This presentation intends to explore the vowel systems of Mẽbêngôkre and Panará, two very divergent languages from the Northern branch of the Jê family, with a particular focus on an analysis of their nasal vowel systems and an extension towards a broader theoretical analysis of nasal vowel systems. The author will present original data collected over the spring of 2015 during fieldwork in the villages of Djudjêkô (Mẽbêngôkre) and Nãsepotiti (Panará), both situated in the state of Pará, in the Amazon region of Brazil.

Mẽbêngôkre has ten oral vowels and seven nasal vowels, for a total of 17 contrastive vowel qualities (Salanova, 2001). Panará has 15 different vowel qualities, of which nine are oral and six are nasal vowels (Dourado, 2001). In addition, recent fieldwork data suggests that Panará contrasts long and short vowels for all of these vowel qualities, which results in a total of 30 vowel phonemes, placing it among the largest inventories reported. Although these languages' strikingly large vowel inventories make them particularly interesting to examine in order to better shape our linguistic knowledge of vowel systems, the phonetics and phonology of both Mẽbêngôkre and Panará are highly understudied, and, to date, no phonetic study has yielded data on either of them.

Acoustic data was collected from a total of 24 participants (all male), of which 12 are native speakers of Mẽbêngôkre and 12 are native speakers of Panará. A carrier sentence was selected in each language, as well as a target word for each vowel quality. Participants were instructed to produce the carrier sentences, which were presented on a computer screen alongside a picture depicting the target word. Each target word was presented ten times and the presentation order of the stimuli was semi-randomized.

A preliminary analysis of the acoustic data reveals that, in both languages, the nasal vowels are centralized when compared to the oral vowels, which results in a general contraction of the acoustic space for nasal vowels. This contraction, which is most prominent in the F1 dimension, manifests itself quite differently in the two sets of data. While the data from Mẽbêngôkre suggests that high and mid-high nasal vowels are lowered (F1 is raised), the data from Panará suggests that the low nasal vowel is raised (F1 is lowered).

This contraction of the nasal vowel space has been observed in a number of other languages, such as European and Canadian French (Carignan, 2014; Martin et al., 2001), European and Brazilian Portuguese (Dos Santos, 2013), Karitiana, (Demolin & Storto, 2002) and Paicĩ, (Gordon & Maddieson, 2004), among many others. Thus, this contraction is not arbitrary, and previous research (Beddor et al., 1986; Beddor, 1993; Maeda, 1993) suggests that it is motivated by a cross-linguistic perceptual constraint (explained below).

Unlike the oral cavity, which can be modified in a great number of ways by the articulators, the nasal cavity cannot be modified. For this reason, the nasal formants that result from the coupling of the oral and nasal cavities are stable for every individual. The anatomical configuration of the nasal cavity varies greatly among individuals, but the value of the first nasal formant (N1, which is most relevant here) is generally found around 400 Hz to 500 Hz. N1, then, is of a higher frequency than the F1 of high vowels and of a lower frequency than the F1 of low vowels. When N1 is in the vicinity of F1, they become perceptually merged, and F1 appears to have a wider bandwidth. The center of gravity of this area of high amplitude in the vowel spectrum is shifted toward N1. Experimental evidence suggests that this seemingly cross-linguistic acoustic-perceptual constraint on nasal vowels can be the trigger of sound change (Beddor et al., 1986). Specifically, this interaction of acoustics and perception causes high vowels to raise F1 and low vowels to lower F1. This results in a general contraction of the acoustic vowel space that is most prominent in the F1 dimension, just as in the case of Mẽbêngôkre and Panará's nasal vowel inventories.

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While this centralization of nasal vowels within the acoustic space is well-known and has been attested in a large number of languages, current theories of vowel systems fail to predict the organization of nasal vowel systems. Major theories of vowel systems predict, among other things, a dispersion of vowels within the acoustic space. However, the proponents of these theories recognize that nasal vowels behave differently. For instance, the proponents of the Dispersion-Focalization Theory of Vowel Systems recognize that “the nasal feature […] leads to significant changes in the formant space and is likely to be processed on another dimension than the oral one” (Schwartz et al., 1997b), but they do not make separate predictions for the organization of nasal vowel systems (Schwartz et al., 1997a).

I suggest that the acoustic space of phonologically nasal vowels is inherently reduced in the F1 dimension. This being so, one can maintain that maximal dispersion applies normally in nasal vowels, albeit in a reduced space. This prediction is consistent with data from natural languages, in which we observe a larger number of contrasts among the F2 dimension than the F1 dimension for nasal vowels.

Furthermore, the reduced size of nasal vowel inventories as compared to oral vowel inventories appears to be a natural consequence of contracted nasal vowel acoustic space. Indeed, Kingston (2007) reports that half of the languages observed in the UPSID database had the same number of nasal and oral vowels, while the other half had fewer nasal vowels. Specifically, no language had more nasal vowels than oral vowels.

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What matters in artificial learning, sonority hierarchy or natural classes?

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In recent phonological research, an artificial grammar (AG) paradigm (e.g., Moreton & Pater 2012 a, b, Finley 2011, Nevins 2010, Moreton 2008, Wilson 2006) has been used to test language universals. This paradigm allows the study of aspects of proposed universals that can be hard to test with real language. My research examines one proposed universal, the implicational nasal hierarchy scale, testing whether this scale is found with speakers of a language with no clear evidence for a nasal hierarchy.

Walker (2011) proposes a universal implicational nasalized segment scale based on evidence from typological frequency, Vowels > Glides > Liquids > Fricatives > Stops. She argues that if a more marked blocker class blocks harmony (vowels are least marked targets, so least likely to be blockers, and most likely to be targets), so do the less marked blocker classes (stops are most marked targets, so most likely to be blockers, and least likely to be targets). I address whether a pattern that is predicted by this implicational universal is easier to learn than one that is not. In particular, I investigate if it is easier to make a generalization when a more marked blocker (vowel)/target (stop) is presented during training and a less marked blocker (stop)/target (vowel) in testing rather than vice versa.

In the experiments, different groups were presented with the four patterns as in Table 1. The predictions are based on expectations if the nasal hierarchy is universal: it should be easier to learn a grammar if in the test phase the new segment is more sonorant than the target (cf. Pattern 1) or equivalent in sonority to the blocker (cf. Patterns 3, 4) in the exposure phase. If the test segment is less sonorant than the target (cf. Pattern 2), then there is essentially no prediction.

A critical prediction then is that what I call **direction** is important: exposure to a less sonorant target makes predictions about the treatment of a more sonorant sound, but exposure to a more sonorant target makes no predictions about the treatment of a less sonorant sound.

Table 1. Four patterns

	exposure	test	prediction
Pattern 1	more sonorant: target **s** less sonorant: blocker k	new segment **w**: more sonorant than target	new segment is a target
Pattern 2	more sonorant: target **w** less sonorant: blocker k	new segment **s**: less sonorant than target	no prediction
Pattern 3	more sonorant: target s less sonorant: blocker **k**	new segment: **t** same class as blocker	new segment is blocker

Pattern 4	more sonorant: target w less sonorant: blocker **k**	new segment: **t** same class as blocker	new segment is blocker

Learners fell into two distinct categories, what I call categorization learners and statistical learners. The former grouped new segments with old segments, while the latter used fragmentary knowledge (e.g., phonotactic information) to determine what served as a blocker and what as a target. I focus on the results for the categorization learners. Categorization learners appears at first to focus more on natural classes: for instance, with exposure to k and w, they group k and test segment s together as well as k and test segment t together. In general then, the categorization learners appeared to be comparing whether a new segment's natural class is closer to an old segment's natural class, and pattern the new segment with that old one. Based on descriptive statistical findings, direction did not seem to matter with the categorization learners: it appeared from these statistics that they were simply creating **natural classes**.

However, the inferential statistics tell a different story: they show a positive influence of direction for both groups (Patterns 1, 2) of categorization learners, with testing on a more sonorant segment than learners were exposed to (Pattern 1) being better learned than testing on a less sonorant segment (Pattern 2). The inferential statistics suggests that a **hierarchy (nasalized segment scale)** matters to categorization learners.

In sum, the current study is a new kind of paradigm to investigate with the Artificial Grammar paradigm - most of the work in this area tests natural classes, while this study examines **the relationship between natural classes as well**. Both descriptive and inferential statistics show evidence that both natural classes (new segment is of the same natural class as the blocker) and a hierarchy play an important role in learning for the categorization learners.

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Solving Chuvash stress with sonority-sensitive feet

This paper suggests a novel approach to motivate the sonority-sensitive default-to-opposite stress pattern in Chuvash. This single-ranking account utilizes sonority-sensitive feet to induce rightmost word-level stress and a high-ranking INITIALPROMINENCE constraint to account for default leftmost word-level prominence. This distinction between rightmost word-level stress and leftmost word-level prominence reflects the phonetic distinctions between these two types of prominence. Reordering the standard constraint ranking produces the patterns found in middle and lower Chuvash dialects. This account is both simpler and accounts for more of the data than the alternative quantity-insensitive approach (Kenstowicz 1996).

The Chuvash stress system has traditionally been described as DEFAULT-TO-OPPOSITE, whereby stress falls on the rightmost prominent syllable, else leftmost. Prominent syllables ($_{s}\sigma$) contain strong vowels (/i y ʉ u e ɑ/), while non-prominent syllables ($_{w}\sigma$) contain weak vowels (/ø ɔ/). Thus, in a word with at least one strong vowel, stress is predicted on the rightmost strong vowel (1a-c). In a word with only weak vowels, stress is predicted on the leftmost syllable (1d).

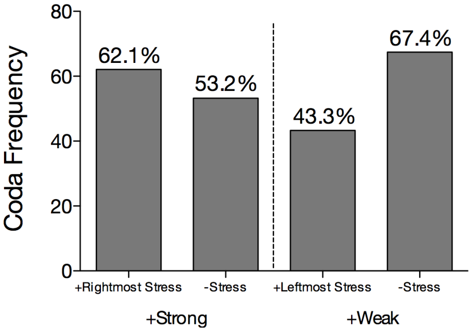
However, Dobrovolsky (1999) revealed that rightmost stress on strong vowels (1a-c) is correlated with longer vowel duration and higher intensity, while leftmost stress on weak vowels (1d) is instead characterized by greater pitch. Crucially, this pitch peak is associated with every initial syllable, whether or not it is stressed. Consequently, words with stress in non-initial position (1a,b) will also have prominence (↗) on the first syllable. This peak is more consistent with phonetic prominence (as a boundary tone) than phonological stress (as a pitch-accent). The words in (1) are more accurately transcribed in (2).

(1) a. $_{s}\sigma$.$_{s}\sigma$.ˈ$_{s}\sigma$ ju.lɑ.ˈnut
    b. $_{s}\sigma$.ˈ$_{s}\sigma$.$_{w}\sigma$ ɕy.ˈle.vøɕ
    c. ˈ$_{s}\sigma$.$_{w}\sigma$.$_{w}\sigma$ ˈmɑ.kɔ.rɔtʲ
    d. ˈ$_{w}\sigma$.$_{w}\sigma$.$_{w}\sigma$ ˈɔ.rɔm.ɕɔ

(2) a. ↗$_{s}\sigma$.$_{s}\sigma$.ˈ$_{s}\sigma$ ↗ju.lɑ.ˈnut ‘horse’
    b. ↗$_{s}\sigma$.ˈ$_{s}\sigma$.$_{w}\sigma$ ↗ɕy.ˈle.vøɕ ‘lynx’
    c. ↗ˈ$_{s}\sigma$.$_{w}\sigma$.$_{w}\sigma$ ↗ˈmɑ.kɔ.rɔtʲ ‘moo (3sg)’
    d. ↗$_{w}\sigma$.$_{w}\sigma$.$_{w}\sigma$ ↗ɔ.rɔm.ɕɔ ‘sorcerer’

Leftmost prominence and rightmost stress also differ phonologically. Stressed strong vowels are more likely to have a coda than “stressed” weak vowels, see Figure 1. Syllables with rightmost stress attract more material than unstressed syllables. This trend flips for weak vowels, suggesting initial prominence is phonetic not phonological.

Figure 1: Coda frequency across syllable types



Rightmost stress occurs word-finally if the vowel is strong (/i y ʉ u e ɑ/) but shifts leftward if the vowel is weak (/ø ɔ/). Strong and weak vowels are not distinguished by height, backness, roundness, or length. A production experiment shows that both vowel classes cross-cut these features (Tables 1-2, Author 2014).

Table 1: Chuvash vowel features

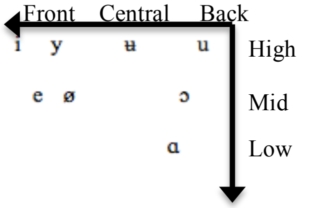
	Front		Central	Back	
	-Round	+Round	+R	-R	+R
High	/i/	/y/	/ʉ/		/u/
Mid	/e/	**/ø/**			**/ɔ/**
Low				/ɑ/	

Table 2: Normalized Vowel Length Means
*Calculated by dividing vowel length by length of preceding /s/.

Vowel	Normalized Vowel Length*	Vowel	NVL*
/ɑ/	.749	/u/	.641
/ʉ/	.747	**/ø/**	.599
/y/	.735	**/ɔ/**	.590
/e/	.655	/i/	.572

The /ø ɔ/ vowels are unique in that they occupy the most central part of the vowel space (Figure 2), and are fully central when unstressed (Degtjarjov 2012). The other vowels /i y ʉ u e ɑ/ occupy the periphery and do not reduce when unstressed (Degtjarjov 2012). This differentiation between peripheral and central vowels is indicative of a sonority-sensitive system.

Figure 2: Chuvash vowel space



In my analysis, stress pattern where every word receives word-initial prominence and rightmost strong-sonority vowels receive word-level stress is motivated by the constraint rankings in Box 1, defined in Box 2, and shown in Table 3. A reordering of the interactions between these six constraints produces eight possible languages (OT-Help, Staubs et al. 2010). Five are represented by Chuvash dialects.

Box 2: Constraint Rankings

1. FootSonority » Culminativity
2. InitialProminence » FinalProminence
3. Stress-to-Sonority » Align-Right (Stress, PWd)

Box 1: Constraint Definitions

Init(Fin)Prominence	Every prosodic word has an initial (final) peak.
Stress-to-Sonority	Strong sonority syllables are stressed.
Align-R (Str, PWd)	Stress right-aligns with the prosodic word.
FootSonority	Feet contain at most one strong sonority syllable.
Culminativity	Every word has at least one stressed syllable.

Table 3: OT Tableau for Standard Chuvash Ranking

/pulɑslɔχ/ ‘future’	InitialProm	FtSon	Str-to-Son	Align-R (Str, PWd)	Culm	FinProm
☞ a. ↗(pu).(ˈlɑs).lɔχ			*	*		*
b. (pu).(ˈlɑs).lɔχ	* W		*	*		*
c. ↗(ˈpu).(lɑs).lɔχ			*	** W		*
d. ↗(pu).(lɑs).(ˈlɔχ)		* W	** W	L		*
/nørsørløχ/ ‘abnormality’						
☞ e. ↗nør.sør.løχ					*	*
f. nør.sør.løχ	* W				*	*
g. (ˈnør).sør.løχ		* W			L	*

An alternative quantity-insensitive approach is Kenstowicz’ unbounded foot model (1996). It accounts for stress by ranking Align-Right (Foot, Word), Align-Left (Stress, Foot) and *Trough/ $_{s}\sigma$, higher than Align-Left (Foot, Word).

Kenstowicz’ unbounded foot model and my sonority-sensitive foot model assume different syllables to be footed or unfooted. Consequently, these accounts make different phonetic/phonological predictions, for example which syllables can carry word-level stress, attract codas and allow vowel elision. This paper shows that Dobrovolsky’s (1999) phonetic experiment, original phonotactic data and new stylistic vowel deletion data all suggest that the sonority-sensitive foot model’s predictions align best with the actual data.

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On the Phonetics and Phonology of Focus marking in Boro

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It has been discussed widely in the literature on tone and intonation that both these phenomenon make use of changes in the f0 (also perceived as pitch change). It is often assumed that intonation in tone languages is only slightly more limited than it is in non-tonal ones (Yip 2002). A second perspective proposes that intonation certainly exists as a phenomenon independent of tone in languages with elaborate omnisyllabic tone systems (Matisoff 1994). Owing to these widely divergent views, the precise division of labour between tone and intonation in tonal languages gains importance as a subject of enquiry. In this paper we address the question of tone assignment in Boro and investigate how it operates as a function of focus. Boro belongs to the Tibeto-Burman group of languages, and forms a branch along with Dimasa, Tiwa and Kokborok. Boro lexically distinguishes L and H tones and this tonal specification aligns to the rightmost syllable leading to a pattern of every non-derived lexical entry surfacing with only one tonal specification (Sarmah 2004). This paper studies both the phonetics and phonology of intonation in Boro to carefully delineate the ways in which the in-situ and morphological focus markers influence sentence prosody. Four speakers of Boro were asked to produce scripted sentences of the target words in a carrier frame. A series of question-answer patterns were designed so as to elicit broad focus and in-situ focus on the subject NP, object NP or on the Adverbial in the VP. The same question-answer pattern was repeated to elicit answers with the MF markers [sɯ́/nɯ́] attached to the target constituents to see the effect of MF markers which also indicate in-situ focus in Boro (Brahma 2012). F0 normalized pitch curves, pitch maximum, pitch minimum, average pitch and durational values of 20 tokens of each of the sentences (4 speakers x 5 iterations) were extracted with the aid of Prosody Pro (Xu 2013) in Praat. The results show that in-situ focus does not result in any change of the f0 value of the target word as shown in Figure 1. The only consistent acoustic correlate for focus marking is found to be post focus compression. The morphological focus marker leads to discrete downstepping of the following High tone and also emerges with an H* by deleting the neighboring H tones as Figure 2 explains. One of the significant results of this experiment is that while H tones were realized at a higher f0 while co-occurring with the H* of the MF marker, L tones did not lead to any changes unless the stem were disyllabic, showing that there are phonological factors constraining sentential prosody.

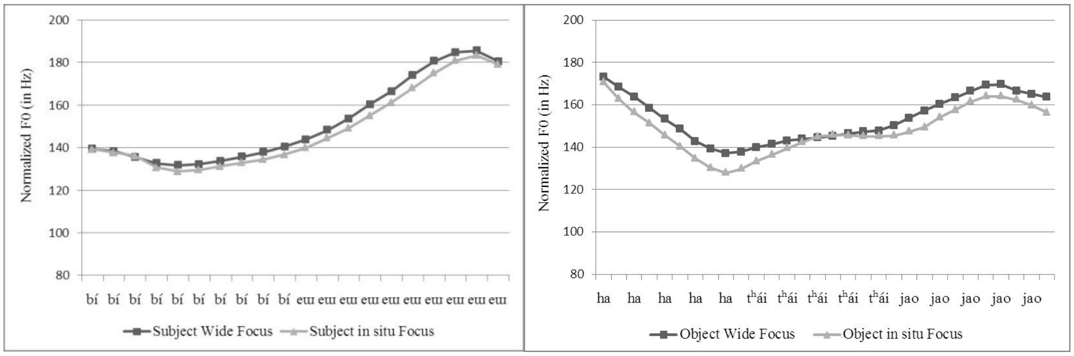

Figure 1: Time normalized mean f0 for the subject bieɯ́ 'he-NOM' and hatʰaíjao 'market-LOC' in broad focus and in-situ focus condition when they feature in the sentence bieɯ́ hatʰaíjao tʰáŋgɯn 'he will go to market' (tones are marked on their point of origin)

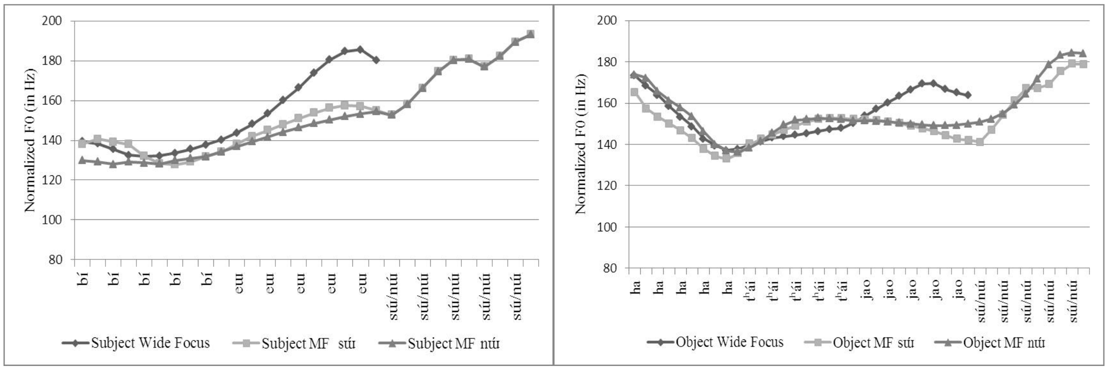

Figure 2: Time normalized mean f0 for the subject bieɯ́-sɯ́/nɯ́ 'he-NOM-MF' and hatʰaíjao-sɯ́/nɯ́ 'market-LOC-NOM' in broad focus and in-situ focus condition when they feature in the sentence bieɯ́-sɯ́/nɯ́ hatʰaíjao-sɯ́/nɯ́ tʰáŋgɯn 'he will go to market'.

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Modeling the gradient evolution and decay of harmony systems

Adam McCollum

While some work has addressed the potential motivations and evolutionary trajectories of vowel harmony (Hyman 1976; Ohala 1994; Beddor & Yavuz 1995; Harrison et al. 2002; Przezdziecki 2005; Wayment 2009), very little has focused on the decomposition of vowel harmony (Binnick 1991; Nevins & Vaux 2004), leaving the nature of decaying systems largely unexplored. In this paper I propose that, as with the evolution of phonological harmony, the decomposition of harmony reveals a coarticulatory basis. Using the decay of labial harmony in Kazakh (Kaun 1995, 2004; McCollum 2015) as testing grounds, I present a novel framework through which to view categorical and gradient harmony in one unified model (Flemming 2001).

McCollum (2015) notes that rounding harmony in Kazakh applies categorically to second syllable vowels on three conditions: the target vowel is root-internal (1a), the target vowel is high (1b), and the trigger vowel is not [o] (1c).

(1) a. *qʊłʊ̲n* ‘colt’ b. *kømʏ̲r* ‘coal’ c. *køsʏ̲k* ‘desert carrot’
*qʊł-ə̲ (*qʊł-ʊ)* ‘slave-POSS.3’ *tøbe̲ (*tøbø)* ‘hill’ *qozə (*qozʊ)* ‘lamb’

He suggests that the perceptual salience of the [o]-[ɑ] contrast relative to other [round] pairs distinguishes active, [ʏ, ø, ʊ], from inert, [o], triggers. However, he notes a variety of exceptions- suffixal rounding after a liquid (2a), rounding between two round vowels (2b), as well as rounding modulated by speech rate.

(2) a. *øl-ʏp ~ øl-ɪp* ‘die-CVB’ b. *qos-ʊ̲ł-u* ‘add-PASS-GER’
*øs-ɪp (*øs-ʏp)* ‘grow-CVB’ *qos-ə̲ł-də (*qos-ʊł-də)* ‘add-PASS-PST.3’

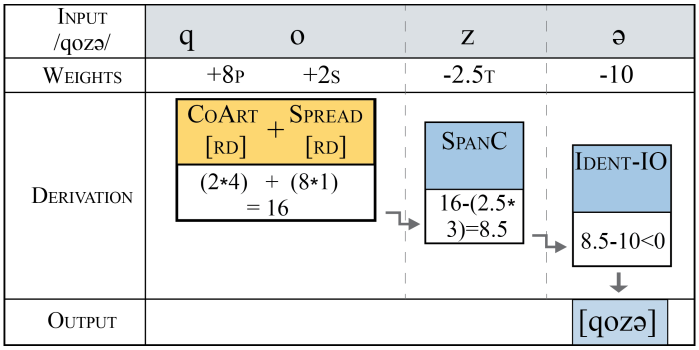
I directly encode these findings into a novel formalism that is able to capture both the categorical application of harmony and subphonemic teamwork (Lionnet 2014). Crucially, harmony is construed as a positive force that is depleted through its application. Phonological, morphological, and temporal forces may reduce the strength of harmony, in accordance with the empirical generalization made regarding some languages, that harmonic force diminishes throughout the domain of harmony (Mutaka 1995; Kirchner 1998; McPherson & Hayes 2014).

Both the drive for harmony and the cost of harmony are scalar, weighted variables. Triggers may differ according to strength, and constraints on harmony are not violable, but rather inexorable costs incurred by harmonic spreading.

Phonological harmony (SPREAD) is an augmentation of phonetic coarticulatory force (COARTICULATE), their combined strength equaling the assimilatory force of the trigger vowel. Diachronically, SPREAD develops from and devolves back to COARTICULATE. When the combined strength of these two forces does not equal the cost of a categorical shift in target vowel quality (IDENT-IO, e.g. /ə/ → [ʊ]) the effect of rounding is gradient, and by extension, perception and discrimination are variable and continuous (Fry et al. 1962).

Categorical vowel assimilation becomes generalized via ITERATE, a function that spreads assimilation to all potential targets within a domain. The evolution of harmony, then, requires the augmentation of phonetic coarticulation by phonological spreading (Przezdziecki 2005), which targets the most proximate vowel. These combined forces driving assimilation are then iterated throughout a particular domain. The generalization of this process via iteration typically obscures the underlying motivations for harmony (Barnes 2006), but when harmony decays that ITERATE function is lost, and the underlying cause(s) for harmony may resurface. In the Kazakh case, trigger strength asymmetries derived from perceptual weakness reemerge despite no evidence of their existence in older works (Menges 1947; Korn 1969).

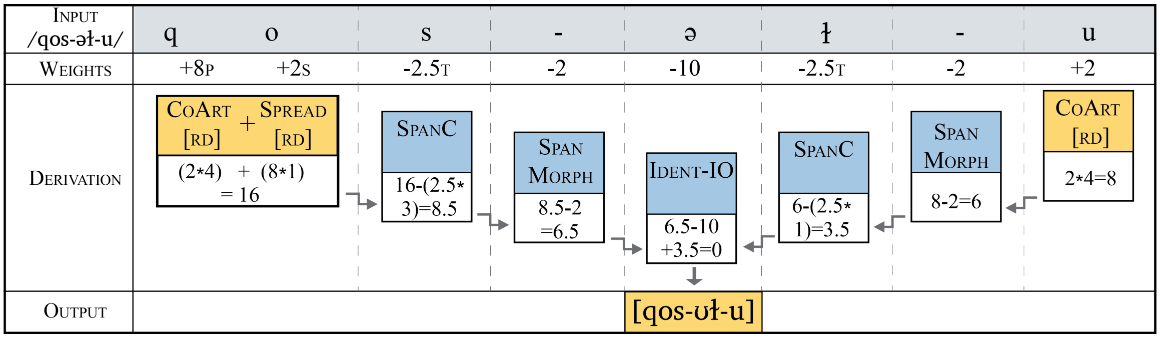
(3)



Thus, in [qozə], (3), the residual strength of harmony after spreading across the fricative is insufficient to trigger categorical rounding of [ə], but in [køsʏk] ‘desert carrot’, rounding obtains because [ø] is a better trigger than [o] (Kaun 1995).

However, when coupled with anticipatory rounding before GER /u/, [o] triggers rounding of the second syllable vowel in qos-ʊɫ-u ‘add-PASS-GER’, (4). The effect of the root vowel, [o], plus the coarticulatory pressure of [u], equals the cost of categorical vowel assimilation (IDENT-IO), modeling this instance of teamwork in assimilation.

(4)



This work analyzez a decaying harmony system, also addressing the interface of phonetics and phonology in understudied transitional harmony systems. This paper argues for a combination of phonetic and phonological forces in Kazakh labial harmony, and in transitional harmony systems generally, proposing that the evolution and decline of vowel harmony symmetrically may reflect a phonetic origin. The model developed herein offers a unified treatment of gradient and categorical harmony by the interworking of COARTICULATE, SPREAD, and ITERATE.

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The phonological grammar is probabilistic: New evidence pitting abstract representation against analogy

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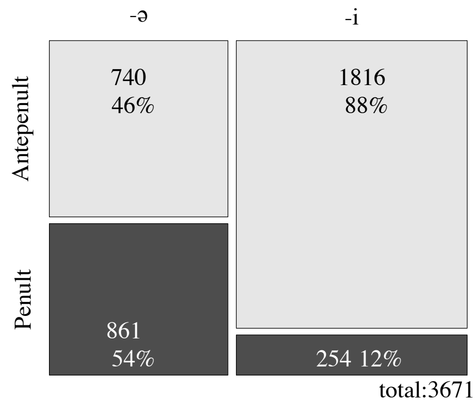
Speakers and listeners extend both categorical and probabilistic regularities in the lexicon of their native language to novel forms. Ernestus and Baayen (2003); Hayes et al. (2009) demonstrate that speakers can 'probability match' - rather than applying a trend in the lexicon categorically to new forms, speakers produce a distribution of output forms which matches the distribution of form types found in the lexicon. As Ernestus and Baayen demonstrate, this probability matching behavior can be modeled equally well via a set of abstract generalizations situated within a probabilistic grammar, or via a process such as analogy which is an epiphenomenon of the organization of the lexicon. Experimental evidence such as Guion et al. (2003) suggests that both mechanisms are at work, a notion that is formalized in dual-route or two-systems models (Ullman, 2004; Pinker, 1999). These models typically incorporate abstract grammatical knowledge for categorical phenomena, and analogical mechanisms for probabilistic phenomena.

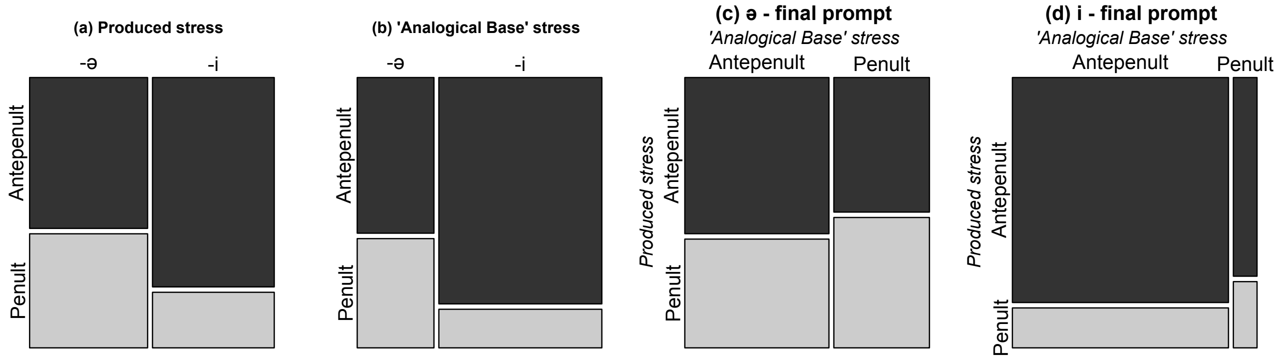
I examine a probabilistic trend within the English stress system, showing that speakers extend it to new words, but they do not use information about particular existing words to do so. I argue that speakers' knowledge of this trend is both abstract and probabilistic in nature. This supports the use of inherently probabilistic grammatical models such as Maximum Entropy to model probability matching behavior (Goldwater and Johnson, 2003; Hayes and Wilson, 2008; Coetzee and Kawahara, 2013).



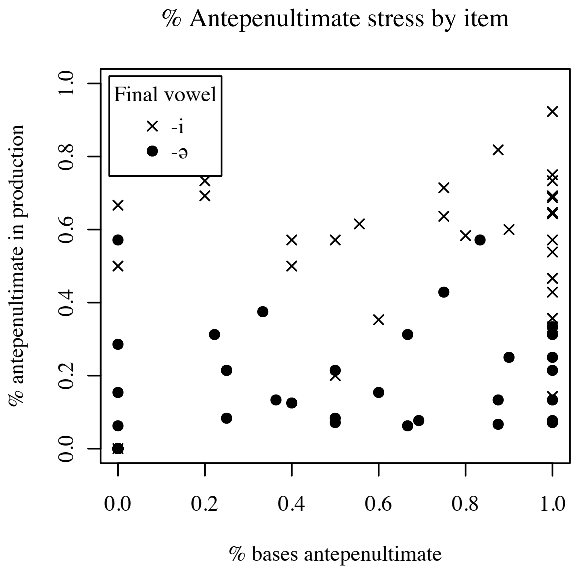
The probabilistic trend: In English words longer than two syllables, stress is typically penultimate ('banána') or antepenultimate ('Cánada'). A search of the CMU pronouncing dictionary (Weide, 1994) revealed that [i]-final words were biased towards taking antepenultimate stress, and [ə]-final words were unbiased. In words at least 3 syllables long, 88% of i-final words were antepenultimately stressed, but only 54% of ə-final words, were antepenultimately stressed. This trend can be captured in a constraint-based phonological grammar through the use of a constraint which demands that a final [i] be extrametrical.

Methods: Building on the methods of Guion et al. (2003), 50 participants recruited through Amazon Mechanical Turk performed 2 tasks. Production Task: Nonwords (half -i, half -ə) were constructed so as to have very sparse neighborhoods (less than 0.01) according to the Generalized Neighborhood Model (Bailey and Hahn, 2001). Nonwords were presented auditorily as three individual syllables, each spoken as a separate prosodic word ([bæ] [mæ] [ki]). The syllables were resynthesized so that they had identical acoustic cues to stress: duration, intensity, and pitch contour. Participants were recorded as they spoke the syllables fluently as a single word. Next, participants 'transcribed' their own production by listening to 2 versions of the nonword ([bǽməki], [bəmǽki]) and selected the version most similar to what they produced. Analogical Base Task: Participants heard each stress-ambiguous nonword again, and filled in a blank with a real word that it reminded them of.

Results: Data from 32 participants was analyzed, all at least 90% accurate in their ‘transcriptions’. Participants extended the probabilistic trend in the lexicon to nonwords: i-final words took antepenultimate stress 77% of the time (88% in the lexicon) while ə-final words took antepenultimate stress only 58% of the time (54% in the lexicon). In production, i-final nonwords received more antepenultimate stress than ə-final nonwords (a). Likewise, i-final ‘analogical bases’ provided by participants were more likely to be antepenultimately stressed than ə-final bases (b). However, the stress of these analogical bases did not directly relate to a participant’s produced stress (c,d).



A mixed effects logistic regression (random slopes and intercepts for subjects and items) showed an effect of final vowel on produced stress (-ə items have less antepenultimate stress than -i, β= -1.27, p<0.001, AIC=290). The stress of the analogical base provided by each participant did not predict that participant’s produced stress, and did not improve the model’s fit (Penult vs. Antepenult, β= 0.42, p=0.20, AIC=290).



Analogical base responses to each nonword were also examined in aggregate. Nonwords differed from each other in the distribution of analogical bases given. Some were majority antepenultimately stressed, and others were majority penultimately stressed. Each item’s percentage of antepenultimately stressed bases was calculated, and is plotted here against the item’s rate of antepenultimate stress in production. The two percentages are not related (ρ_{i}=0.16,$\rho_{\text{ə}}$=0.37). Participants successfully extended the trend in the lexicon to nonwords, and their chosen analogical bases follow the trend in aggregate, but these two behaviors do not proceed from the same underlying (lexical access) process.

Participants ‘probability-match’ the trend in the lexicon for i-final words to take antepenultimate stress, but this behavior is not attributable to an analogy process. Rather, speakers’ phonological grammar must be able to represent probabilistic tendencies as well as categorical generalizations.

Learning the context-dependent perception of novel speech sounds

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When a sound is produced in different contexts, the acoustic signal associated with that sound can show a significant amount of variation due to coarticulation with the surrounding sounds. Despite this, listeners are able to establish a single percept by taking information from the contexts into consideration and potentially factoring out the aspects of the variation that can be attributed to the coarticulation [1]. We are interested in how listeners come to have this ability, that is, to perceive speech sounds by integrating acoustic information from the sounds and their contexts.

Recent studies have suggested that contextual cue integration plays an important role in the learning of phonological status [2, 3]. In our previous study, we exposed native English-speaking adults to input in which the tokens of two novel sounds, retroflex [ʂa] and alveolopalatal [ɕa], showed a frequency profile known to lead to the learning of phoneme-like categories [4], but occurred in mutually exclusive contexts. After exposure, the participants showed reduced sensitivity to the contrast between the novel sounds, suggesting that they learned the novel sounds as allophone-like categories. This change in sensitivity, however, only occurred when the pattern of the complementary distribution was phonetically "natural", that is, when there were phonetic similarities between the sounds and their respective contexts; i.e. retroflex [ʂa] occurred after [u] and alveolopalatal [ɕa] occurred after [i] [3].

A possible explanation for this asymmetry is that the participants lost their sensitivity to the contrast between the sounds not only because the sounds were presented in complementary distribution, but also because the connections between the sounds and their respective contexts induced contextual cue integration in such a way that the perceptual distance between the sounds became smaller than the acoustic distance between the sounds. The contrast between retroflex [ʂa] and alveolopalatal [ɕa] is cued by F2 transition, [ʂa] having a lower F2 onset than [ɕa] . When a token of [ʂa] is presented after [u], however, the low F2 onset of the token can be analyzed as a result of coarticulation with the preceding [u] and the token may sound less retroflex. Similarly, when a token of [ɕa] is presented after [i], the high F2 onset of the token can be analyzed as a result of coarticulation with the preceding [i], and the token may sound less alveolopalatal. In this way, perceptual distance between the sounds can be reduced if presented in natural contexts, which would interfere with learning or maintaining the distinction between the sounds.

In this study, we investigated the possibility that the learners in our previous study might have learned the contextual cue integration as they learned two novel sounds. We assessed the perception of the same novel sounds in the same natural and unnatural contexts by native English-speaking adults before and after exposure to the same learning stimuli as in our previous study. If the contextual cue integration was learned via exposure, participants should perceive the sounds as being more similar to each other in natural contexts than in unnatural contexts, but only after exposure to the learning stimuli. In contrast, if the contextual cue integration is inherent to auditory processing, participants' perception of the sounds should be dependent on the contexts even before the exposure.

Method: 20 adult native English speakers participated in the study. The experiment consisted of two sessions over two consecutive days. In session 1, participants performed a similarity rating task first, then listened to ~15 mins of input. In session 2, participants listened to the input first, then did another similarity rating task. The input comprised 512 bisyllabic strings. Half of the strings contained tokens of novel sounds, and the rest were fillers. Novel sound tokens were 8 distinct syllables taken from a 10-step continuum between [ʂa] and [ɕa]; 4 syllables from each side of the category boundary were selected. The frequencies of these syllables were manipulated so that their aggregate distribution showed a bimodal shape with a frequency peak on each side of the category boundary. The novel sound tokens were presented in both natural and unnatural contexts: both after a syllable with vowel [u] and a syllable with vowel [i]. In the similarity rating task, participants rated the similarity of [ʂa] and [ɕa] from the end points of the continuum on a scale from 1 to 7 where1 = "very similar" and 7 = "very different." The test stimuli were presented in three different contexts: (1) same context with both sounds presented after the same vowel, (2) natural contexts with retroflex [ʂa] presented after [u] and alveolopalatal [ɕa] after [i], and (3) unnatural contexts with retroflex [ʂa] presented after [i] and alveolopalatal [ɕa] after [u].

Results: Responses were analyzed using mixed effects ordinal logistic regression models with subject as a random effect. An analysis with session (session 1,session 2) and context (same, natural, and unnatural) as fixed effects revealed a significant effect of session (LR.stat=40.56, df=1, p<0.001, the odds of rating the test stimuli as more dissimilar was 2.16 times higher in session 2 than in session 1), and interaction between session and context (LR.stat=16.46, df=2, p<0.001). To understand the nature of the interaction, we did separate analyses for each session. The session 1 analysis revealed no significant effect of context, suggesting that the perception of the novel sounds was not significantly dependent on information from the contexts before exposure. The session 2 analysis revealed a significant effect of context (LR.stats=20.64, df=2, p<0.001, the odds of rating the test stimuli as more dissimilar was 2.21 times higher in same contexts than in natural and unnatural contexts, and 1.59 times higher in unnatural contexts than in natural contexts). Participants' perception of the novel sounds became significantly dependent on information from the contexts after exposure. Of particular interest is that participants perceived the test stimuli as being more dissimilar from each other in the unnatural contexts than the natural contexts. This suggests that participants likely learned to do contextual cue integration after exposure in our previous study.

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Partial identity preference in Oromo co-occurrence restrictions

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Even though fully identical segments are often exempt from OCP constraints, it has been suggested that partial identity between segments is never treated preferentially in co-occurrence restrictions (Gallagher and Coon 2009). In fact, in many cases of OCP restrictions, partial agreement is dispreferred compared to disagreement. For example, in Arabic, homorganic segments rarely co-occur, but when they do, those that are less featurally similar (e.g. coronals [s] and [d] that disagree in manner) are more likely to co-occur compared to those that share more features (e.g. coronals [t] and [d] that agree in manner) (Frisch et al. 2004). It has thus been suggested that, to the extent that similarity is relevant to dissimilatory co-occurrence restrictions, there is a distinction between total and partial identity: while some languages exempt total identity from such restrictions, no languages exempt partial identity, and some disprefer it.

This study reports on a case of consonant co-occurrence restrictions in Oromo (Cushitic; Ethiopia) for which this generalization does not hold. Oromo has stops/affricates at four places of articulation and contrasts in the laryngeal features [constricted glottis] and [voice]. At the velar and post-alveolar places, there is an ejective ([+cg, -voice]), a plain voiceless stop ([-cg, -voice]), and a voiced stop ([-cg, +voice]); the coronal place also has an implosive, while the bilabial place lacks the plain voiceless stop (Gamta 1989). Based on an analysis of an Eastern Oromo dictionary (Abd and Youssouf, in progress) using the software Phonological CorpusTools (Hall et al. 2015), a very strong tendency emerges for pairs of co-occurring stops that share a place of articulation to also share all laryngeal features. Indeed, while words with two identical stops, like hypothetical *t'at'a* and *tata*, are quite common in Oromo, words with homorganic stops that disagree in laryngeal features, like hypothetical *tat'a*, are quite rare. This basic pattern seems like a typical case of an OCP-place restriction with an exemption for total identity.

However, an unexpected trend appears within the exceptions to this pattern: in Oromo, unlike in languages like Arabic, homorganic stops/affricates are less likely to co-occur when they are less featurally similar. There is near-categorical absence of co-occurrences of homorganic stops/affricates where one is ejective and the other is voiced, like hypothetical *k'aga*, with only a single exception in the dictionary (Observed/Expected=0.01).[1] In contrast, there are many more examples of homorganic ejective/plain and voiced/plain co-occurrences, like hypothetical *k'aka* and *gaka*; such forms are still highly under-represented compared to total identity (O/E=0.19, 0.29 respectively), but far better represented than ejective/voiced pairs. This result is precisely the opposite of the prediction made by previous accounts of the role of similarity in OCP effects. Indeed, regardless of how similarity is computed, ejective/plain and voiced/plain pairs, where the consonants differ only in [constricted glottis] or [voice] respectively, are more similar than ejective/voiced pairs, where the consonants differ in both [constricted glottis] and [voice] and therefore share a subset of the features shared by ejective/plain and voiced/plain pairs. Thus, Oromo shows a gradient effect in which pairs of homorganic stops/affricates that disagree in multiple laryngeal features are more dispreferred than pairs disagreeing in only one. Crucially, this effect is the opposite of what is typically seen in OCP patterns (e.g. Frisch et al. 2004).

Given these new data from Oromo, I argue for the need to refer to partial identity in phonological accounts of co-occurrence restrictions. I propose an approach to Oromo that modifies Gallagher and Coon's (2009) Optimality Theoretic account of co-occurrence restrictions in Chol. In order to require homorganic stops/affricates to be in a formal linking

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[1] Interestingly, the exception is with stops at the bilabial place of articulation, with a co-occurrence of [b] and [p']. This exception could therefore relate to the lack of a plain bilabial stop [p] (see e.g. Mackenzie 2009).

relationship, to which agreement constraints refer, I adopt Gallagher and Coon's similarity-sensitive LINK-CC constraint (cf. the CORR-CC constraints of Rose and Walker 2004). However, I reinterpret their IDENTITY constraint, which for Gallagher and Coon (2009) requires total identity between linked consonants, as a weighted constraint that is sensitive to the similarity of linked consonants. Specifically, I propose that in Oromo, the weight of the IDENTITY constraint is inversely correlated with the similarity of the linked segments, so that more similar segments cause less of a violation. In this way, rather than penalizing all cases of non-total identity between linked consonants equally, this revised constraint prefers partial identity to dissimilarity. I demonstrate that this analysis is more effective at accounting for the Oromo patterns than existing theories, because it can capture the ways in which Oromo consonant co-occurrence restrictions are sensitive to both total and partial identity. The LINK-CC constraint accounts for the fact that these restrictions appear in consonants similar in place, while the weight of IDENTITY captures the preference for laryngeal similarity among homorganic consonants. Thus, this approach accounts for the partial similarity effects in Oromo, while maintaining both the special status of total identity and the similarity-sensitive LINK-CC constraints that allow Gallagher and Coon (2009) to capture the fact that some languages disprefer partial similarity.

Finally, I show how allowing for partial identity within a framework that prefers total identity better accounts for the cross-linguistic typology of laryngeal co-occurrence restrictions. Specifically, I compare this approach to ones in which all long-distance assimilations that are not articulatory spreading are requirements for total identity (e.g. Gallagher and Coon 2009) and those in which total identity has no special status, but instead is comprised of partial identity (e.g. Rose and Walker 2004). By adding IDENT-IO[place] and IDENT-IO[manner] constraints to the proposed IDENTITY constraint that prefers partial identity to no identity, this account can be extended to languages that require heterorganic consonants to agree in laryngeal features, even though such agreement does not create total identity. Unlike in Gallagher and Coon (2009), partial identity in this approach does not require articulatory spreading, which is problematic for laryngeal harmony that does not appear to affect intervening vowels. Furthermore, while it still captures attested laryngeal patterns, this account is unlike Rose and Walker (2004) in that it gives special status to total identity, as is motivated by the cross-linguistic typology. Thus, I propose that building a partial similarity preference into a total identity system is not only necessary for Oromo, but also creates a better motivated account of other laryngeal co-occurrence systems.

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Perceptual evidence for blocking in Slovenian sibilant harmony

Avery Ozburn (University of British Columbia) and Peter Jurgec (University of Toronto)

Blocking is exceedingly rare in consonant harmony (Hansson 2001; Rose & Walker 2004), with only a handful of cases reported. For instance, retroflex harmony in Kinyarwanda is blocked by non-sibilant coronals (Walker et al. 2008). Another case is found in Slovenian. Regressive sibilant harmony optionally applies within a word (1-a), but is blocked by coronal stops (b).

(1) Regressive sibilant harmony in Slovenian (Jurgec 2011)

a. Most consonants are transparent (variable)

sux	‘dry’	**ʃ**uʃ-i		‘dries’
spi	‘sleeps’	**ʃ**p̲i-ʃ		‘(you) sleep’
sl-ux	‘hearing’	**ʃ**l̲-iʃ-i		‘hears’
pozabi	‘forgets’	po**ʒ**ab̲i-ʃ		‘(you) forget’

b. Coronal stops are blockers (no variation)

sit	‘full’	na-**s**it̲-iʃ	*na-**ʃ**it-iʃ̲	‘(you) make full’
zid	‘wall’	**z**id̲a-ʃ	***ʒ**ida-ʃ	‘(you) build’
zdi	‘seems’	**z**d̲i-ʃ	***ʒ**di-ʃ	‘(you) seem’

These data present one of the clearest cases of blocking in consonant harmony. However, one challenge is that sibilant harmony in Slovenian has considerable inter- and intraspeaker variation, which makes any generalizations based solely on production/elicitation less reliable.

To address this problem, the present study investigates two questions related to blockers in Slovenian sibilant harmony, both of which are fundamentally about whether blocking effects could be due to perception. First, we ask whether blocking effects are present in the perception of sibilant contrasts by Slovenian speakers, and second, we examine whether any such blocking effects appear in perception with speakers who have no exposure to Slovenian.

We investigate these questions using a forced-choice s∼ʃ categorization task. A group of Slovenian speakers and a group of English speakers categorized six different 11-step s∼ʃ continua in each of two conditions: non-local and local. In the non-local condition, the continuum was in initial position of SaCaʃ nonce words, where the final consonant was the potential harmony trigger [ʃ] and the intermediate consonant was either a blocker {t d} or not a blocker {n m p b}. The local condition involved CaSaʃ nonce words where the final consonant was again [ʃ], but in these forms, the continuum appeared in the middle of the word, and the first consonant was one of the six non-sibilant consonants {t d n m p b} used in the non-local condition. The continua were created in the Matlab program STRAIGHT (Kawahara et al. 2008) from natural productions by a male native speaker of Slovenian; both English and Slovenian speakers heard the same stimuli.

Pilot results suggest that Slovenian and English speakers differ in their categorization of the non-local blocking contexts. For English speakers, the local and non-local conditions patterned similarly, with few differences among the different consonant contexts. In contrast, for Slovenian speakers, the differences among the consonant conditions are much larger for the non-local condition than for the local condition. In particular, in the non-local condition, the context [t] has higher [ʃ] response, while [d] has higher [s] response, compared to the non-blocking contexts with the nasals and the other voiceless-voiced pair {p b}.

The lack of effect for English speakers suggests that the blocking effect in Slovenian is not due to a cross-linguistic perceptual tendency. However, the results for Slovenian speakers suggest that sibilant harmony blocking is linked to perception. Interestingly, the two coronal stops seem to have the opposite effect. With the non-blocker consonants, long-distance harmony is possible, and we expect to see those effects in perception. Ozburn (in press) found that when categorizing the initial consonant of SVCV nonce forms, where S is an s∼ʃ continuum, English speakers respond with [ʃ] more often when C is [ʃ] compared to when it is a non-sibilant. Based on her findings, we expect that if harmony and blocking both appear in perception by Slovenian speakers, there should be greater [ʃ] response in non-blocking contexts, but greater [s] response in blocking contexts. Indeed, the blocking [d] has more [s] responses, which is what we would expect given that [sadaʃ] does not alternate with [ʃadaʃ]. On the other hand, [t] does not clearly behave as a blocker, since speakers give more [ʃ] responses than in the non-blocking contexts. The higher [ʃ] response rates could be a compensatory effect, along the lines of Ohala (1993). Under this analysis, the language-independent effects of sibilants on each other are in competition with the Slovenian-specific effects. In general, [ʃataʃ] could be a harmonized form for [sataʃ], but not in Slovenian. It is therefore possible that with [t], Slovenian speakers overcompensate for language-particular effects, "correcting" responses where Slovenian exposure might make an [s] response more likely, but doing so more than would be necessary to correct for the effect. The result is more [ʃ] response for [t]. It therefore seems that blocking in Slovenian harmony could arise from different perceptual mechanisms, hypocorrection for [d] and hypercorrection for [t], despite the fact that the end result in the language is a similar pattern for both blockers.

These data provide further evidence for the blocking effect in Slovenian sibilant harmony, by showing that the effect is also present in perception. However, it seems that similar blocking effects for different consonants arise from different perceptual mechanisms. Further, given that such effects do not appear for English speakers listening to the same stimuli, these results raise questions about how and why blocking effects exist in Slovenian. In summary, this experiment shows that blocking effects do exist perceptually in Slovenian sibilant harmony, but that they are not a property of cross-linguistic perception of sibilants in blocking contexts.

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VOWEL DISPERSION IN ENGLISH DIPHTHONGS: EVIDENCE FROM ADULT PRODUCTION

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This study addresses two main omissions in previous work on vowel inventories in Dispersion Theory. The first is to evaluate the ability of Dispersion Theory to account for actual production data; Flemming's (2004) similarity space is an idealized version of what the vowel space should look like, with very strict segmentation of the space into the corresponding vowels. In addressing vowel inventories, Flemming does not base inventories on actual production; instead, he assumes production matches the common IPA transcriptions used for a language's inventory. This study addresses this first issue by measuring a set of monophthongs in connected speech to make the vowel inventory reflect true production. The second aspect addressed is the omission of diphthongs from Flemming's vowel inventories, despite diphthongs being common productive members of vowel inventories in a large number of languages cross-linguistically.

Flemming (2004)'s analysis adapts the ranking and competition framework of OT to the goals and hypotheses of Dispersion Theory. Two goals are perception-based: (1) maximize the distinctiveness between the contrasts by maximizing their distance with the MINDIST constraint, and (2) maximize the number of contrasts the speaker can make with the MAXIMIZE CONTRASTS constraint. These perception-based goals are in competition with a speaker-oriented goal: (3) minimize effort of articulation with the *EFFORT constraint. Problematically, the strict F1 and F2 coordinates of the similarity space do not accurately reflect the positions of the vowels as they are spoken, leading to a discrepancy between the idealized theoretical analysis and true production. Additionally, this analysis can only account for monophthong vowel inventories; ideally, vowel inventories with diphthongs should be included in this framework to create a unified theory.

To address the first issue, data was collected from three native English speakers, from which recordings monophthong and diphthong data were extracted. Previous literature guided choices in diphthongs to be evaluated, points of measurement, and cues that are most important to diphthong perception (Gay 1968, Miret 1998, Morrison 2013). The purpose of measuring monophthongs in addition to the diphthongs is twofold: (i) to establish a basic map of the vowel space against which the diphthongs can be plotted; (ii) to determine the nature of where the diphthongs are in the vowel space without relying on the orthographic transcription, which the previous literature cites as untrustworthy when it comes to vowels (Lehiste & Peterson 1961, Gay 1968).

Data was then plotted and against Flemming (2004)'s similarity space for comparison, see Figure 1. From the three speakers, monophthong formant measurements were taken from a total of 252 tokens and diphthong formant measurements from 200 tokens. Compared to the similarity space, monophthongs (especially lax vowels) were consistently centralized. Actual monophthong and diphthong production both do not align with how they are transcribed. The Euclidean distance is shorter in all the phonemic diphthong pronunciations than where they would be placed by their IPA labels in Flemming (2004)'s similarity space. The two phonetic diphthongs, [eɪ] and [oʊ], however, have equal or longer distances.

In the analysis, I first provide Dispersion Theory OT derivations for the entire monophthong production data set on the F1 and F2 dimensions. The constraints and procedure from Flemming (2004) were sufficient to provide correct rankings for the monophthongs, despite the fact that the monophthongs showed a large amount of vowel reduction. To derive the correct diphthongs, additional constraints were introduced to account for the diphthong production data, including the inherently ranked *EffortNucleus=x (Grosz 2006), HearClear (Minkova & Stockwell 2003), and the constraint proposed here, *ReduceOnset. These additional constraints were based on articulatory goals to minimize effort: on one hand, reduced effort led to shorter diphthongs; on the other, reduced effort caused the onset target to be reduced to a central vowel position. Each derivation evaluated one diphthong amongst a set of possible candidates; I derive the individual diphthongs as they are pronounced compared to losing forms (ie. the vowels within diphthongs rather than diphthongs compared to each other in the vowel space).

Overall, it appears that (at least in reading-rate speech) the goal for minimization of effort tends to take precedence over the goal to maximize distance in individual diphthongs. This conclusion is not entirely consistent with previous literature, which mainly states that the two targets in a diphthong seek to maximize distance. The production data even suggests that the onset target may the least reliable cue for diphthong identification, contrary to Morrison (2013)'s study, due to its tendency toward reduction.

My future research focuses on expanding the analysis to evaluate diphthongs in comparison to one another in the vowel space and expanding to evaluation of cross-linguistic trends. At this next stage of implementing diphthongs in Dispersion Theory, it will become evident how the goal of maximum distinctions applies to the diphthong inventory, if at all.

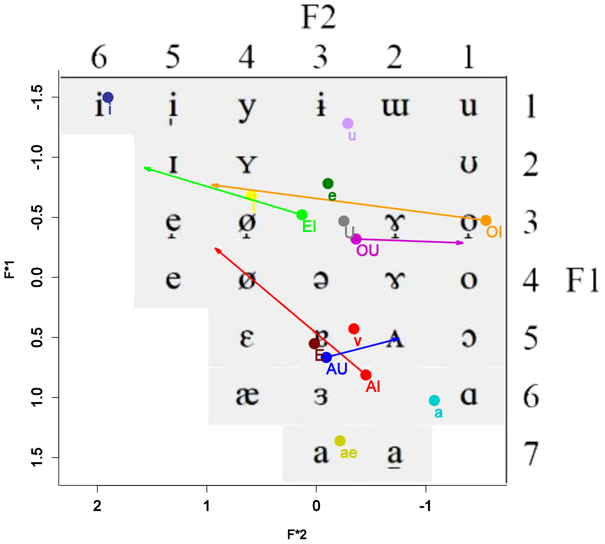

Figure 1: Normalized values plotted over Flemming (2004)'s similarity space

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Learning alternations affects phonotactic judgments

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It has long been recognized that alternations often serve to resolve violations of the phonotactic constraints of a language, and it has often been claimed that this entails a unified analysis. Chomsky and Halle (1968) advocate in favor of encoding both types of generalizations in terms of rules that apply both to create alternations and "internally to a lexical item" (p. 382). Optimality Theory (Prince and Smolensky 1993/2004) uses a single constraint ranking to both rule out ill-formed structures, and generate alternations. However, there are many cases in which alternations have no phonotactic motivation, for example in derived environment effects (Kiparsky 1973; Mascaró 1976), in which a rule is specifically blocked from applying morpheme-internally, and the reverse can occur when a restriction is limited to the roots of a language, as is often the case in OCP-Place effects. It thus remains plausible that phonotactics and alternations are encoded completely separately. In this paper, we provide experimental evidence that the learning of an alternation does affect phonotactic judgments, thus arguing against such a completely disjoint treatment.

Pater and Tessier (2003) investigated the relationship between phonotactics and alternations in adults, by asking whether knowledge of a phonotactic generalization affected the ease with which an alternation is learned. The experiment involved teaching two novel alternations to English speakers, only one of which served to resolve a phonotactic violation. While the phonotactically motivated alternation was indeed better learned, Pater and Tessier note that many of their test items involved phonotactically illicit forms, and that when these items were removed, the results showed a trend in the predicted direction, but were not statistically significant. In our design, we avoid this problem by using a counterbalanced design in which the only difference between the two conditions is whether they learned one of two alternations.

One of the phonotactic constraints was against a voiced obstruent followed by a voiceless obstruent (*DF), and the other was against a nasal followed by an obstruent of a different place (*NF). One rule was constructed to repair each constraint: voicing dissimilation is repaired by devoicing the first obstruent, and place dissimilation is repaired by changing the place of the nasal. These constraints and rules guided the construction of words in an artificial language. The language has a plural suffix -[fa], and singular nouns have no suffix. When pluralization is applied to stems ending in voiced obstruents, which in this language include only [b] and [d], *DF is violated and Devoicing applies. When pluralization is applied to stems ending in non-labial nasals, which in this language include [n] and [ŋ], *NF is violated and Place Assimilation applies. All of the stimuli were orthographically presented.

The experiment has a between-subjects design, where the participants are divided into two groups and each exposed to a different exposure and training phase. Neither group sees any violations of either constraint. However, each group only sees direct evidence for one rule. Thus, for each treatment there is an active rule and a hidden rule. For a given treatment, participants are shown both the singular and plural form of stems that undergo the active rule, but only a singular or a plural for each stem that would undergo the hidden rule. Thus, the application of the hidden rule is neither confirmed nor denied.

An exposure phase was to familiarized the participants with the language without testing their memory. Participants simply repeated the words by typing in the words after they were orthographically presented. Examples of the exposure stimuli, and the numbers of each type, are shown in the following table.

Exposure stimuli examples when Devoicing is the active rule
Singular-only (10): lobon   Singular-plural, faithful (5): teldus - teldusfa
Plural-only (10): funemfa   Singular-plural, alternating (10): nemab - nemapfa

Exposure stimuli examples when Place Assimilation is the active rule
Singular-only (10): nemab   Singular-plural, faithful (5): teldus - teldusfa
Plural-only (10): funepfa   Singular-plural, alternating (10): lobon - lobomfa

In the subsequent training phase, the goal was to choose the correct plural for a singular. Feedback, in the form of presentation of the correct response, was given only for the active rule and non-alternating fillers.

The test phase, which is the same for both groups, then poses two-alternative forced choice questions concerning both constraints. For each constraint, there are questions pitting an apparently stem-internal violation of the constraint against a word that satisfies the constraint.

One hundred participants were recruited from Mechanical Turk and paid for their participation. They were all located in the United States and claimed to be over 18 years old and native speakers of English. One participant was excluded based on having response times under 50 ms, and 36 failed to learn the rules to an 80% correct criterion over a training block, leaving 63 participants whose data were analyzed.

If the treatment affects performance in the test phase, we expect a statistical interaction between the treatment and the tested constraint in predicting the proportion of violations chosen in the test phase. The prediction held: the participants trained on Devoicing chose fewer *DF violations than those trained on Place Assimilation, and the participants trained on Place Assimilation chose fewer *NF violations. A logistic mixed effects model was fitted to the data. It included random slopes and intercepts for subjects and items. The fixed effects were the training condition, the testing condition, their interaction, and one "nuisance variable," the side of the page the constraint-violating word was presented on. The interaction was in the predicted direction, with $p < 0.001$.

A potential confound is the fact that the feedback in the training phase may have drawn extra attention to the sequences generated by the alternation, increasing their phonotactic acceptability. A second experiment was thus performed, removing feedback from the design, resulting in an experiment with an exposure phase, one iteration of training where no feedback is given, and a testing phase. 200 participants were tested, since the lack of feedback generally resulted in lower performance on the training items. The criterion was also reduced to 70% in order to have 80 participants, rather than 57, in the final analysis. The effect was not found to be significant in a mixed effects model, perhaps due to a lack of power, but a trend was present in the predicted direction.

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Constraints on URs and blocking in nonderived environments

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Summary: I argue that nonderived environment blocking (NDEB) is the result of an opaque interaction between a component that constrains possible URs in the lexicon and the usual phonological component that maps URs into surface forms. I present several arguments for this approach over previous proposals. This amounts to an argument for a dual-component architecture of phonology and against the elimination of constraints on URs (the principle of Richness of the Base in OT).

The problem: In standard NDEB cases, which I exemplify using Finnish assibilation (Kiparsky, 1973), a phonological process (t → s / _ i) applies across morphemes boundaries ([halut-a]-[halus-i]) or morpheme-internally when fed by a prior phonological process (final-vowel raising, [vete-nä]-[vesi]) but is otherwise blocked from applying ([tila], [äiti]).

Architecture: My claim is that NDEB supports a component that restricts possible URs in the lexicon. I will have nothing to say about the phonological formalism (e.g., rule-based or constraint-based) or the nature of lexical representations (e.g., underspecified or fully specified). To make the proposal explicit, I will adopt a ruled-based formalism and underspecification, but these choices are arbitrary. The architecture, which I now describe, is schematized in the box below. **The alphabet:** a phonological grammar includes an inventory of feature bundles Σ, the elements of which can be concatenated: if k,a,t $\in \Sigma$, then $\{$kat$\}$ and $\{$takta$\}$ are possible concatenations, among others. **Constraints on URs (CURs)** come in two forms: a) constraints on the alphabet: language-specific restrictions of Σ to a subset $\Sigma' \subset \Sigma$; if x $\notin \Sigma'$, then $\{$bax$\}$ is not a possible concatenation of the elements of Σ'; b) morpheme structure rules, which are formally identical to regular rules. **Generating URs:** URs are generated in two steps. Step I: concatenate elements from Σ'. Step II: apply morpheme structure rules. **Underspecification:** the elements of Σ may be underspecified for some of their features (e.g., T stands for a voiceless alveolar underspecified for CONT). Underspecified features are later filled by morpheme structure rules or by phonological rules. Both types of rules may be feature-filling. For example, if assibilation is feature-filling (T → s / _ i), it applies to underspecified /T/ but not to fully-specified /t/.

$$\Sigma' \rightarrow \{\text{CONCATENATION}\} \xrightarrow{\text{Morpheme structure rules}} /\text{UR}/ \xrightarrow{\text{Phonological rules}} [\text{SR}]$$

Analysis: Consider first a hypothetical grammar with two feature-filling rules: (1) assibilation: T → s / _ i and (2) "anti-assibilation": T → t / _ i, where (2) is ordered before (1). A UR like /Ti/ surfaces as [ti]: (2) applies first and removes the environment for (1) by specifying T as [-cont]. This interaction is at the core of my proposal: assibilation is blocked in environments present at the stage of the derivation when anti-assibilation applies. Assibilation only applies to environments created in later stages of the derivation. **The grammar: CURs:** (1) t $\notin \Sigma'$, (2) T → t / _ i. **Phonological rules:** (3) T → s / _ i, (4) T → t. The two CURs require that /t/ occur only before /i/ in URs; /T/ occurs elsewhere. When possible, assibilation (3) applies to /T/, which is otherwise specified as [t] by the elsewhere rule (4). **Derivations: Morphological NDEB:** Consider the derivation of [tilas-i] (alternating with [tilat-a]). Here assibilation applies between two morphemes but not within the stem. First, morpheme structure rules apply to {TilaT} and {i}, yielding the URs /tilaT/ and /i/. Phonological rules apply to /tilaT-i/: /Ti/ (but not /ti/) satisfies the environment for assibilation, yielding [tilas-i]. The derivation of [tilat-a] is similar: here assibilation does not apply in /tilaT-a/, but the elsewhere rule (4) does, yielding [tilat-a]. **Phonological NDEB:** nothing further has to be said. The derivation of [vesi] starts with {veTe}, anti-assibilation does not apply, leaving T underspecified, and the environment for assibilation is met after vowel raising.

Previous proposals: For **Kiparsky (1993)**, the input-output mapping is identical to mine: assibilation is a feature-filling rule and the distinction between application and misapplication corresponds to underspecification (/T/) vs. full specification (/t/). The absence of CURs leads to over-generation: the underlying distribution of /T/ and /t/ remains an accident of the Finnish lexicon; nothing prevents /t/ from occurring root-finally and incorrectly blocking assibilation before a suffix-initial /i/. The grammar incorrectly generates ungrammatical SRs such as *[hirat-i]. In approaches such as the **Strict Cycle Condition** (Mascaró, 1976) and **Colored Containment** (van Oostendorp, 2006), a sufficient condition for application in cases of morphological NDEB is that the triggering environment spans two morphemes. Romanian palatalization (Steriade, 2008a) suggests that this characterization is incorrect. The process (k → tʃ / _ {e, i, j}) applies across a morpheme boundary ([mak]-[matʃ-j)] and is blocked morpheme-internally ([rokie], [unkj]), but when a stem-final vowel is deleted before the suffix ([bere]-[ber-j]), palatalization of a stem-penultimate /k/ is blocked exactly when the deleted vowel had been a palatalization trigger ([pəduke]-[pədu**k**-j] vs. [mɨnekə]-[mɨnetʃ-j]). This behavior is predicted by the current approach, as the presence of a palatalization trigger in the UR provides the environment for anti-palatalization before suffixation. **Wolf's (2008) Optimal Interleaving with Candidate Chains** accounts for morphological NDEB through a condition on crucial precedence between suffixation and the application of a process: if the environment is present both before and after suffixation, the process is blocked. Vowel raising in Romanian (Steriade, 2008b) and reduction in Armenian (Khanijan, 2008) provide counter-evidence. In Romanian, where stress is predictable, newly-unstressed [a] raises to [ə] ([bárbə]-[bərb-ós] vs. [mazíl]-[mazil-í]). For URs such as /bárbə/, Wolf's approach makes the right prediction: raising applies in [bərb-ós] since [a] is not unstressed before suffixation. But given Richness of the Base, /barbə/ and /barbə́/ are possible URs in which [a] is not stressed before suffixation and surface stress is fixed by the grammar. This leads to over-generation of SRs like *[barb-ós] where raising does not apply. In the current approach, a judicious choice of CURs could filter out the relevant URs. **Burzio's (2000) Sequence Protection** faces the same challenge. Faithfulness constraints protect underlying environments from undergoing a change. In Romanian, underlying unstressed [a] would be protected from raising. For URs such as /bárbə/, raising is correctly licensed in the suffixed form since stressed [a] evades faithfulness. But unstressed [a] in the hypothetical /barbə/ and /barbə́/ is subject to faithfulness, incorrectly yielding *[barb-ós].

Implications: OT dispensed with CURs primarily for reasons of theoretical simplicity: a single-component architecture seemed more appealing than a dual-component one; output constraints unified CURs and the input-output mapping. The present work identifies NDEB as a domain in which the predictions of the two architectures diverge and presents new empirical evidence in favor of a dual-component architecture of phonology.

An ‘unnatural’ pattern of variation in vowel harmony: a frequency-based account

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Variation and transparency in Hungarian front/back harmony is known to be sensitive to the height of the neutral vowels in the language /i(ː)/, /eː/, /ɛ/ (dubbed the Height Effect by Hayes & Cziráky Londe 2003 (H&C)) and the proximity of a back trigger to a target separated from it by neutral vowels (called the Count Effect by H&C). Various analyses of these effects have been proposed but very little attention has been given to the *interaction* of these two effects. The extant approaches (Bowman 2013, H&C) assume, implicitly or explicitly, that the two effects are ‘additive’ in the sense that they reinforce each other when both can apply. In this paper we want to show that this assumption is empirically incorrect in some cases and propose an analysis that accounts for the non-additive nature of the interaction.

The Height Effect (HE) consists in the fact that higher neutral vowels are easier to skip (i.e. are more transparent) than lower ones. Accordingly, there is a hierarchy of vowel transparency in Hungarian (below X>Y means that, when suffixed with a harmonically alternating suffix, a stem of the type X is more likely to co-occur with a back suffix alternant than a stem of the type Y; B is a back vowel; consonants are not indicated):

(1) HE Bi(ː) > Beː > Bɛ

Thus, in a [Bi(ː)]_ context (where [,] are morpheme boundaries) the harmonic value of a harmonically alternating suffix is back (*B*): e.g. *koʧi-nɒk/*nɛk* ‘car+DAT’; in a [Beː]_ context there is (lexically conditioned) variation, but the harmonic value in the suffix is more likely to be *B* than front (*F*): e.g. *kaːveː-nɒk/*nɛk* ‘coffee+DAT’, *ɒrzeːn-nɒk/nɛk* ‘arsenic+DAT; in a [Bɛ]_ context there is variation, but the value is more likely to be *F* than *B*, e.g. *konʦɛrt-*ok/ɛk* ‘concert+PL’ and *fotɛl-ok/ɛk* ‘armchair+PL’.

The Count Effect (CE) means that a sequence of more than one neutral vowel (N) is more difficult to skip (i.e. less transparent) than a single one. This again results in a hierarchy in transparency:

(2) CE $BN > BNN^+$

Thus, for instance, a single high N in a [Bi(ː)]_ context is fully transparent so a following harmonically alternating suffix is *B* (in accordance with HE), but variation occurs after more than one high N, in the context [Bi(ː)i(ː)]_, e.g. *ɒlibi-nɒk/nɛk* ‘id.+DAT’.

The question we address here is whether CE and HE are additive, i.e. whether it is true that a sequence of N vowels less transparent by CE is necessarily less transparent than a sequence (of the same number) of N vowels which are more transparent by CE, as in (3):

(3) Additive interaction

$$\text{If } BN_i > BN_j \text{ then } BN_iN_i > BN_iN_j\,,\ BN_jN_i > BN_jN_j$$

(3) seems to hold true in some cases, e.g. there is variation between *F* and *B* suffix alternants in the context [Bii]_ *ɒlibi-nɒk/nɛk* ‘id.+DAT’, but in the context [Biɛ]_ suffix alternants are practically always *F*: *kɒlibɛr-*nɒk/nɛk* ‘calibre+DAT’. This is to be expected by (3) since Bi > Bɛ. However, [Bii] vs. [Bieː]_ (especially when eː is root final) do not conform to (3). The suffix alternants in the latter context are predominantly *B* although Bi > Beː, e.g. *mɒtineː-nɒk/$^{*?}$nɛk* ‘matinée+DAT’.

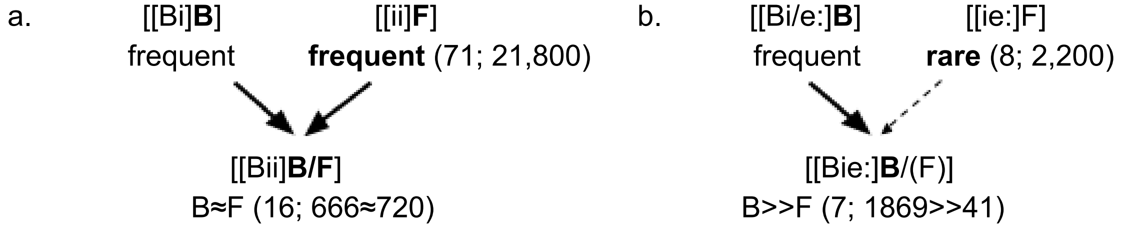
(4) CE+HE
  a. Bii > Biɛ (additive interaction)
  b. Bii < Bie: (non-additive interaction)

Why is it that [Bieː]_ stems do not follow a general strategy like (3) for suffix harmony when this strategy *is* otherwise available, cf. (4a)? This 'unnatural' behaviour (i.e. ungrounded in markedness or phonetics, cf. Hayes *et al* 2009) of the harmonic context [Bieː]_ is puzzling if we want to derive it from the *inherent* properties of the context itself but can be explained with reference to its connections to other, partially similar contexts.

In an analogy-based approach (e.g. Bybee 2007) the behaviour of a pattern (analogical target) is related to that of other similar patterns (analogical sources), the strength of whose influence depends on their frequency and their degree of similarity to the target. The greater these are, the stronger the connection is between the source and the target. Variation in a target pattern is the result of conflicting sources with approximately equal strengths (e.g. Kálmán *et al.* 2012). In this spirit, the variation in the context [BNN]_ can be interpreted as a result of conflicting harmonic behaviour in partially similar contexts, namely [BN]_ and [NN]_ (relativised to the specific N segments). As [Bi] stems have *B* suffixes, (in line with HE) and [ii] stems always get *F* suffixes (e.g. *kifli-*nɒk/nɛk* 'crescent roll+DAT'), this conflicting behaviour of the analogical sources results in variation in the case of [Bii] stems.

Frequency asymmetries in the sources result in strength differences between the source-target connections and therefore different target behaviour. We argue that this approach to variation *can* explain the unnatural harmonic behaviour of the [Bieː]_ context. The predominance of *B* suffixes in this context is due to the relative weakness of the [NN] (=[ieː]) analogical source: although the context [ieː]_ invariably has an *F* suffix (e.g. *file:-*nɒk/nɛk* 'filet+DAT'), the frequency of these forms is strikingly low and cannot 'counterbalance' the conflicting influence of the other sources, the [BN] contexts [[Bi/e:]_, where predominantly *B* suffix alternants occur. By contrast, *F*-suffixed forms of [ii] stems are very frequent and therefore exert a greater influence on the [Bii] context resulting in near-free variation in suffix harmony. (5) shows these connections for the special case of vowel-final roots with the number of lemmas and the token frequency of suffixed forms from the Szószablya webcorpus containing 103k lemmas and 541M word tokens (Halácsy *et al.* 2004). Note that the frequency data of the type [[ii]F] are greater than those of [[ie:]F] by an order of magnitude.

(5) Analogical sources of [BNN]-targets with frequencies (lemma; token)


a. [[Bi]**B**] frequent — [[ii]**F**] **frequent** (71; 21,800) → [[Bii]**B/F**] B≈F (16; 666≈720)

b. [[Bi/e:]**B**] frequent — [[ie:]F] **rare** (8; 2,200) → [[Bie:]**B**/(F)] B>>F (7; 1869>>41)

We conclude by arguing that the significance of the phenomenon is that an unnatural pattern may be not simply exceptional but may have an explanation that lies in its frequency-sensitive connections to patterns which are sufficiently similar to it.

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Sonority-driven stress does not exist

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1. Introduction: This talk presents a new claim about sonority-driven stress: namely that there is no such phenomenon. This proposal contrasts with Kenstowicz (1997) and de Lacy (2002 et seq.)'s proposals that metrical structure can be sensitive to sonority. I will first show that Gujarati is central to the evidentiary claims that sonority-driven stress exists. I will then argue that Gujarati does not have sonority-driven stress – the head syllable is consistently the penult. Finally, I will present a theoretical proposal that explains why vowel reduction in unstressed syllables and sonority increase in stressed syllables is possible, but sonority-driven stress is not.

2. Conflicting Accounts: Two types of stress patterns have been reported for Gujarati: penultimate stress (Turner 1921, Master 1925, Patel & Mody 1960) and sonority-driven stress (Cardona 1965, Adenwala 1968, de Lacy 2002, Doctor 2004, among others). The sonority-driven stress descriptions generally agree that a syllable that contains the most sonorous vowel [a] always attracts stress, whereas the least sonorous vowel [ə] repels stress. However, the descriptions are impressionistic – no acoustic or phonological evidence is provided. This study is the first to examine the acoustic realization of sonority-driven stress in Gujarati. I report the results of two experiments that aimed to determine whether stress is attracted by [a] and retracts from a penult [ə] onto a non-[ə] initial syllable.

3. Methodology & Predictions: Four male and two female native Gujarati speakers participated in the experiment (ages between 19 and 25 years old). For the experiment on [a], disyllabic words with the shape [Ca_1Ca_2], [Ca_3CV], and [CVCa_4] (where V ranges over [o, u, i, ə]) were used to allow multiple comparison of [a] in both putatively stressed and unstressed states. Crucially, the penultimate hypothesis predicts [a_4] to be unstressed, but the sonority-driven hypothesis predicts it to be stressed. For the experiment on [ə], trisyllabic words with the shape [Cu.C$ə_1$C.CV] and [C$ə_2$.C$ə_3$C.CV] were examined. The penultimate hypothesis predicts [$ə_1$] and [$ə_3$] to be stressed, whereas the sonority-driven hypothesis says only [$ə_3$] is stressed because the antepenult is [$ə_2$]. Each word was placed in two frame sentences to control for phrasal-final lengthening. Acoustic correlates of stressed/unstressed vowels were measured, including intensity, duration, F0, F1 and F2. The results of each measure were analyzed using linear mixed effect models.

4. Results: According to all descriptions, the penult is the default location for stress. In [Ca_1Ca_2] words, [a_1] in [Ca_1Ca_2] was found to have significantly longer duration, higher intensity, and higher F1 than [a_2] (Duration: [a_1]=95.3 ms, [a_2]=78.7 ms, $p<0.01$; Intensity: [a_1]=73.3 dB, [a_2]=70 dB, $p<0.01$; F1: [a_1]=867.4 Hz, [a_2]=666.6 Hz, $p<0.01$). As expected, [a_3] in [Ca_3CV] was found to be the same as the 'stressed' [a_1] (Duration=98.2 ms, p=0.986; Intensity=75 dB, p=0.435; F1=844.5 Hz, p=0.0624). Previous descriptions have reported that [a_4] in [CVCa_4] is stressed – this is essential to the claim that Gujarati has sonority-driven stress. However, [a$_4$] had the same quality and intensity as the ‘unstressed’ [a$_2$] in [Ca$_1$Ca$_2$] (F1=690.7 Hz, p=0.336; Intensity=72 dB, p=0.382). Therefore, the results show that stress is not attracted by [a] but always falls on the penultimate syllable.

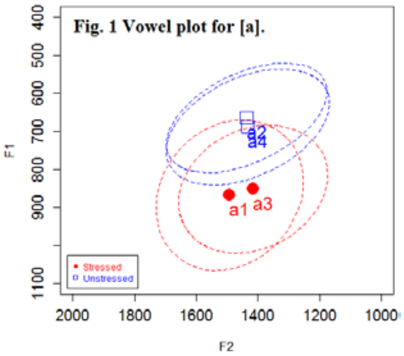
Fig. 1 Vowel plot for [a].

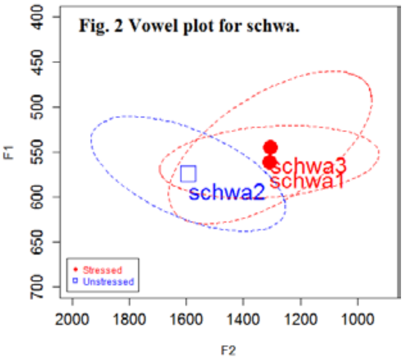
Fig. 2 Vowel plot for schwa.

If [ə] repels stress, [ə$_1$] in [Cu.Cə$_1$C.CV] words is expected to be realized the same as the 'unstressed' [ə$_2$] in [Cə$_2$.Cə$_3$C.CV]. However, [ə$_1$] was found to be more peripheral than [ə$_2$] (F2: [ə$_1$]=1309.3 Hz, [ə$_2$]=1594.1 Hz, p<0.01), but the same as [ə$_3$] (F2=1305.6, p=0.9713). The results from schwa also support the penultimate hypothesis since both [ə$_1$] and [ə$_3$] are in the penultimate syllable. There was no evidence of a duration, F0, or intensity difference between the schwas. In sum, vowel quality is the most robust cue for stress in Gujarati: stressed vowels are more peripheral while unstressed vowels are more central, as shown in Fig. 1 and 2.

5. Implications: Gujarati stress has been the subject of more descriptions than any other sonority-driven stress case, and is one of the very few cases where stress is sensitive to multiple sonority levels, and does not simply avoid schwa. Consequently, the disturbing implication is that if Gujarati does not have sonority-driven stress, perhaps none of the other cases do, either. This consequence then presents interesting challenges to OT’s property of symmetric effects. For example, de Lacy (2002) argues that *HdFt≤{e,o} plays a crucial role in Gujarati stress (de Lacy 2002) since it is the foot head which requires high sonorous vowels. However, *HdFt/v cannot exist if there is no sonority-driven stress. Similarly, *non-HdFt/a cannot exist because it can be used to generate the Gujarati system. However, these constraints are necessary to account for stress-driven neutralization, deletion, and vowel reduction (de Lacy 2006:ch.7). I further show that stringent constraint formulation cannot avoid this problem. Instead, I argue that there is necessarily fixed constraint ranking, with those that locate prosodic structure (e.g. ALIGN-Ft-L) universally outranking constraints that refer to a prosodic node and sonority level (e.g. *Hd$_{\text{Ft}}$≥ə).

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Morphologically-conditioned tonotactics in multilevel Maximum Entropy grammar

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This paper presents a novel approach to probabilistic lexically-conditioned tonotactics, featuring a case study of Mende in which tonotactics vary by lexical category. The study contributes to the understanding of morphologically-conditioned phonology in several ways. First, the observed part-of-speech sensitivity goes beyond the noun-adjective-verb distinctions noted by e.g., Smith 2011, more closely resembling the complexity of morphophonological variation, as addressed in both single grammar (e.g., indexed constraints: Itô & Mester 199; Alderete 2001) and multiple grammar (e.g., cophonologies: Anttila 2002; Inkelas & Zoll 2005) theories. Second, the variation is not just a matter of differential faithfulness; it involves markedness reversals of the kind that Alderete's 2001 'grammar dependence' hypothesis predicts impossible (cf. Pater 2009). Third, the study models not just the space of variation but also the frequency of variation. This is accomplished by indexed weight adjustments for each constraint (i.e., 'varying slopes'; see also Coetzee & Pater 2011) in a Maximum Entropy Harmonic Grammar (MaxEnt HG; Goldwater & Johnson 2003). Couched in multilevel statistical models, the approach presented here unites the treatment of lexical class-sensitive phonotactics with the treatment of morphophonology, and directly addresses the overarching issue in morphophonology of how to quantify the heterogeneity that morphological conditioning can engender in a phonological system.

Early generative accounts of Mende surface tonotactics dealt only with nouns and focused on the majority tone patterns, modeled by a pre-specified, limited set of five surface tone 'melodies' (H, L, HL, LH, LHL), mapped onto syllables by universal autosegmental processes (e.g., Leben 1978). However, as discussed by subsequent studies (Dwyer 1978; Conteh et al. 1983; Zoll 2003; Zhang 2007), many surface patterns deviate from the supposed five melodies and their universal autosegmental association principles. Inkelas & Shih 2015 argue for abandoning the original autosegmental insights and modeling tonal patterns in Mende nouns with general similarity- and proximity-driven surface correspondence, an approach that has recently gained traction for both phonotactics and phonological alternations (e.g., Frisch et al. 2004; Hansson 2001; Rose & Walker 2004; Wayment 2009; Bennett 2013). The basic (violable) insights for Mende tonotactics, as formalised in ABC+Q by Inkelas & Shih 2015, are as follows:

(1) *Contour tones are avoided.* CORR-q::q, IDENT-XX [tone] mandate agreement between subparts of a segment (*q*). E.g., *[ǎ], ✓[à].
(2) *If necessary, contour tones are tolerated at the right edge.* CORR-$[q_w::q_w]_\sigma$, IDENT-XX [tone] mandate agreement between subsegments (*q*) within nonfinal ('weak') syllables. E.g., *[ǎ.à], ✓[à.ǎ].
(3) *Tone changes align with syllable boundaries (more syllables leads to more non-level tone patterns).* qq-EDGE σ, CORR-q::q prevent correspondence (and resulting tone agreement) across syllable boundaries. E.g., *[á.á], ✓[à.á].
(4) *HLH troughs are avoided.* CORR-q[H]q[H], q[H]q[H]-qADJ mandate correspondence and adjacency of H tones. E.g., *[á.à.á], ✓[à.á.á].
(5) *Words preferably have at least one H tone.* HAVE H mandates the presence of one H tone. E.g., *[á.á], ✓[à.á].

This study argues that variation across part of speech in Mende can be captured in MaxEnt HG in terms of the degree to which the basic tonotactic principles in (1)-(5) (the 'Base Grammar') are followed in each lexical class (inspired by e.g., Anttila 2002 in classic OT). The data come from a cor-

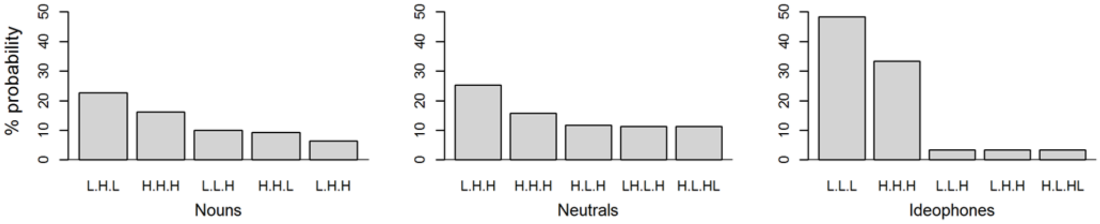

Figure A. Observed % probability for top 5 most frequent trisyllabic surface tone patterns per lexical class.

pus lexicon developed from Innes' 1969 Mende dictionary. Results are reported here from the three largest lexical classes: nouns (*n*=2707), neutrals (i.e., verbs/adjectives) (*n*=792), and ideophones (*n*=546). Figure A illustrates the top 5 most frequent observed tone patterns for trisyllabic words. Relative tone pattern frequencies vary by lexical class: e.g., Nouns prefer the L.H.L pattern; Neutrals, the L.H.H pattern; Ideophones, the L.L.L pattern.

We provide an analysis in Maximum Entropy grammar, for which the output is a probability distribution over all possible surface tone patterns, per the number of syllables and lexical class of the word. Morphological conditioning is modeled as an additive, lexical class-sensitive weight adjustment for each constraint in the Base Grammar: e.g., w_1·CORR-q::q + w_2·(CORR-q::q×NOUN) + w_3·(CORR-q::q×NEUT). In essence, each lexical class is allowed varying slopes for every model parameter, formally executed here as interaction terms (cf. e.g., Gelman & Hill 2007), and overall tonotactics are predicted by the main base weights for the constraints.

The results of the varying-slope approach accurately capture both shared features across lexical classes and class-specific morphological conditioning on the distribution of surface tone patterns. The Base Grammar for Mende tonotactics reveals the importance of contour tone avoidance and contour tone alignment to the right edge (see 1–2): *w*(CORR-q::q)=1.175, *w*(CORR-$[q_w::q_w]_\sigma$)=0.815, other constraints are *w*=0. This is true across all lexical classes, reflecting universal dispreferences for (nonfinal) contour tones (Gordon 2001; Zhang 2004). Constraint weights also vary by class. Nouns and neutrals are more similar to each other than to ideophone tonotactics. Both nouns and neutrals exhibit tone disagreement across syllable boundaries (see 3; *w*(qq-EDGE×NOUN)=0.16, *w*(qq-EDGE×NEUT)=0.18), whereas ideophones preferentially feature more level tones across the board (*w*(qq-EDGE×ID)=0): this pattern can be observed in Figure A. Nouns and neutrals also show greater affinity for the requisite H tone than ideophones (5), with neutrals leading the trend: *w*(HAVEH×NEUT)=1.32, *w*(HAVEH×NOUN)=0.41, *w*(HAVEH×ID)=0. Differences between nouns and neutrals include a greater avoidance of HLH troughs for nouns (4) (*w*(q[H]q[H]-qADJ×NOUN)=1.51, *w*(q[H]q[H]-qADJ×NEUT)=0) and a greater preference for H tones and transitions at the word-final syllable for neutrals: in fact, the adjusted weighting of CORR-q::q and CORR-$[q_w::q_w]_\sigma$ for neutrals is reverse that of the base grammar.

Reinterpreting cophonology subgrammars as indexed weight adjustments of the basic grammar captures the insights of indexed constraints and cophonology approaches in the same system. Our approach shifts the burden of deciding which constraints require exceptional indexation to the grammar itself (cf. Pater 2009): this is necessary in particular for probabilistic phonotactic applications (see e.g., Coetzee & Pater 2011). While previous approaches to language-internal morphophonological variation have focused on constraining it (Kiparsky 1982; Alderete 2001; Smith 2011), we still have only a rudimentary understanding of the quantitative *extent* to which variation (i.e., entropy) is possible within a coherent grammar. This case study offers a way to quantitatively probe the heterogeneity, and suggests the potential value of examining probabilistic morpho-phonotactic variation, which is almost certainly not unique to Mende (see e.g., Arabic, Japanese). Morphologically-conditioned phonotactics are potentially an important cue for part of speech, with consequent implications for language processing and acquisition.

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A Gestural Account of Neutral Segment Asymmetries in Harmony

Neutral segments in harmony may either block the spread of a harmonizing feature or remain transparent to it. Often, these two distinct types of neutral segments are accounted for via the same mechanism, usually some kind of feature co-occurrence restriction. Such analyses come with the tacit prediction that within a given harmony phenomenon the sets of attested transparent and blocking segments should be the same. However, both nasal harmony and rounding harmony display asymmetries within the sets of attested blocking and transparent segments, with the sets of transparent segments being considerably more restricted than the sets of blocking segments. This work accounts for this asymmetry by adopting gestural representations, as in Articulatory Phonology (Browman & Goldstein 1986, 1989), and by providing a representation of harmony in which only a small set of segments may induce transparency based on the involved articulators.

In nasal harmony, all consonants are attested blockers but only obstruents are attested as transparent (Walker 1998/2000). A well-known case of obstruent transparency in nasal harmony comes from Guaraní, in which underlyingly nasal vowels act as triggers:

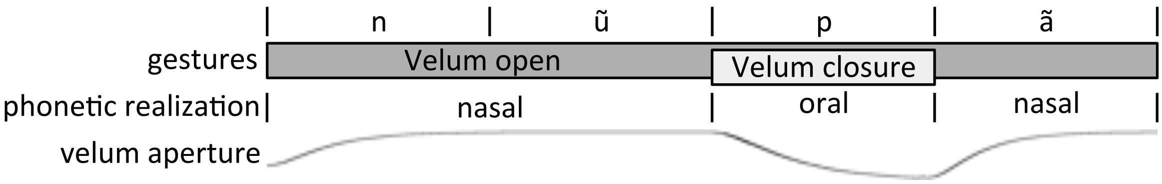
a. nũpã ‘to hit’ b. mõtĩ ‘to cause shame’ c. mõkõ ‘to swallow’

There is no similar case of nasal harmony in which liquids or glides are the transparent segments. Similarly, in rounding harmony a multitude of blocking behaviors by vowels is attested but only /i/ behaves transparently (Kaun 1995). Transparency of /i/ is found in Halh Mongolian, in which a round vowel in an initial syllable triggers rounding harmony on all vowels except /i/:

a. poor-ig-o ‘kidney’ ACC REFL *poor-yg-o b. pɔitɔ ‘clumsy’ *pɔytɔ

These typological patterns can be captured by adopting a gesture-based account of harmony. In Articulatory Phonology, gestures are goal-based units of representation, each specified for an articulatory task to be carried out over some span of time. Harmony is analyzed here as the result of the extended duration of a gesture whose period of activation may possibly span an entire word. When the phonological grammar requires a gesture specified for velum opening to extend in duration, this gesture will overlap additional consonants and vowels in a word, resulting in their nasalization; this is nasal harmony. Likewise, an extended-duration lip protrusion gesture is responsible for rounding harmony. Nasal harmony and rounding harmony are triggered whenever a consonant or vowel is accompanied by an extended-duration velum opening gesture or lip protrusion gesture, respectively.

Blocking of harmony can be modeled as cutting short an extended-duration gesture in order to satisfy constraints on the temporal overlap of incompatible gestures, similar to featural co-occurrence constraints. A gestural account of transparency, on the other hand, does not rely on this ban on overlap. This account must then explain why the overlap of a velum opening gesture and the gestures of an obstruent results in an oral consonant and not a nasal one, and why the overlap of a lip protrusion gesture with the gestures of /i/ results in an unrounded vowel and not a rounded one. It is proposed that these sounds behave transparently because they include gestures that are antagonistic to the harmonizing gesture. An obstruent is transparent to nasal harmony because it includes a velum closure gesture that is active for a period within the span of time in which a harmonizing velum opening gesture is active. When this concurrent activation of the two opposing velum gestures occurs, the obstruent’s velum closure gesture overpowers the velum opening gesture, following the workings of the Task Dynamic Model of speech production (Saltzman & Munhall 1989). The result is a period of orality within the span of nasality. When the velum closure gesture ends, the velum opening gesture once again exerts full control over the velum, causing it to open. The following figure demonstrates:



The restricted sets of transparent segments in nasal harmony and rounding harmony fall directly out of the gestural coactivation account of transparency. The inclusion of a velum closure gesture in the representation of obstruents in Articulatory Phonology is necessary to create the aerodynamic conditions responsible for obstruency. No other consonants or vowels include this velum closure gesture, and thus these consonants are unable to behave transparently to nasal harmony. Similarly, it is proposed that the transparency of /i/ in rounding harmony is caused by the inclusion of a lip spreading gesture in the representation of /i/. When this lip spreading gesture is active, it overpowers the effect of the harmonizing lip protrusion gesture that overlaps it, and the result is unrounded /i/. Because only /i/ is proposed to include this lip spreading gesture, in order to maximize its acoustic/perceptual distance from the back vowels, it is the only vowel that may behave transparently in rounding harmony. The gestural representation of transparency in harmony thus correctly predicts that the set of transparent segments for a given harmony phenomenon is restricted and specific to the involved articulators.

Feature-based accounts of harmony such as those in Archangeli & Pulleyblank (1994), Cole & Kisseberth (1994), and O'Keefe (2005) often account for all neutral segments by positing phonetically based co-occurrence restrictions or similar devices between a harmonizing feature and some other feature of a neutral segment. However, such an approach is unable to account for the asymmetries between transparency and blocking behavior observed in nasal harmony and rounding harmony. In a feature-based analysis, the co-occurrence constraints that are responsible for a harmony phenomenon's blocking behavior can easily be reranked such that they produce systems in which any segment that is attested as a blocker may behave transparently as well, significantly over-generating possible patterns of transparency in harmony. In contrast, the gestural account of harmony makes no such prediction as transparency and blocking are the results of two distinct mechanisms. While blocking is the result of gestural co-occurrence restrictions, transparency is the result of concurrent activation of antagonistic gestures.

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Environmental shielding is contrast preservation

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Overview. The term "environmental shielding" refers to a class of processes where the phonetic realization of a nasal depends on its vocalic context. In Kaiwá (Tupí, Bridgeman 1961), for example, nasals are prenasalized before oral (/ma/ → [mba]) but not nasal (/mã/ → [mã]) vowels. Herbert (1986:199) claims that shielding occurs to protect a contrast in vocalic nasality: if Kaiwá /ma/ were realized as [ma], the [a] would likely carry some degree of nasal coarticulation, and be less distinct from nasal /ã/ as a result. This paper provides new arguments for Herbert's position. I show that a contrast-based analysis of shielding correctly predicts several typological generalizations, and argue that any successful analysis of shielding must make reference to contrast.

The argument for contrast. Herbert's claim that shielding protects contrasts makes a basic prediction: if the purpose of shielding is to preserve a V–Ṽ contrast, shielding should only occur in languages that have a V–Ṽ contrast. In other words, shielding is only necessary when there is a contrast to protect. To test this prediction, I conducted a survey composed of 188 languages from SAPhon (Michael et al. 2012). With the sole exception of Ese Ejja (Tacanan, Vuillermet 2012), the prediction holds: *all languages that allow shielding also exhibit a V–Ṽ contrast* (1).

(1) Shielding survey results

	✓Shielding	**Shielding*
✓V–Ṽ	55	44
**V–Ṽ*	1	88

The contrast-based approach also makes language-specific predictions. If a language limits V–Ṽ to certain contexts, it should also limit shielding to those same contexts. The logic behind this is the same: shielding is only necessary in contexts where there is a contrast to protect. Evidence that this prediction is correct comes from Wari' (Chapakuran, Everett & Kern 1997), where both the V–Ṽ contrast and shielding phenomena are restricted to stressed syllables.

The picture, then, is clear. If a language allows shielding to occur in some context *x*, this asymmetrically implies that the language licenses a V–Ṽ contrast in *x*. I propose a contrast-based analysis referencing auditory factors (following Flemming 2008) that derives this generalization.

Asymmetries in the typology. Further asymmetries in the typology of shielding mirror cross-linguistic asymmetries in the direction and extent of nasal coarticulation. I focus on two well-supported generalizations: (i) vowels preceding coda nasals (V/_N]$_\sigma$) are more nasalized than vowels preceding onset nasals (V/_]$_\sigma$N) (e.g. Schourup 1972), and (ii) vowels following nasals (V/N_) are more nasalized than vowels preceding onset nasals (V/_]$_\sigma$N) (e.g. Jeong 2012). Whether there is more nasalization in V/N_ or V/_N]$_\sigma$ is language-dependent: Greek nasalizes more in V/N_, while English nasalizes more in V/_N]$_\sigma$ (see Jeong 2012:450). Assuming that the greater the extent of nasal coarticulation in an oral V, the less distinct the contrast wrt a nasal V, we expect to find two types of systems. In *Type 1* systems (2a), the V–Ṽ contrast should be more distinct in V/_]$_\sigma$N than V/N_, and more distinct in V/N_ than V/_N]$_\sigma$. In *Type 2* systems (2b), the V–Ṽ contrast should be more distinct in V/_]$_\sigma$N than V/_N]$_\sigma$, and more distinct in V/_N]$_\sigma$ than V/N_.

(2) Two possible types of system (Δ = perceptible difference between *x*–*y*)

a.	*Type 1*	ΔV/_]$_\sigma$N–Ṽ/_]$_\sigma$N	> ΔV/N_–Ṽ/N_	> ΔV/_N]$_\sigma$–Ṽ/_N]$_\sigma$
b.	*Type 2*	ΔV/_]$_\sigma$N–Ṽ/_]$_\sigma$N	> ΔV/_N]$_\sigma$–Ṽ/_N]$_\sigma$	> ΔV/N_–Ṽ/N_

If shielding is a strategy to protect V–Ṽ contrasts, then the phonetic asymmetry in (2) should lead to a typological one. If a language requires shielding in a context where V–Ṽ is more distinct, this should asymmetrically imply shielding in all contexts where V–Ṽ is less distinct. So while we expect to find languages that shield in V/N_ only *(Type 2)*, or V/_N]$_\sigma$ only *(Type 1)*, or V/N_ and V/_N]$_\sigma$, or all contexts, what we don't expect to find are languages that shield in V/_]$_\sigma$N but not all other contexts: in V/_]$_\sigma$N, V–Ṽ is most distinct. As shown in (3), this prediction is correct.

(3) Contextual asymmetries in shielding

	Context of shielding			*Attested?*	*Example*
	V/N_	V/_N]$_\sigma$	V/_]$_\sigma$N		
a.	✓			Yes (42)	Kaiwá (Bridgeman 1961)
b.		✓		Yes (4)	Nadëb (Barbosa 2005)
c.	✓	✓		Yes (7)	Krenak (Pessoa 2012)
d.	✓	✓	✓	Yes (2)	Karitiâna (Storto 1999)
e.		✓	✓	No	
f.	✓		✓	No	
g.			✓	No	

Similar considerations allow us to explain more subtle, language-specific contextual asymmetries. In Krenak (Macro-Ge, Pessoa 2012), for example, V–Ṽ is licensed in all contexts, but shielding occurs more frequently adjacent to stressless (short) than stressed (long) vowels. If in a given language the amount of nasal coarticulation induced on a neighboring vowel is constant, we would expect for a short vowel adjacent to a nasal to be more nasalized than a long one. In other words, we would expect for ΔV/N_–Ṽ/N_ to be greater when the vowels are long than when they are short. What we find in Krenak is a language-specific instantiation of the more general pattern in (3): shielding protects the most endangered V–Ṽ contrasts. I show that the contrast-based analysis proposed for (1) can easily be extended to account for these patterns.

Predictions. Faced with an insufficiently distinct V–Ṽ contrast, a language has two options: preservation through enhancement (e.g. by shielding) or neutralization. A contrast-based analysis predicts that contextual asymmetries in the typology of V–Ṽ neutralization should mirror those from the typology of shielding. This is because the motivation for the two phenomena is the same: they are both strategies to avoid insufficiently distinct V–Ṽ contrasts. So if two contexts C_1 and C_2 differ in that V–Ṽ is better cued in C_1 than C_2, then both enhancement and neutralization phenomena targeting V–Ṽ in C_1 must also target V–Ṽ in C_2. Preliminary results of a study on contextual V–Ṽ neutralization suggest that this prediction is correct: the typologies are identical.

(4) Contextual neutralization of vowel nasality

	Context of neutralization			*Attested?*	*Example*
	V/N_	V/_N]$_\sigma$	V/_]$_\sigma$N		
a.	✓			Yes (10)	Coatzospan Mixtec (Gerfen 1999)
b.		✓		Yes (2)	Brazilian Portuguese (Medeiros 2011)
c.	✓	✓		Yes (1)	Kiowa (Watkins 1984)
d.	✓	✓	✓	Yes (3)	Lua (Boyeldieu 1985)
e.		✓	✓	No	
f.	✓		✓	No	
g.			✓	No	

Are there alternatives? A contrast-based analysis accurately predicts three generalizations regarding the typology of shielding: (i) the existence of shielding in some context *x* implies the existence of a V–Ṽ contrast in *x*, (ii) shielding in a context where V–Ṽ is more distinct implies shielding in a context in which it is less so, and (iii) contextual asymmetries in the typologies of shielding and V–Ṽ neutralization are identical. I argue that no alternative can predict even one of these generalizations, let alone all three. From this, we can conclude two things: environmental shielding is contrast preservation, and contrast is an essential part of phonological analysis.

Phonological movement in Ukrainian

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Extant accounts of scrambling in Ukrainian generally don't extend past object- and other NP-related processes (Féry et al. 2007, Mykhaylyk 2010). Slavic scrambling is analyzed as XP-movement (Corver 1992, Bošković 2005) but this runs into problems with split constituency, as does OT syntax (Gouskova 2001). Remnant movement (Sekerina 1997, Bašić 2004) runs afoul of Slavic data and theory too (Pereltsvaig 2008, Kariaeva 2009). Analyses that mix syntax with prosody (Antonyuk-Yudina & Mykhaylyk 2009; Mykhaylyk 2012) are more promising but we show that they also fail because they assume *syntactic movement*. Ukrainian scrambles only *prosodic* objects, it ignores syntactic principles, and it respects phonological ones.

A great deal speaks against syntactic analyses of Slavic scrambling. It is category-blind, affecting N, V, A, P, Det, Adv, etc., and thus hard to motivate in terms of feature-checking, EPP, etc. It is also blind to the head/phrase distinction. Most seriously, though, it moves strings that don't form syntactic constituents:

(1) *cieju*$_a$ *radisnoju*$_b$ sxvyl^{j}ovanyj [t_a [t_b [*novynoju*]]]
this-INSTR good-INSTR excited-NOM news-INSTR
'excited by this good news'

(2) u$_a$ červonyx$_b$ vin žyv [t_a [bahat^{j}ox [t_b budynkax]]]
in red he lived many houses
'He lived in many red houses.' (Fery et al. 2007:24)

(3) *vona*$_a$ *zavdannja*$_b$ ja vpevnena, ščo [t_a [vykonaje t_b]].
she-NOM task-ACC I am.sure that perform-FUT
'I'm sure that she will perform the task.'

Scrambling ignores robust syntactic islands including the CSC (3), LBC (4), Subject Condition (Ross 1967), Adjunct Condition (Huang 1982), Freezing Islands (Wexler & Culicover 1980), and Anti-Locality (Grohmann 2002).

(4) *mašynu*$_a$ maje [t_a i *kvartyru*]
car-ACC has and apartment-ACC
'has a car and an apartment'

(5) *taku*$_a$ vona spivala [t_a [*garnu* *pisn*^{j}*u*]]
such-ACC she sang beautiful-ACC song-ACC
'She sang such a beautiful song.'

Scrambling is LF-blind, fronting reflexives (6) and reciprocals (7) past their antecedents:

(6) [*sebe*$_i$] ja$_i$ pro ce ves^j čas pytaju *t*
self-ACC I about this-ACC all time ask
'I ask myself about this all the time.'

(7) duže [*odyn* vid *odnogo*]$_i$ vony$_i$ vidriznjajut^{j}s^{j}a *t*
greatly one-ACC from another-ACC they differ
'They differ greatly one from another.'

It can move all, part, or none of a focus/topic (Fanselow & Lanertová 2012: Czech, German), and it splits names and compounds (8-9), thought to be syntactic atoms:

(8) *Olenu*$_a$ ja s^{j}ogodni zustriv [t_a *Verbyc*^{j}*ku*]
Olena-ACC I today met Verbyc'ka-ACC
'Today I met Olena Verbyc'ka.'

(9) *v*$_a$ *školi*$_b$ vin navčavsja [t_a [t_b *internati*]]

in school-PREP he studied boarding-PREP
'He studied in a boarding-school.'

Three kinds of data implicate phonology directly. First, scrambled strings are ω and φ even when they aren't X or XP. Thus in (1-3), the moved strings are (probably recursive) ωs, consisting of a function word and following content word (Selkirk 1986): in (1) the scrambled material was a ω before scrambling, but in (2-3) the scrambled string is a ω *only after scrambling*; as in Japanese, scrambling only requires that the moved material form a prosodic consituent at the end of the phonological day (Agbayani et al 2015). Second, polysyllabic prepositions can scramble (10) but monosyllabic ones can't, a purely prosodic restriction.

(10) *Protʲagom*$_a$ vony zustričalysʲ [t_a [*lita*]]
during they met summer-GEN
'They were seeing each other during the summer.'

Third, scrambling is blocked if it brings together homophonous function words (11) but allowed in otherwise identical contexts (12), an OCP effect requiring phonological identity.

(11)* *Tomu* [tomu čolovikovi]$_a$ vona ne mogla dovirjaty t_a
that's.why that-GEN man-GEN she not could trust-INF
'That's why she couldn't trust *that man*.'

(12) *Tomu* [*tij* žinci]$_a$ vona ne mogla dovirjaty t_a
that's.why that-GEN woman-GEN she not could trust-INF
'That's why she couldn't trust *that woman*.'

These facts show that phonology plays a direct role in how scrambling works in Ukrainian.

Sekerina (1997) distinguishes *split scrambling* (moving less than an XP) from *XP-scrambling* (moving a full XP). We claim for Ukrainian that

- *split-scrambling* is movement of ω,
- *XP-scrambling* is movement of φ, and that
- scrambling is completely phonological and makes no reference to anything syntactic.

Following recent work on phonological movement (Agbayani & Golston 2010; Agbayani et al. 2015; Bennett et al. to appear) we argue that ω and φ in Ukrainian are scrambled within a purely prosodic tree *after* all syntactic structure has been converted into prosodic structure. This eliminates the need for a pragmatic component that can permute word order after syntax (Kallestinova 2007).

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Specific Exceptions Driving Variation: the case of spirantization in Modern Hebrew

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Spirantization in Modern Hebrew has high levels of variation in its acquisition and production largely due to the high frequency of exceptions (Adam 2002). In this paper, we report the results of an experiment examining variation in the production of Modern Hebrew Spirantization (MHS) in real and nonce verb paradigms, linking the patterns of variation to specific exceptions that are encoded in the orthography.

Spirantization in Modern Hebrew is characterized by the alternation of the stops [p], [b], and [k] with [f], [v], and [χ], respectively. Fricatives generally occur in post-vocalic position and stops occur elsewhere. This alternation is especially noticeable in verbal paradigms where a specific segment within a root may occur in different syllable positions, as in (1).

(1) Spirantization distribution in Modern Hebrew

	Root	Infinitive	3rd Person Sg. Past.m.	Gloss
[f] ~ [p]	/**p**gʃ/	[li**f**goʃ]	[**p**agaʃ]	'meet'
[v] ~ [b]	/**b**gd/	[li**v**god]	[**b**agad]	'betray'
[χ] ~ [k]	/**k**tb/	[li**χ**tov]	[**k**atav]	'write'

However, there are exceptions to the distribution of spirantization in Modern Hebrew. Exceptional segments are non-alternating [p], [b], [k], which surface as stops in post-vocalic position, and [f], [v], [χ], which surface as fricatives in non-post-vocalic context, as in (2), often for historical reasons.

(2) Exceptions to spirantization in Modern Hebrew

	Root	Infinitive	3rd Person Sg. Past.m.	Gloss
/k/ (< *q)	/**k**rʔ/	[li**k**ro] (*liχro)	[**k**ara]	'read'
/v/ (< *w)	/**v**tr/	[le**v**ater]	[**v**iter] (*biter)	'give up'

In some cases, the difference between alternating and non-alternating segments is encoded orthographically. Namely, the exceptional labial fricative and both the exceptional velar fricative and stop are represented with a different grapheme than their alternating counterparts. The high frequency of exceptions to MHS in the modern lexicon has led to the acceptability of non-alternation in segments that ought to alternate (Adam 2002), as well as to a delay in the mastery of the language's phonological system – whereas cross-linguistically, phonological mastery is attained by the age of 6, Modern Hebrew speakers do not do so until the age of 12. Since conformity to spirantization is encoded in the orthography, it is suggested that the delay in phonological mastery may rely on literacy (Ravid 1995).

In a perception experiment, Temkin Martinez (2010) found that the segment's word position had a significant effect on the acceptance of variants of the segments, with the unexpected variant in post-consonantal position being more pervasive than variants in other positions (i.e. [lik**v**or], with a post-consonantal fricative was more likely thank [ka**b**ar] with a post-vocalic stop). Additionally, her rating task results showed that low levels of variation in exceptional forms are also acceptable, though at much lower rates than the alternating segments, which had not been attested previously, and is not typical for exceptions (Becker 2009).

In the current production study, 48 native speakers of Modern Hebrew participated in a sentence-completion task containing either real or nonce verbs. Each sentence was presented to participants aurally and contained a verb in the first part of the sentence. Participants were instructed to complete the second part of the sentence using the correct inflection for the verb they heard initially. Verbs were inflected so that the target segment's position would be different in the first and second sentences, as illustrated in (3).

(3) Sample target sentence

[dani	ohev	*levagel*	dvarim.	Amru	li	ʃeʔetmol	hu ______]
Danny	loves to	*NONCE*	things.	Told	to me	that yesterday	he ______

'Danny loves to NONCE things. I've been told that yesterday he______'

In the case of nonce verbs, segments in the first instance of the verb were placed in a position that conformed with the distribution in (1) so that participants would find it ambiguous as to whether the segment was supposed to alternate. Therefore in (3), participants could perceive the [v] in [levagel] as alternating, opting to produce the expected [bigel] or variant [vigel], or they can perceive it an exceptional segment and opt to not alternate it, producing [vigel].

A total of 32 nonce verb roots and 44 real verb roots were used. In sentences containing nonce verbs, after completing the sentences verbally, participants were prompted to provide their perceived orthographic representation for the nonce root. This task aids in our ability to determine whether participants intended for the produced form to be the variant of the alternating or exceptional underlying forms. For example, in (3), the production of [vigel] paired with the orthographic representation for the alternating segment would indicate that the participant didn't alternate the segment but intended for it to be a variant of the alternating form.

Results show that variation patterns in the production of both real and nonce verbs matched those reported in Temkin Martinez (2010), with the highest variation present in post-consonantal position. However, unlike previous results, real verbs containing exceptional segments did not show a significant level of variation. In nonce verbs, when participants produced non-alternating segments, they preferred to use the orthographic representation correlating with exceptionality, but there were also high rates of use of the alternating segments, indicating significant levels of variation in alternation. Additionally, in nonce verbs, patterns indicate higher instances of non-alternation when the verb presented aurally contained a labial fricative or a velar, indicating that participants prefer to not alternate sounds that have a different orthographic representation for their exceptional and alternating iterations. These results indicate that preferences for non-alternation were affected not by the high frequency of exceptions to spirantization in general, but were most prevalent in the segments whose exceptionality was encoded in the orthography.

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Sign Language Phonetic Annotation meets *Phonological CorpusTools*: Towards a sign language toolset for phonetic notation and phonological analysis

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Adequately representing data is challenging even for spoken languages, but in the field of sign language research this task proves to be one of the hardest nuts to crack. In the few decades that sign languages have been subject to linguistic research, several attempts have been made to create a written notation system for handshapes, such as Stokoe's (1960) Notation; the Hamburg Notation System, or HamNoSys (Prillwitz et al. 1989); and the Prosodic Model based transcription (Eccarius and Brentari 2008), among others. Though adequate for some purposes, those notation systems are inadequate for representing phonetic data or in phonological studies, especially for cross-linguistic studies (see Hochgesang 2014 for a detailed evaluation of the above systems). Recently Johnson and Liddell (2010, 2011a, 2011b, 2012) addressed this problem by proposing a notation system of hand configurations that aims to be as exhaustive as possible. We follow Hochgesang 2014 in calling this system Sign Language Phonetic Annotation, or SLPA. Johnson & Liddell argue that even though only linguistically relevant information should be included in a notation system, it is probably necessary to start with more information and reduce the description as certain phenomena are found not to be linguistically relevant. As a result, this system is too exhaustive, requiring between 23 and 33 symbols for each possible handshape, and capturing handshapes that are implausible in terms of being linguistically meaningful, either because they are perceptually nondistinct despite being anatomically different or because they are anatomically impossible to produce. Consequently, while allowing for an extraordinary amount of phonetic detail, it is too hard to capture patterns and make generalizations with this notation system, even the basic ones such as allophonic variants of the same phoneme.

We discuss three ways of simplifying SLPA in order to make it more linguistically relevant without losing valuable phonetic detail. First, the annotation should not include any of the anatomically impossible handshapes--these are analogous to the shaded boxes on an IPA chart. For example, Ann (2000) explains patterns in sign language handshapes in terms of hand muscle structure. There are separate extensor and tendon muscles for the index finger and the little finger, which allow them to extend independently; but in order to extend either the middle finger or the ring finger, a shared by all fingers extensor muscle has to be applied, while other muscles simultaneously flex the rest of the fingers. This means that when either the middle finger or the ring finger is fully extended, the rest of the fingers cannot be fully flexed, and therefore all the denotations of such forms with the rest of fingers fully flexed should be eliminated. Second, redundant handshape representations should be merged. For example, in order to flex distal joints the medial joints have to be flexed first; therefore, the representations that distinguish between cases where both the medial and the distal joints are flexed and cases where the distal joints are flexed but the medial joints are extended or hyperextended should be merged. And third, determining which types of handshape differences are perceptually nondistinctive will help to reduce the number of unnecessary phonetic details and make finding phonological patterns easier. As signers tend to look each other in the face during a signing conversation, the handshapes that are below the face area are perceived with peripheral vision which is not very sensitive to fine details, and therefore many handshapes that are anatomically different are not perceived as distinct from each other (Siple 1978). Distinguishing such forms in the notation system is likely to obscure linguistic analyses rather than elucidate them. Adopting these three kinds of changes will make phonological analysis of handshape easier in general, but will also have the benefit of making computational approaches to such analysis feasible. In particular, we will demonstrate how the revised SLPA system will allow corpora of phonetic handshapes to be imported into the *Phonological CorpusTools* software (PCT; Hall et al. 2015). PCT allows researchers to make fast, replicable analyses of various phonological patterns, such as the predictability of distribution and functional load of phonological units (e.g., for determining which units are contrastive vs. allophonic in a language) and the similarity of phonetic or phonological strings (e.g., for use in calculating neighbourhood density). By creating a relatively fine-grained, consistently applicable, and, importantly, unicode-character-based transcription system, these same measurements can be applied to sign language corpora. This will allow both for the documentation and analysis of individual languages and also for the comparative analysis of different languages, allowing greater understanding of the physiological vs. phonological patterns in sign language handshape.

We will give some illustrative examples of the revised SLPA and of the PCT adaptation of the revised system, as well as initial examples of PCT-based analyses of corpora of handshape inventories from different sign languages.

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The Phonology of Contrastive Focus in Standard Colloquial Assamese

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In this paper we discuss how Contrastive Focus (in the sense Zubizarreta (1998), Selkirk (2002) and Kratzer (2004) used the term) is realised prosodically in Standard Colloquial Assamese (SCA henceforth), which is an eastern Indo-Aryan language (Goswami, 1982).

In SCA, Contrastive Focus (CF henceforth) is obligatorily marked by prosodic phrasing and final lengthening. The post-focal constituents behave as a single dephrased prosodic constituent, which lacks a pitch accent; the F_0 curve drops gradually through the dephrased part until the last syllable of the Intonational Phrase (IP henceforth) due to low IP boundary tone (L%). The phrasing of the pre-focus constituents remains phonologically undisturbed. However, if CF splits a two worded P-phrase by highlighting the second word, the first word forms a separate P-phrase. The paper discusses the results of an experiment designed to investigate the phonetic and phonological cues to CF in SCA. Compound sentences containing two declarative (SOV, head final) IPs combined by the conjunction *kintu* (but) are used in the experiment. The first IP is uttered by the speaker with wide focus and the second one with focus on the object. The latter IP is then compared with the former. In our study it is found that contrastively focused constituent constitutes a Phonological phrase (P-phrase henceforth) [‘mɔmɔta’ (proper noun)] overriding wide focus, syntactically motivated, P-phrasing [‘mɔrɔna buli’ (that threshing)]. The phrasing is marked prosodically by a pitch accent and a phrase boundary; here L* and HP.

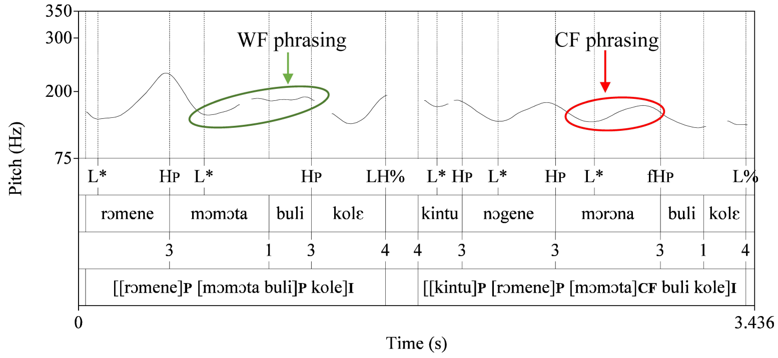

Figure 1: In the sentence ‘*rɔmene mɔmɔta buli kole kintu nɔgene mɔrɔna buli kole’* (Romen said Momota but Nogen said morona), ‘mɔmɔta buli’ (that Momota) forms a P-phrase in the1st IP (wide focus), and ‘mɔrɔna’ forms an independent P-phrase (B) in the 2nd IP (CF)

The phrasing induced by focus also exhibits phrase internal assimilation processes like /r/ deletion internally within p-phrases. /r/ deletion is compensated with vowel lengthening in SCA. These assimilation processes are blocked by p-phrase boundary. For example:

a)	[[rɔmene]P	[dɔrzar | | ɔ a	sabipat]P	[milɔnɔk]P	dilɛ]I
	Ramen.SUB	door.GEN	key.OBJ	Milan.OBJ	give.PAST
	Ramen gave Milan the door key				
b)	[[rɔmene]P	[dɔrzar]P | | ɔ r	[sabipat]P	[milɔnɔk]P	dilɛ]I

Acoustically, phrasing is manifested in terms of increased duration p<0.05 [F (1, 178) = 11.70, p= 0.00] of the focused constituent. Another phonetic cue to the phrasing of a focused constituent is the significant fall of pitch values of the immediately post focal constituent [‘*buli*’ (complementizer) in (B)]. The F_0 contour starts at the same level in ‘*buli*’ (F_0-onset, p>.05 [F (1, 237) = 1.67, p=0.19]) in both the focus conditions (wide & contrastive). However, the F_0-offset of the word in wide focus condition displays a significantly higher pitch value compared to when it is the immediate post-focal constituent (F_0-offset, p<0.05[F (1, 237) =174.06, p=0.00]) where the pitch drops smoothly. In the paper it is argued that in SCA, CF is phonologically marked in terms of phrasing and phrase internal deletion processes. Further, from an acoustic point of view, more than pitch increase on the focused constituent, it is the pre- and post-focal compression which is suggestive of the prominence of the focused item.

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Guttural Semi-Transparency

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Studies of transparent gutturals in vowel copy harmony have had important ramifications for theories of segment and syllable structure (McCarthy 1994, Rose 1996, Hall 2006). The class of gutturals typically consists of laryngeals, pharyngeals and uvular fricatives. This paper focuses on guttural 'semi-transparency', namely, patterns that display transguttural copy harmony where gutturals show some interaction with vowels in the process. Key properties are that (i) gutturals can influence the quality of the vowels that assimilate across them, and (ii) laryngeal and supralaryngeal gutturals may pattern differently within a language with respect to transparency and influence on vowel quality. We argue that guttural semi-transparency is best understood in terms of the phonetics of gutturals, which informs the phonological analysis.

The potential for gutturals to influence neighboring vowels is well-known. Under focus here is their capacity to do so even when they do not block vowel copy across them. In Jibbāli (Semitic, Hayward et al. 1988), vowels flanking a guttural are identical (1a). Gutturals cause neighboring unround vowels to lower (1b). The lowered quality is present in both vowels in VGV copy sequences (1c) (G = guttural).

(1) a. /j-deħɔs/ → jĭdɔ̱ˈħɔs 'annoy somebody' IPFV
no harmony: /j-fek'ɔr/ → jĭfe̱ˈk'ɔr 'become poor' IPFV
b. /j-ʁdɔl/ → jă̱ʁˈdɔl 'carry on one's back' 3MS.SBJV
c. /deħes/ → da̱ˈħa̱s 'annoy somebody' PRF

Laryngeal and supralaryngeal gutturals can show different degrees of transparency and interaction with vowels. In Gitksan (Tsimshianic, Yamane-Tanaka 2007), copy harmony to an unstressed inserted vowel regularly operates across a laryngeal (2a), but it vacillates across a supralaryngeal guttural (uvular) (2b). Elsewhere harmony does not occur, e.g. [ˈwagi̱'j] 'my (man's) brother'.

(2) a. sɪˈsɛʔɛ̱'j 'my feet' ˈtsaʔa̱'j 'my eyes (face)'
b. ˈbɛːχɛ̱'j ~ ˈbɛːχa̱'j 'my lungs'

In Jibbāli, supralaryngeal gutturals cause lowering and backing of a neighboring unround vowel to [a] (1b–c). However, [h] – the only phonemic laryngeal – causes lowering without backing: /leheθ/ → [lɛˈhɛθ] 'pant' PRF.

We propose that semi-transparency of gutturals is related to their articulation. Gutturals lack contact on the upper surface of the vocal tract and involve lesser jaw control than nonguttural (oral) consonants (Goldstein 1994, Lee 1994), which facilitates cross-guttural vowel copy. Among the gutturals, laryngeals impose the least jaw and lingual control, but they can influence vowels through synergistic relations, as can other gutturals (Moisek 2013). The generally weaker interference of laryngeals with vocalic articulations is consistent with the patterns of guttural differentiation.

The phonetics of gutturals informs the phonological analysis. Nonguttural (oral) consonants (O) exhibit greater influence on vowels' articulation in the oral cavity (superior to oropharynx) than supralaryngeal gutturals (G^S), which in turn do so more than laryngeal gutturals (G^L). This forms the basis for a harmonic ordering that gives rise to the constraint hierarchy in (3a), where V_x's represent identical vowels with shared specification overlapping the consonant. (Further subcategorization in O obtains coronal transparency; Paradis & Prunet 1989.) The harmony-driver is expressed as a sequential prohibition in (3b) (Pulleyblank 2002), with participation of the consonant in harmony enforced by locality (Ní Chiosáin & Padgett 2001). On the other hand, gutturals' post-velar articulations and their synergies favor lowering and backing of vowels in their context, as enforced in the phonology by constraints like those in (3c).

(3) a. $*V_xOV_x >> *V_xG^SV_x >> *V_xG^LV_x$ Features of V_x are continuous in the sequence.
b. $*V_xCV_y$ $V_x \neq V_y$ in quality, C = any consonant.

c. $*V_{[-\text{low}]}/G$, $*V_{[+\text{high}]}/G$, $*V_{[-\text{back}]}/G$

An overview of the typological predictions is given in (4). The harmony driver (in bold) is assumed to dominate faithfulness and markedness constraints for the assimilating vowel qualities in these patterns. It is noteworthy that copy harmony frequently targets vowels that are inserted, affixal or short, contexts where faithfulness to vowel quality is exempt or less strictly enforced.

(4)	**Ranking**	**Pattern**	**Ex. Language**
Copy harmony	$\mathbf{*V_xCV_y}$ >> $*V_xOV_x$ >> $*V_xG^SV_x$ >> $*V_xG^LV_x$	V copy across all Cs	Servigliano dialect
	$*V_xOV_x$ >> $\mathbf{*V_xCV_y}$ >> $*V_xG^SV_x$ >> $*V_xG^LV_x$	V copy across all Gs	Jibbāli
	$*V_xOV_x$ >> $*V_xG^SV_x$ >> $\mathbf{*V_xCV_y}$ >> $*V_xG^LV_x$	V copy across G^L's only	Gitksan (nonvacillating)
Vowel lowering	$*V_{[-\text{low}]}/G$ >> Faith	Vs are low adjacent to G	Jibbāli
	$*V_{[+\text{high}]}G$ >> Faith	Vs are [–high] before G	Tiberian Hebrew (short Vs)

Vacillating harmony across uvulars in Gitksan is obtained by variable ranking of $*V_xG^SV_x$ and $*V_xCV_y$. Transguttural vowel assimilation and lowering may both be enforced, as in Jibbāli. For Jibbāli, lowered vowels back to [a] next to gutturals except [h] via the constraint $*V_{[-\text{back}]}/G^S$.

Guttural semi-transparency is challenging for accounts where gutturals behave as transparent to vowel copy by virtue of lack of specification or lesser markedness. If gutturals lack the spreading node in copy harmony and are thus skipped (McCarthy 1994, Rose 1996), then the guttural's influence on vowel quality is unexpected, or multiple features that affect vowel height are required, located in different places in the geometry. An alternative treats [pharyngeal] as the least marked place feature and best able to cooccur with vowel place (Gafos & Lombardi 1999). Yet a scale based in place-markedness does not predict gutturals' effect on vowel height, as triggering of assimilation is diagnostic of a marked feature value (de Lacy 2006). Also, the potentially distinct behavior of laryngeals escapes the place-markedness account, since [pharyngeal] is posited to be present in all gutturals (Lombardi 2001).

An alternative articulatorily-informed account considers at least some copy vowels to be intrusive gestures; they do not form phonological segments or a syllable nucleus (Hall 2006). Yet this approach is not sufficient for the range of guttural transparency phenomena, because not all copy vowels can be considered intrusive. Some affected vowels are underlying rather than inserted, as in Jibbāli, and some affected inserted vowels show evidence of phonological visibility (Iraqw, van der Hulst & Mous 1992; Tiberian Hebrew, Prince 1975). In Iraqw, an inserted vowel that is usually realized as [i(:)] may be tone-bearing and alternate in length (5a), indicating that it is phonologically visible and syllabic, and hence not an intrusive gesture. This vowel undergoes copy harmony across a guttural (5b).

(5)	a.	aː xaɬí̲t	'she kept quiet'	aː xaɬí̲ːt	'he kept quiet'
	b.	tuʕu̲ːm	'uproot' DUR	ufaħa̲ːm	'blow' DUR

In sum, gutturals can show semi-transparency effects, with the potential to affect vowel quality and for laryngeal and supralaryngeal gutturals to behave differently. The phonetics of gutturals sheds light on these patterns. A phonological analysis informed by the production of gutturals makes better-fitting typological predictions than previous accounts.

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Morphoprosodic structure and categorization in Blackfoot nominals

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Overview

This paper concerns the internal morphoprosodic structure of words in a polysynthetic language. I present evidence from Blackfoot (Algonquian) that uncategorized $\sqrt{}$ROOTS in the sense of Distributed Morphology (Marantz 1997) are mapped to Prosodic Roots, while categorized morphemes (such as English 'bare roots') are mapped to Prosodic Stems. In other words, prosodic structure is sensitive to syntactic categorization. The evidence comes from a domain-sensitive process of velar assibilation (/k/ → [k^s]) which occurs across the boundary of a noun-noun compound, but not across the boundary between a $\sqrt{}$ROOT and a noun. One consequence of my account is a more direct mapping between prosodic and syntactic structures which treat $\sqrt{}$ROOTS as distinct from categorizing heads (e.g. n^0, v^0).

Problem

There are two types of velar stops in Blackfoot: a voiceless unaspirated [k] ('plain [k]'), and a voiceless unaspirated assibilant [k^s] (Derrick 2007; Frantz 2009). Their distribution partially overlaps morpheme-initially and morpheme-medially, but is predictable morpheme-finally for at least some types of morphemes. In particular, the Blackfoot dictionary contains no instances of a [k^s]-final modifying prefix or noun (Frantz and Russell 1995).

All /k/-final nouns also have a [k^s]-final allomorph which occurs when the noun is the first part of a compound. For instance, *stamik* 'steer' is shown in (1) followed by inflectional suffixes, where the final /k/ surfaces as [k]. In (2), *stamik* 'steer' is the first noun in a noun-noun compound, and the final /k/ surfaces as an assibilant [k^s]. Crucially, this assibilation is not due to phonological context. Example (3) shows that a /k/ at the right edge of a modifying prefix *pa'ksik-* 'mud' does not assibilate, although it stands in the same phonological context as in (2).

(1)	SIMPLEX N	(2)	N_1+N_2 COMPOUND	(3)	MODIFIER + N_2
	stá.mi.ka		stá.mi.**k^s**ɔː.óʔ.si.ni		paʔ.k^{s}i.**k**ɔ́ː.óʔ.si.ni
	stami**k**–a		stami**k**–aoo'ssin–i		pa'ksi**k**–aoo'ssin–i
	steer–AN.SG		steer–berry.soup–IN		goopy–berry.soup–IN
	'steer'		'beef stew'		'thick soup'

Previous analyses of /k/-assibilation assume that assibilation, when it occurs, is triggered by an immediately following [i] (Armoskaite 2006; Frantz 2009). However, compounds in Blackfoot do not contain an *i* at the boundary between the two nouns. I take this as evidence that assibilation within compounds is conditioned solely by structure.

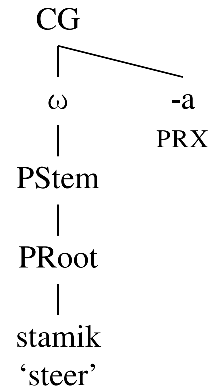
Solution

I propose that the difference between nouns like *stamik* 'steer' in (2) and modifiers like *pa'ksik-* in (3) is that nouns are categorized in Blackfoot while modifiers are uncategorized $\sqrt{}$ROOTS. Evidence for this is that nouns can occur immediately before inflectional suffixes, as in (1), while modifiers cannot (4a). Instead, to be a well-formed stem, they must first be categorized by combining with either a nominalizing suffix like *-itapi* 'person' (4b), or a verbalizing suffix like *-ii* STAT (4c) (where *ohpok-* is an allomorph of *pok-*).

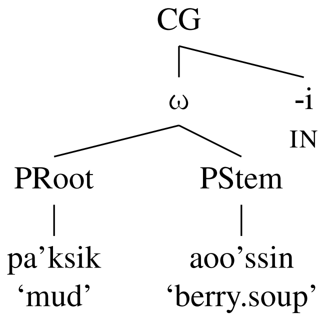
(4) a.	*po.k$^{(s)}$i.k^{s}i	b.	po.ki.tá.pɛː.k^{s}i	c.	iː.^{h}po.kíː
	pok–iksi		pok–itapi–iksi		ohpok–ii–wa
	small–AN.PL		small–AN.PL		IC\small–STAT.II–3
	Intended: ‘the small ones’		‘small persons’		‘it is small’

Consequently, modifiers map to a Prosodic Root (PRoot), while nouns map to a PRoot contained within a Prosodic Stem (PStem) (Inkelas 1989; Nespor and Vogel 2007). A phonological rule assibilates /k/ → [k^{s}] at the right edge of a PStem, unless the right edge of the PStem coincides with the right edge of a Prosodic Word (ω). This is demonstrated in (6), (7), and (8) below. The /k/ in *stamik-a* ‘steer’ in (6) does not assibilate because although it is at the right edge of a PStem, it is also at the right edge of ω. The /k/ in *pa’ksik-* ‘mud’ in (7) also does not assibilate, because it is not at the right edge of a PStem. Finally, the /k/ in *stamik* ‘steer’ in (8) does assibilate, because it is at the right edge of a PStem which is not final in ω.

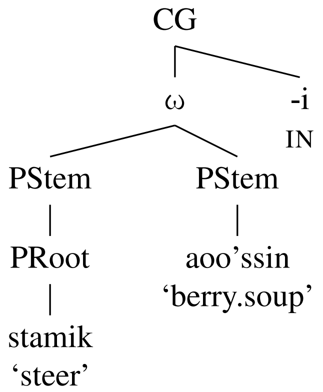
(6) ω=PSTEM



(7) ω=PROOT+PSTEM



(8) ω=PSTEM+PSTEM



Consequences

There are several consequences of this account for both Blackfoot and the prosody-syntax interface in general. Regarding Blackfoot, this data shows that (a) some instances of [k^{s}] are caused by structure, and not simply by assibilation of /k/ before [i], and that (b) we expect other phonological processes to show sensitivity to these domains. Regarding the prosody-syntax interface, this account suggests that word-internal morpho-prosodic domains may be definable by syntactic structure and elements. For instance, in a Distributed Morphology framework (Marantz 1997), PRoots map to √ROOTs, while PStems map to categorized roots (e.g. *nP* in this case).

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A voicing asymmetry in nonnative cluster epenthesis: perception vs. production

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Introduction. A long-standing goal of research on sound systems is to understand the phonetic bases of phonological patterns (e.g., Ohala, 1983; Flemming, 1995[2002]; Blevins, 2004; Hayes et al., 2004). Many processes and static restrictions, such as consonant place assimilation (e.g., Steriade, 2001) and consonant deletion (e.g., Côté, 2004) as well as the distribution of voicing and other features (e.g., Steriade, 1997; White, 2014), have been shown to mirror perceptual similarity relations. Vowel epenthesis into a consonant cluster is also perceptually grounded: epenthesis is more frequent when there is a strong 'perceptual break' between the two consonants (e.g., Fleischhacker 2005; Zuraw, 2007).

On the basis of evidence from a previous study of nonnative cluster production, and new perceptual identification results collected for the same clusters, we argue that speech production makes an independent contribution to detailed epenthesis patterns. Spoken and identification responses are sensitive to many of the same properties, but only speech production shows a strikingly higher rate of epenthesis into clusters that begin with a voiced stop (e.g., /bn/ vs. /pn/).

Production study. As previously reported in Wilson et al. (2014), English speakers (N=24) listened to and produced CCVCV nonwords beginning with a range of nonnative consonant clusters, including stop-nasal and stop-stop clusters of interest here (e.g., /km/, /gm/, /kp/, /gb/). Several coders analyzed waveforms and spectrograms to identify instances of epenthesis (77% of all errors) and other modifications. The most extreme finding was that clusters beginning with *voiced* stops showed higher rates of epenthesis (46% of all responses) than those with initial *voiceless* stops (only 21%). Additionally, epenthesis was more frequent for *stop-nasal* clusters than for *stop-stop* clusters (37% vs. 30%), an anti-sonority-sequencing pattern that has been replicated in similar experiments (e.g., Davidson, 2010). Epenthesis rate also tracked the *release duration* of the initial stop release (20ms: 44% epenthesis responses vs. 50ms: 52% epenthesis).

Identification studies. The effects found previously could reflect asymmetries in perceptual epenthesis across clusters (e.g., Berent et al., 2007) or arise in the speech production process. Two new perception experiments, conducted on Mechanical Turk, sought to distinguish these possible phonetic origins. In Experiment 1, English-speaking participants (N=90) completed a forced-choice identification task on exactly the same stimuli used in the production study. On each trial four options were presented in pseudo-English orthography, representing the target nonnative cluster, epenthesis, prothesis, and deletion or one-feature change of the initial stop (e.g., *bdazo*, *bedazo*, *ebdazo*, *dazo*/*gdazo*). The arrangement of response options was randomized across participants. The entire stimulus set was divided into lists of 28 items; each list was used for two participants and contained a balance of cluster types and release durations. The lists also included filler items beginning with CəC and əCC sequences consonants matched to the critical clusters. The fillers elicited very high accuracy in the production study; in the present experiment they provide a measure of participants' ability to perform the web-based identification task.

The results of Experiment 1 and those of the production experiment were combined into a single data set and submitted to a mixed-effects logistic regression with epenthesis as the binary dependent variable. Note that the prothesis and deletion/feature change response options were chosen infrequently (< 5% of total responses each), justifying a focus on the epenthesis repair. Rate of epenthesis was significantly influenced by cluster type (SN > SS; $\beta = 0.76$, SE = 0.19, $p < .001$), cluster voice (vcd > vcl; $\beta = 1.07$, SE = 0.20, $p < .001$), and release duration (20 ms > 50 ms; $\beta = 0.70$, SE = 0.10, $p < .001$). There was one significant interaction, which indicated that the voice effect differed in the two studies (β = 2.03, SE = 0.24, *p* < .001).

Subsequent analysis of the results from Experiment 1 alone indicated significant effects on epenthesis of cluster type (SN 44% > SS 34%; β = 0.76, SE = 0.21, *p* < .001) and release duration (longer 44% > shorter 33%; β = 0.89, SE = 0.16, *p* < .001)—but *no effect of cluster voice* (vcd 38.7% ≈ 39.2% vcl; *p* = .89), contrary to the strong asymmetry in the production experiment. The disparity with production cannot be due to difficulties in performing the transcription task: the SN vs. SS and release duration effects were found in both experiments, and furthermore the identification of filler items was quite accurate (> 93% correct).

A second identification experiment was performed to ensure replicability of these findings and control for possible strategic effects. Experiment 2 contained the same critical items, but there were more fillers per list (20/36 items) and the set of fillers included items that matched the deletion and change (as well as epenthesis and prothesis) response options. The results confirmed the interaction of response type (production vs. identification) and voice (β = 1.87, SE = 0.20, *p* < .001) and the absence of a significant voice effect in identification (*p* = .72).

Discussion. This pattern of findings supports a modular account of nonnative cluster processing in which perception, phonology, and production make separable contributions. The release duration effect plausibly results from a combination of perceptual similarity—longer transitions between consonant closures are more acoustically consistent with a reduced vowel—and phonological bias against nonnative clusters. Perhaps the greater epenthesis rate on SN clusters has a similar source, with nasal formants (cf. oral stop closure) being misparsed as vocalic material. However, the effect of voice appears to emerge downstream, in production: all stop-initial nonnative clusters are subject to error in gestural timing (Davidson, 20006); an interval of inaccurate vocal tract opening that is accompanied by voicing is more likely to produce vowel-like formant structure. Preliminary simulations with an articulatorily-based synthesizer are consistent with the idea that equivalent levels of gestural mistiming can lead to clearer formant structure after voiced (vs. voiceless) stops. Our results converge with previous experiments that have not found voicing asymmetries in perceptual tasks (e.g., Davidson & Shaw, 2012). They also provide a novel type of evidence for restrictive theories (e.g., Steriade, 1997; Lombardi, 2001) according to which the [voice] feature cannot participate in conditioning vowel epenthesis within the phonological component. The perceptual grounding and phonological triggering of vowel epenthesis appear to be restricted to supralaryngeal properties.

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Neutralization avoidance and naturalness in the learning of palatalization

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Previous researchers have appealed to a neutralization avoidance constraint in analyses of phonological patterns (e.g. Flemming, 2004; Padgett, 2009), raising the possibility that learners are biased against neutralizing alternations. Furthermore, typological studies indicate that there is a cross-linguistic tendency for languages to suppress neutralization, especially when it would increase the level of homophony (e.g. Silverman 2010). We tested whether learners indeed have a bias against neutralization in an artificial language learning task.

Native English speakers (n=30) learned four novel alternations involving palatalization [t, d, s, z] ~ [tʃ, dʒ, ʃ, ʒ] in an artificial language. In the exposure phase, participants heard pairs of singular-plural nonce forms. Each trial consisted of an auditory CVCVC form (accompanied by a singular picture) followed by the corresponding CVCVC-i form (accompanied by a plural picture), e.g. [tusut]…[tusutʃi]. The final C of the singular form was the target sound, and the plural suffix *–i* provided the trigger for the palatalization. For half of the participants (Language A), the exposure also included singular forms with final non-changing [tʃ] and [dʒ], e.g. [tusutʃ]…[tusutʃi], making the [t, d] ~ [tʃ, dʒ] alternations neutralizing. To enhance the neutralizing nature of the alternations, we included cases of singular minimal pairs that became homophonous in the plural (e.g. singular [tusut] and [tusutʃ], both [tusutʃi] in the plural). For the other half of participants (Language B), the exposure instead included singular forms with final non-changing [ʃ] and [ʒ], making the [s, z] ~ [ʃ, ʒ] alternations neutralizing. Thus, all participants learned the same four alternations, [t, d, s, z] ~ [tʃ, dʒ, ʃ, ʒ], but which alternations were neutralizing varied between the two groups. This counterbalancing measure ensured that any differences observed in learning were due to whether the alternations are neutralizing or non-neutralizing, rather than something inherent to the alternations themselves. In all, the exposure consisted of 48 trials (16 alternating [t, d, s, z], 8 non-alternating [tʃ, dʒ] or [ʃ, ʒ] depending on group, and 24 non-alternating fillers ending in [p, b, k, g, f, v]).

In the following test phase, participants completed a forced-choice task consisting of a mix of trained and novel items. After hearing the singular form (e.g. [dazat]), participants were presented with two plural options, a changing option ([dazatʃi]) and a non-changing option ([dazati]). They had to choose the correct plural option by pressing a button.

The results were analysed using a logit mixed model, with fixed effects for Trial Type (Neutralizing vs. Non-neutralizing), Group (Language A vs. Language B), and Training (Old vs. Novel); we used a maximal random effects structure. Crucially, the main effect of Trial Type was significant (z = 3.25, p = .001): participants had lower accuracy on Neutralizing trials (61.1% correct) compared to Non-neutralizing trials

(71.7% correct), see Figure 1. The Trial Type by Group interaction was non-significant (*p* = .89) and was not justified in the final model, indicating that accuracy was lower for Neutralizing trials in both exposure groups.

These results show that the very same alternations were harder to learn if they resulted in neutralization compared to when they did not result in neutralization, even though both types of alternations were equally represented in the input. Our findings are consistent with the hypothesis that learners have a universal bias against alternations that neutralize contrasts. Such a bias could play a role in shaping language change.

A second noteworthy aspect of our results is that among the filler sounds, participants were significantly more likely to err in choosing the palatalized option for [k, g] (41.1% [tʃ, dʒ] chosen in error) than for [p, b] (26.4% [tʃ, dʒ] chosen in error), see Figure 2; the effect of Place (Velar vs. Labial) was significant ($z = 3.57, p < .001$). The fact that participants spontaneously palatalized velars more often than labials (in spite of their training) suggests a naturalness bias (e.g. Wilson 2006). Cross-linguistically, palatalization of velars before high vowels is common (Guion 1998), whereas palatalization of labials is less common.

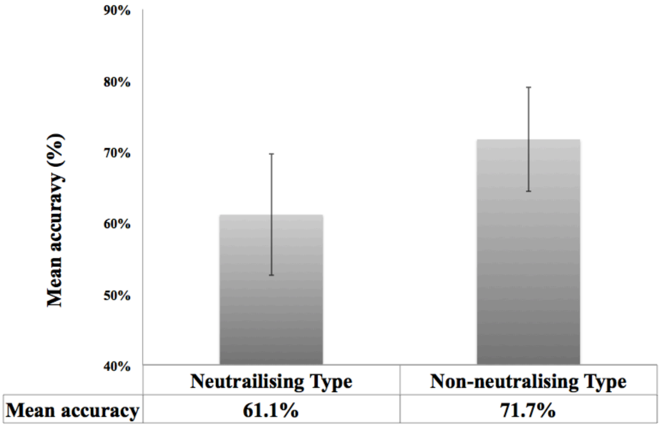

Figure 1. Percentage of test trials in which participants correctly chose the palatalized plural form (+/– 1 SE).

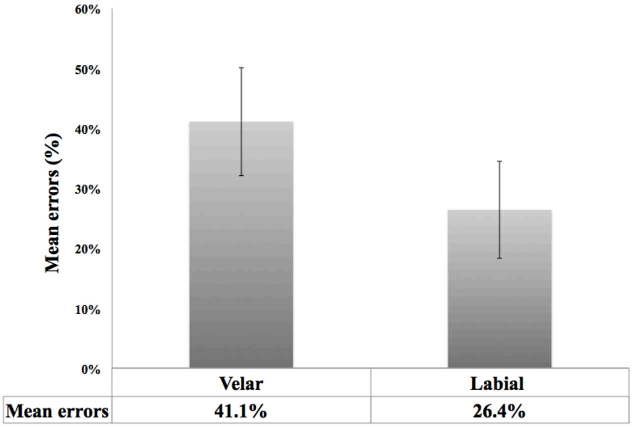

Figure 2. Percentage of filler trials in which participants incorrectly chose the palatalized plural form (+/– 1 SE).

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(In)complete flapping through polysyllabic shortening in English

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Recent studies have shown that not only does the applicability of phonological rules vary but also their realization is gradient (English flapping: Eddington and Elzinga 2008). Unlike this trend, the present study reports an interesting counterexample that the application of English flapping is categorical in production, endorsed by the substantial confusability of flapped words with underlying intervocalic /t/ and /d/ in identification task. Fox and Terbeek (1977) show that duration of a flap consonant does not differ in the flapped words (‘wr**i**[ɾ]ing’ vs. ‘r**i**[ɾ]ing’), but duration of the preceding vowel is significantly different. They suggest that the flapping rule follows the vowel lengthening induced by word-final voiced /d/. Additionally, Steriade (2000) shows an invariant allophonic [ɾ] across morphologically related words (Phonetic Uniformity paradigm: *cápit[ɾ]al*, *capit[ɾ]alístic*), whereas Riehl (2003) presents contradictory findings against phonetic paradigm for a flap. Given that, this study investigated whether flapping is incomplete in contemporary English with respect to a multitude of acoustic correlates of flaps in view of both production and word recognition, and attempted to testify to phonetic uniformity by exploring whether phonetic properties of underlying /t, d/ are preserved in the flapped words.

Fifteen native English speakers participated in a reading task with 24 minimal pairs of word-final /t, d/ words (e.g., ‘bead’ vs. ‘beat’) and 24 minimal pairs of (flapped) words (e.g., ‘beading’ vs. ‘beating’) as exemplified in (1). Additionally, word identification tests were conducted with eight English speakers with two types of listening stimuli: (i) the whole word recognition (‘beating’ vs. ‘beating’) and (ii) the 1st syllable recognition (audio input [bea] in ‘beating’ vs. [bea] in ‘beading’).

(1)

a. underlying voicing contrast		b. flapped words with underlying /t, d/	
*bea**d***	*bea**t***	*bea**d**ing*	*bea**t**ing*
*see**d***	*sea**t***	*see**d**ing*	*sea**t**ing*
*be**d***	*be**t***	*be**dd**ing*	*be**tt**ing*

First, as for production, we replicated the striking differences in the phonetic correlates of word final voicing contrast (2). There were significant differences in duration of the preceding vowel, duration of stop closure, duration of voicing during closure, and the rates of stop burst release. However, these contrasts were incompletely neutralized in flapped words as in (3). Specifically, there were significant differences in duration of the preceding vowel, flap closure duration, and duration of voicing perturbation whereas no differences were found for VOT and F0 of the preceding vowel.

(2) Phonetic correlates of word final voicing

UR cons.Type	Dur. of prec. V (ms.)	Stop clos.dur.(ms.)	Voicing dur.(ms.)	% of stop burst
/t/ words (*write*)	146	100	3.0	65
/d/ words (*ride*)	227	54	42.4	96
	F[1,28]=76.1, p<.0001	*F*[1,27]=3217, p<.0001	*F*[1,26]=43.7,p<.0001	*F*[1,28]=9.28, p=.005

(3) Phonetic correlates of flaps

UR cons.Type	Dur. of prec. V (ms.)	Flap clo. dur. (ms.)	Voicing Dur. (ms.)	VOT (ms.)	F0 of prec.V (Hz)
/t/ words (*writer*)	115	18	18	25	161
/d/ words (*rider*)	130	25	24	15	161
	F[1,27]=8.1, p=.008	*F*[1,27]=6.3,p=.01	*F*[1,27]=6.2,p=.01	*F*[1,27]=3.8, p>.05	*F*[1,27]=.0,p>.05

These findings are, to some extent, consistent with Fox and Terbeek’ incomplete flapping in terms of duration of the preceding vowel. The results of our study provide interesting phonological implications. First, they imply that vowel lengthening seems to precede flapping in derived words with /t, d/ final bases. Of course, the duration of a vowel preceding a flap is markedly shortened in words with underlying /t, d/ to the level of short vowels, but the polysyllabic shortening does not utterly eliminate the length contrast. Accordingly, the opacity problem seems to be still alive for vowel lengthening because of keeping the trace of longer vowel of /d/ based words. In optimality theoretic approach, this opaque interaction can be solved in many ways such as OO-correspondence (V-length contrast). Secondly, the results imply that the concept of phonetic uniformity between base words and derived words might vary depending on each phonetic property). This lack of phonetic uniformity involving flap closure duration, VOT and F0 for /t/-/d/ contrast provides additional evidence challenging phonetic uniformity and against connectionist models (Seidenberg 2005).

Additionally, identification test confirms the complete application of flapping as revealed in the production mode with 24 native speakers of English. Words with final /t/ and /d/ were more accurately and rapidly identified (with accuracy 98% and RT 1.65 sec.) than those that undergo complete flapping. That is, the rates of word recognition sharply decreased for flapped words. Words with underlying /t/ were recovered at chance level, whereas those with underlying /d/ were comparatively higher (50% vs. 67%).

(4) Recoverability of underlying /t, d/ words

	/t/ final (e.g., 'write')	/d/ final (e.g., 'ride')	Words with UR /t/ (e.g., 'writing')	Words with UR /d/ (e.g, 'riding')
Accuracy (%)	98	98	50	67
Reaction time (sec.)	1.6	1.7	2.0	1.9

This difference in recoverability is interesting, considering that there were no statistically significant differences in all the phonetic properties of vowels flanking flaps in words with underlying /t/ and /d/ as seen in (5). One possible source can be located in the average duration of the vowel preceding the flap. The vowel length was slightly longer (15 ms.) before flapped words with underlying /d/ than before those with underlying /t/. Overall results indicate that native English suffer substantial difficulty in recovering words that underwent incomplete flapping unless they are assisted with the broader contexts.

(5) Acoustic properties of listening word stimuli

UR C-Type	Dur. of prec. V (ms.)	Flap dur. (ms.)	Voicing Dur. (ms.)	VOT (ms.)	F0 of prec.V (Hz)
/t/ words (*writer*)	115	20	20	14	156
/d/ words (*rider*)	123	20	20	12	163
	p>.05	p>.05	p>.05	p>.05	p>.05

Finally, it was found that when listeners were presented solely with the first syllable preceding the flapped sound, they had difficulty in recovering the whole words with underlying /t/ and /d/ as in (6) (e.g., auditory input [bi]-> choose 'beading' or 'beating'). This also indicates that absence of contrast in the length of vowel preceding the flap accounts for the greatly low degree of identifiability of flapped words.

(6) Recoverability of underlying /t, d/ words based on the 1st syllable alone

	Words with UR /t/ (e.g., 'writing')	Words with UR /d/(e.g, 'riding')
Accuracy (%)	60	53
Reaction time (sec.)	1.8	1.8

In summary, our study revealed incomplete final devoicing and incomplete flapping along with polysyllabic shortening in English, along with suggestion that phonetic paradigm uniformity is not as typical as phonological paradigms and that phonological opacity still emerges for vowel lengthening.

Selected references

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Steriade, D. (2000). Paradigm uniformity and the phonetics-phonology boundary. In J. Pierrehumbert and M. Broe (eds.) *Papers in Laboratory Phonology V: Acquisition and the Lexicon*, 313-334. Cambridge: Cambridge University Press.

Tonal suppletion as multi-modal featural affixation

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Main Claim An analysis for the allomorphy between realizing a morphological L- or H-tone in Kalam Kohistani is presented that is based on the crucial observation that realization of the H-tone is necessarily connected to vowel lengthening. The existence of such a 'multi-modal' nonconcatenative exponent that affects the tone pattern and segment length of its base follows straightforwardly in an autosegmental account that assumes floating autosegments (tones, moras) as representations for morphemes (Lieber, 1992; Wolf, 2007). **Data** The inflected form for nouns in Kalam Kohistani (=KK) is formed by adding a low tone (=L) to the final syllable for C-final nouns (1) and by realizing the whole base with a high tone (=H) for V-final nouns (2). In addition, the inflected V-final forms contain a floating L-tone that is realized on the following word (=$^{(L)}$) and undergo lengthening of the final vowel. (Additional vowel ablaut is ignored for now.)

(1) *Noun inflection: C-final*

Base	Inflected		
bóːr	bôːr	'lion'	H→HL
ʧä́róːr	ʧä́rêːr	'sparrow'	H.H→H.HL
bòbä́j	bòbä̀j	'apple'	L.H→L.L
băg	bæ̆g	'place'	LH→LH

(2) *Noun inflection: V-final*

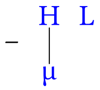
Base	Inflected		
gò	góː$^{(L)}$	'ox'	L→H(L)
dä̀ːrá	dä́ːrä́ː$^{(L)}$	'guest room'	L.H→H.H(L)
báːʧà	bä́ːʧä́ː$^{(L)}$	'king'	H.L→H.H(L)

(Baart (1999*b*):96+97, Baart (1999*a*):36)

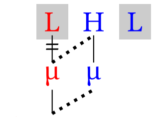
Since the distribution of these allomorphs is completely predictable given the phonological shape of the base, a purely phonological analysis is preferable that derives all surface effects from a single underlying representation for the morpheme in question. Especially since there is a minimal overlap between the surface effects of both allomorphs: an L-tone is realized on C-final nouns and an additional floating L-tone is observed for V-final nouns. The two main questions arising for such an analysis are, *first*, how the quality of the final segment (C or V) determines the choice between realizing L or H, and, *second*, why the affixed H overwrites all base tones whereas the L tone is only realized on the final TBU. And there are additional asymmetries for the realization of this L-tone on C-final bases: the affix-L sometimes results in a falling contour on the final TBU (/ʧä́róːr/ → /ʧä́rêːr/) and it sometimes 'overwrites' the final H of the base (/bòbä́j/ → /bòbä̀j/). And for some bases it remains completely unrealized (/băg/ → /băg/. **Analysis** The crucial observation is that H-tone realization for V-final nouns is always accompanied by V-lengthening as another nonlinear exponent for noun inflection. I argue that the allomorphy in KK can be predicted from the single underlying morpheme representation in (3) (a H that is associated to a μ, followed by an L) in an OT-system: **A.** High-ranked Max-μ demands realization of the affix-μ which necessarily implies realization of the affix-H associated to the μ (cf. (4) & (5)). If the affix-μ associates to the final base segment, the affix-L cannot be realized as well since it can not associate across the affix-H due to the standard concept of NoCrossing (Goldsmith, 1976); the affix-L remains floating and associates to a following word. **B.** That the affix-H then overwrites preceding base L-tones follows from *L: low tones are avoided via H-spreading if possible (cf. (5), tableau (7)). **C.** For C-final bases, realization of the affix-μ is blocked since trimoraic syllables are excluded (and codas are moraic in KK). The affix-L hence can associate to the final TBU (cf. (6), tableau (8)). That the affix-H cannot be realized in those contexts is due to its underlying association to the μ: if this underlying association cannot be deleted, any further association to another TBU results in a violation of OneRoot penalizing elements that are dominated by more than one highest prosodic node. **D.** The remaining asymmetries observed in the realization of the

L for C-final nouns follow from standard markedness and faithfulness constraints: the expected default is creation of a falling contour since this allows to realize both tones faithfully. However, this is blocked for bases with the underlying tone melody LH since the tone melody LHL is generally absent in KK (due to *LHL). And that the affix-L is realized in polysyllabic L.H→L.L but not in monosyllabic LH→LH is due to a standard positional faithfulness constraint preserving the tones of the initial syllable. **Alternatives** Under alternative accounts like word-formation rules (e.g. Anderson, 1992) or paradigmatic OT-accounts (e.g. Alderete, 2001), *first*, the implicational relation between V-lengthening and H realization in KK remains a coincidence and, *second*, the allomorphy between L and H-realization must be analysed as suppletive. An autosegmental account that allows a purely phonological analysis as the one proposed is hence to be preferred.

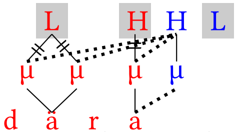
(3) *Suffix*



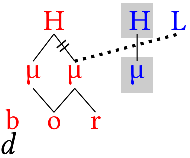
(4) *gò→góː*



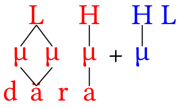
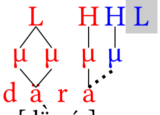
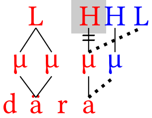
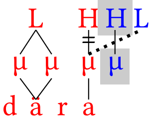
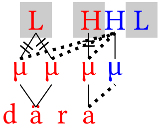
(5) *dä̀ːrá→dä́ːrä́ː*



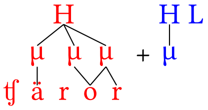
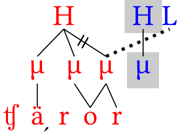
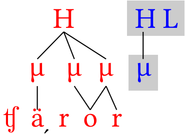
(6) *bóːr→bôːr*



(7) *V-final: Affix-μ and affix-H realized*

	No Cross	Max μ_{Af}	Max L_{Af}	*L
a.  [dä̀ːréː]			*	*!*
b.  [dä̀ːrěː]	*!			**
c.  [dä̀ːrê]		*!		**
☞ d.  [dä́ːréː]			*	

(8) *C-final: Affix-L realized*

	No Cross	Max μ_{Af}	Max L_{Af}	*L
☞ a.  [ʧä́rêːr]		*		*
b.  [ʧä́rêːr]		*	*!	

(Based on containment (McCarthy and Prince, 1995): x =non-realized element; —ǂ— =association line marked as phonetically uninterpretable; ····· =inserted association line)

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