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Seenku argument-head tone sandhi: Allomorph selection in a cyclic grammar

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Seenku (Mande, Burkina Faso) displays a complex tone sandhi system, sensitive to phonological, morphological, and syntactic structure. In this paper, I argue that the opaque, phonetically unnatural alternations are best accounted for in an allomorph selection approach, following work by Tsay and Myers (1996), Zhang and Lai (2008), and others on Taiwanese Southern Min sandhi. In this model, lexical entries contain multiple surface allomorphs along with subcategorization frames, and forms that follow the same pattern are abstracted into increasingly general lexical templates or schemas. Morphology is post-syntactic, with syntactic structure matched with lexical entries, along the lines of Distributed Morphology (Halle and Marantz 1993; Embick and Noyer 2007), but with a richer generative lexicon, as in Construction Morphology (Booij 2010b) or analogical approaches to word formation (e.g. Bybee 1995). The domains of application and the interaction of tone sandhi with both itself and other morphotonological processes point to the need for cyclic application, which I implement using phase-based spell out (Uriagereka 1999; Chomsky 2000). This approach allows for productive extension of the patterns without recourse to an overly complicated phonological component.

Keywords: sandhi; tone; phonology; morphology; phase; interface; fieldwork; Mande

1 Introduction

Tone sandhi, at its simplest, refers to tonal changes that occur in context. But tone sandhi systems are often anything but simple. If sandhi is sensitive to morphological or lexical factors, then it raises the question of whether the alternation belongs in the phonology or the morphology. And when alternations occur between words, the role of syntax in the system must also be considered.

All of these issues are at play in a hitherto little-described sandhi system: argument-head tone sandhi in Seenku. Though Seenku is a Mande language, spoken in Burkina Faso, many elements of the sandhi system are reminiscent of Chinese sandhi, as I will lay out in §2. I will argue that like Taiwanese Southern Min, Seenku sandhi is best analyzed as a case of allomorph selection (cf. Tsay and Myers 1996; Zhang and Lai 2008; Zhang, Lai and Sailor 2011). However, unlike Southern Min, where there is just a single sandhi allomorph for each root, each Seenku root can have up to four sandhi allomorphs, depending on the tone of the trigger. I combine elements of Construction Morphology (Booij 2010b) and word-and-paradigm morphology (Ackerman, Blevins, and Malouf 2009; Blevins 2016) and advocate for a hierarchical lexicon along the lines proposed in Bybee (e.g. 1991; 1995), in which the lexical entries for sandhi-undergoing roots are arranged into phrasal paradigms subcategorizing for morphophonological context. The order of application of sandhi and other morphophonological tone processes points to the need for systemic cyclicity, such as the cyclicity present in the framework of cyclic spell-out

(Uriagereka 1999; Chomsky 2000); in this framework, syntactic structure is sent through Morphology, Phonology, and Semantics in chunks known as phases. This cyclicity allows us to account for both application and non-application without stipulating specific ordering principles and without creating a phonetically unnatural phonological grammar to handle the opaque alternations.

Since the system itself is complex, with many subtleties in terms of both alternations and domains, I will spend the first half of this paper on in-depth description. These sections can be referred back to at any point during the analytical sections later in the paper, or can be read on their own for those more interested in data. The appendix also contains a summary table of data patterns with cross-references to sections and examples in the paper.

The layout of the paper is as follows: In §2, I provide a brief typological overview of tone sandhi cross-linguistically. Section 3 introduces Seenku, while §4 describes the basic tone system of the language to lay the foundation for our discussion of sandhi. An in-depth description of the sandhi system, including alternations, domains, application and non-application can be found in §5. Sections 6 and 7 lay out the analysis, with the former focused on lexical organization and allomorph selection and the latter motivating the need for cyclicity. Section 8 briefly considers alternative analyses, §9 considers remaining issues such as productivity, and §10 concludes.

2 Typology of tone sandhi

Though in principle the term “tone sandhi” refers to any tonal changes that occur at morpheme junctures, in practice it has come to be most closely associated with tonal alternations in Sinitic languages.¹ The sandhi patterns even within this one language family are diverse, with no two languages displaying exactly the same combination of alternations, domains, and directionality.

Building upon the work of Chen (2000), Zhang (2014) summarizes some typological parameters for Chinese sandhi. First, systems can be categorized as either “right-dominant” or “left-dominant”, where the dominant tone triggers sandhi while preserving its own tone. Hence, in a right-dominant system like Mandarin third tone sandhi, Tone 3 becomes Tone 2 before another Tone 3; it is the right-most tone that is preserved. In contrast, in a left-dominant system like Shanghainese, the first syllable’s tone has been argued to spread across the whole sandhi domain, neutralizing non-initial tones.²

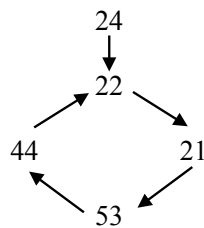
The alternations themselves can be either paradigmatic, replacing one tone with another (either from the base tone inventory or a with a tone specific to sandhi domains), or they can be spreading or extension systems, where one tone spreads its tone pattern to others in the sandhi domain. Zhang points out that these two typological parameters are not independent, with most right-dominant systems being paradigmatic and most left-dominant ones involving extension.

Finally, a third parameter is that sandhi can be either positionally induced or tonally induced. Taiwanese Southern Min represents a classic case of positionally-induced sandhi, where sandhi applies to every non-final tone in the domain and alternations can be captured with an arbitrary paradigmatic tone circle shown in (1):³

¹ Even Matthew Chen points this out in the preface to his 2000 volume on sandhi in Chinese dialects.

² Experimental data (Kuang, Tian and Zhou 2018) has recently challenged this claim, showing that non-initial tones that have undergone sandhi still reflect aspects of their base form. In other words, even well-known and understood cases are more complicated than they first appear.

³ For discussion of how Southern Min sandhi domains are calculated, see e.g. Chen (1987; 2000), Lin (1994), Duanmu (1995).

(1) *Taiwanese Southern Min tone circle*

Mandarin third tone sandhi (T3 → T2/___T3), on the other hand, provides a case of tonally-induced sandhi, where it is the specific presence of Tone 3 that triggers sandhi rather than a more general position in a domain.

Of course, taking a broader view of tone sandhi beyond the canonical Chinese examples, many other tone processes are attested. In African languages in particular, common processes include spreading (bounded or unbounded, e.g. Ekegusii, Bickmore 1999), downstep (either from adjacent H tone autosegments or a floating L, e.g. Luganda, Hyman and Katamba 1993), tonal absorption (HL.L → H.L or LH.H → L.H, e.g. Maradi, Newman 1995), and tone polarity (e.g. Hausa, Newman 1995).

While some of these tone processes are independently attested in Seenku tonology, we will see below that they do not form the basis of Seenku sandhi. Instead, the Seenku system is more reminiscent of Chinese sandhi, only in many respects more complex. In §5, I will illustrate the sandhi system and show it to be left-dominant, a mix of paradigmatic and spreading, and both tonally and positionally induced.

3 Background on Seenku

Seenku is a Mande language spoken in Burkina Faso by approximately 17,000 speakers. According to Kastenholtz's (1997) classification, it belongs to the Northwestern branch of Western Mande, which is no longer a distinct branch in Vydrin's more recent (2009a; 2016) classification. Both genetic classifications agree that Seenku belongs to a smaller group of languages known as Samogo (variant spelling Samogho), which also includes languages like Dzùùngoo (Solomiac 2007; 2014), Jowulu (Djilla, Eenkhorn and Eenkhorn-Pilon 2004), Duungooma (Tröbs 2008), Bankagooma, and Kpeego. At the time of writing, Dzùùngoo is the only language in the group with a thorough reference grammar; the forthcoming grammar of Seenku (McPherson forthcoming) will represent the second in-depth description. Most of Seenku's closest relatives remain radically understudied.

Seenku [sɛ́ɛ-kú] is the endonym for the language, meaning literally 'thing/language of the Sɛ́ɛ (ethnicity)'. It is also known by its exonym Sambla (older French spelling: Sembla), or by the variant names and spellings Seeku or Seen. The language has two primary dialects. Northern Seenku (Prost 1971) is spoken by 5000 people in the administrative center of Karangasso and surrounding villages, while Southern Seenku is spoken by about 12,000 people in the traditional village centers of Bouende, Souroukoudingan, Kongolikan, Toronso, and other surrounding villages and hamlets. I have been carrying out fieldwork on this latter dialect since 2013, working with speakers both in Burkina Faso and living abroad, as part of a larger documentation project (NSF-DEL BCS-1664335).

In terms of typological features, Seenku displays typical Mande S – Aux – O – V – X word order, where X can be an adverbial or postpositional phrase, in addition to areally attested clause-final negation (Dryer 2009; Idiatov 2015). This word order is demonstrated in (2):

- (2) Mó bí fii bà dôn kà né.
 1SG.EMPH goat.PL any give.RLS.PFV child to NEG
 'I didn't give any goats to the child.'

This example serves to highlight two other typological facts about Seenku: first, there is very little segmental morphology in the language, with the majority of morphosyntactic features marked either analytically or through grammatical tone. Second, Seenku vocabulary is largely mono- and sesquisyllabic, where the latter refers to words where a short “half” or “minor” syllable precedes a full syllable (Matisoff 1990; Pittayaporn 2015). Examples of sesquisyllabic vocabulary include words like the following:

- (3) məní ‘woman’
 səmâ ‘dance’
 təgê ‘chicken’

These sesquisyllabic forms are a case of extreme reduction of erstwhile V1 in the Mande “metrical foot” (Vydrine 2010); reduction of this sort even when the medial consonant is not a liquid appears to be a relatively rare pattern in Mande. The half syllable is not an independent tone bearing unit, meaning that the same tone melodies are found on mono- and sesquisyllabic vocabulary (captured in the transcription system by marking tone just once on the full syllable). As a consequence, their behavior with respect to sandhi is the same. Vowels in mono- and sesquisyllabic words can be either short or long, and the only permissible coda is a non-contrastive nasal which often surfaces as prenasalization of a following obstruent or nasalization of a following sonorant in phrase-medial position, or as late nasalization of the vowel in phrase-final position. See McPherson (in pressb) for further discussion.

4 Seenku tone

Seenku has a highly complex tone system, with four contrastive levels of tone forming the basic tonal primitives:⁴

- (4) *Seenku’s four tonal primitives*
 Super-high (S) ǎ
 High (H) á
 Low (L) à
 Extra-low (X) ã

The following minimal set demonstrates the contrastive nature of these four tones:

- (5) a. sí
 ‘*Terminalia* sp.’
 b. sí
 RECIPROCAL

⁴ Seenku’s four level tones and multiple contours pose a challenge for transcription. This situation is exacerbated by the fact that many contours can appear on short vowels (e.g. HX *kâ* ‘griot’ or SX *bǎ* ‘hit (PERF)’), where there are not two TBUs that would allow us to transcribe the contour tones as a sequence of two level tones. The following diacritics are used to represent contour tones: HX *â*, LS *ǎ*, SX *ä* (with the umlaut commonly used in the Mande literature as a “wild card” tonal diacritic). To maintain uniformity across tonal categories, I transcribe contour tones on both short and long vowels with just a single diacritic, i.e. *kâ* ‘griot’ versus *kâa* ‘fight’, reflecting the fact the tone marking applies to the whole syllable. The unmarked vowel at the end of the syllable should thus not be seen as toneless—it is part of the long vowel carrying a HX contour. Similarly, certain morphosyntactic features are marked by tone melodies, such as SX marking the perfect (see *bǎ* above). Added to an X-toned verb, this creates the sequence LSX, which could be transcribed in a number of different ways (such as *ǎä* or *àä*). Again, for maximum uniformity in the marking of the perfect, I adopt the latter convention *àä*. Most other contour tones (HS, XH, SH, etc.) are only found on lengthened vowels, and hence they are captured with a sequence of two level tone diacritics (e.g. *ɲǎǎ* ‘yawn’).

- c. s̀i
‘first son (proper name)’
- d. s̃i
‘water jar’

The primary acoustic correlate of these four levels is fundamental frequency, or f0, as shown in the normalized tone plot of a female speaker’s tones in Figure 1.⁵

In McPherson (2017a; c), I argue that Seenku’s four tones are the product of two binary tone features, [upper] and [raised] (following proposals by Yip 1980; Pulleyblank 1986):

(6) *Featural specification of Seenku tone*

	X	L	H	S
[upper]	-	-	+	+
[raised]	-	+	-	+

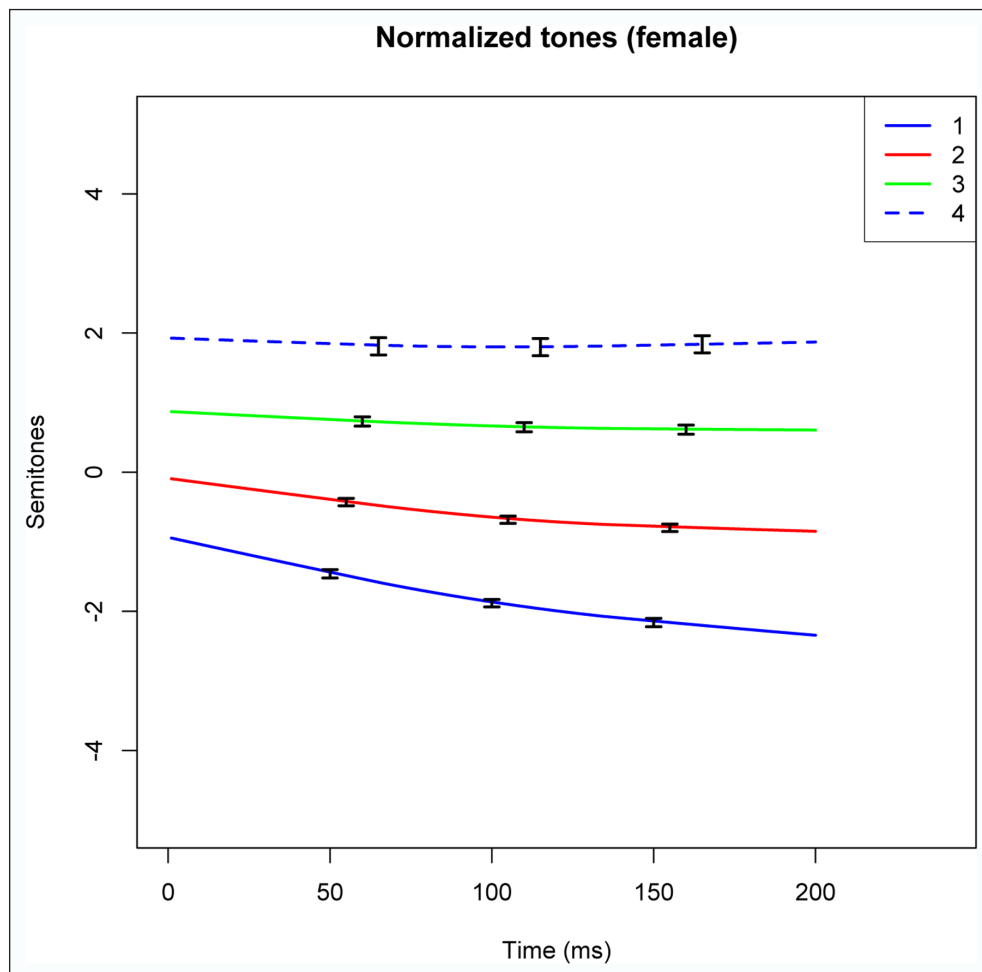


Figure 1: Normalized f0 traces of Seenku’s four level tones, where 1 = X and 4 = S.

⁵ To normalize tones, f0 was extracted from vowels using a Praat script. The tone was normalized to semi-tones based on the speaker’s mean pitch using an R script developed by James Stanford. Other speakers showed a comparable distribution of normalized tone.

While in the last decade, the need for tone features has been challenged (e.g. Clements, Michaud and Patin 2010; Hyman 2010), evidence in Seenku shows active use of tonal features in both phonological and morphological processes. One of these processes, plural formation, will be discussed in the context of this paper (§7 below); for further discussion, see McPherson (2017a).

There is an asymmetry in the tone system in that level L is never attested in pronominal, verbal, and nominal roots, with the exception of a closed class of birth order proper names (e.g. *Sì* ‘first son’, *Jè* ‘first daughter’, etc.). It is created in plural formation and can act as a sandhi trigger, which is first shown in §5.1.2 and discussed further in §7.1 where I cover the interaction between sandhi and other tonal processes.

Seenku’s four tonal primitives can combine to create a large number of contour tones, divided in the following between rising and falling tones. Contour tones that are only derived morphologically are explicitly noted:

- (7) a. *Rising tones*
- | | | | |
|----|-------|-----------------|-----------------|
| XH | ǎá | 3SG.SUBJ | (Morphological) |
| LH | mǎ́ǎ́ | ‘people (SUBJ)’ | (Morphological) |
| LS | tǐe | ‘black’ | |
| HS | ǎáá | ‘yawn’ | |
- b. *Falling tones*
- | | | | |
|----|-------|--------------------|--------------------------|
| SH | mǐí | 1PL.SUBJ | (Morphological) |
| SX | nǐò | ‘eaten (PERF)’ | (Morphological) |
| HL | gǎǎ | ‘wood’ | (Morphological – sandhi) |
| HX | gǎǎ | ‘wood’ | |
| LX | mǎ́ǎ́ | ‘people (REL.SUB)’ | (Morphological) |

Looking at these examples, we can see that three of the contour tones—LS, HS, and HX—are lexical in nature (demonstrable in the minimal set *kǎ́i* ‘bug’, *kǎ́í* ‘snore’, *kǎ́i* ‘deny’), while the others are created morphologically. In most cases, these contours are created by the elision of grammatical particles, such as the subjunctive *lé* or the relative subject marker *lè*, which leave behind their tone on the preceding subject. In the case of HL, however, it is derived from HX via argument-head tone sandhi, as I will detail below.

A smaller number of three-tone contours are attested, shown in (8):

- (8) *Three-tone contours*
- | | | | |
|-----|-------|----------------|-----------------|
| XHX | gǎǎǎ | ‘hibiscus’ | |
| LSH | mǎ́ǎ́ | ‘small’ | |
| LSX | nǎ́ǎ́ | ‘came (PERF)’ | (Morphological) |
| HXS | dǎǎǎ | ‘child (PST)’ | (Morphological) |
| HXH | dǎǎǎ | ‘child (SUBJ)’ | (Morphological) |

The question of tone bearing unit (TBU) in Seenku is not entirely clear, with data pointing to a more duration-based distribution along the lines of Zhang (2004) rather than a phonological one. Short syllables can host a single tone or a falling contour, while more “effortful” rising contours and three-tone contours are only found on long or lengthened syllables (e.g. a syllable in phrase-final position). I will not go into further detail here, as these issues are orthogonal to the sandhi system that is the focus of this paper.

5 Argument-head tone sandhi

Seenku tone sandhi is morphosyntactically constrained, occurring only between a head and its preceding internal argument. It is by and large a left-dominant system, in which the argument on the left is the trigger and the head on the right is the target. According to Zhang's (2014) typology, we might predict that Seenku would show a spreading system. Surprisingly, it is largely paradigmatic. In the following subsections, I first describe the alternations before turning to the question of domains.

5.1 Alternations

The alternations involved in argument-head tone sandhi are complex, dependent upon both the tone of the argument and the tone of the head. Making the situation even more complicated is the fact that the patterns differ slightly depending upon whether the argument is a simplex pronoun, a complex pronoun, or a non-pronominal DP, and, in some tonal combinations, on the syntactic category of the head. I will address (simplex) pronominal arguments first in §5.1.1 then describe how non-pronominal arguments diverge in §5.1.2.

5.1.1 Pronominal arguments

When the argument is a pronoun, the tone changes on the head are best described as paradigmatic; that is, there is no consistent phonological explanation for the tone change, such as spreading, assimilation, or dissimilation. A schematic table of the tone changes is shown in (9). Note that there are no L-toned pronouns to act as trigger, nor are there any L-toned forms in the classes that undergo sandhi (inalienable nouns, verbs, postpositions; see §5.2 for discussion of undergoers and non-undergoers). Thus, only the categories X, H, S are represented.

(9) *Tone sandhi with a pronominal argument*

Head tone		X	H	S
Argument tone	X	L	X	H
	H	S	X	H/X
	S	S	S	S

The pronominal argument's tone is shown down the left-hand side, and the head's base tone is shown along the top row. The cells in the middle of the table represent the surface form of the head. There is some variation in the behavior of S-toned heads after H-toned arguments, having to do both with the trigger (the argument) and with the target (the head). First, emphatic pronouns, consisting of a simple pronoun and an emphatic clitic *wó*, trigger X rather than H; this is parallel to the behavior of non-pronominal arguments, addressed in §5.1.2, even in the case of the 1SG, where /*ń* + *wó*/ merge to create *mó*. If we look at the 1PL, we see that *mV* is a permissible pronoun shape, and yet 1SG emphatic *mó* behaves like a noun for the purposes of sandhi alternations, showing that the Seenku sandhi system is sensitive to more than just phonological shape of the argument. Second, only inalienable nouns become H after H-toned arguments; as I will illustrate in §5.2, postpositional and verbal heads have X-toned allomorphs in this environment. In short, sandhi behavior is not entirely uniform in how it is triggered or undergone.

We can fill in the schematic for inalienable possessive paradigms (e.g. 'his/her head', 'your head', etc.), as in (10):

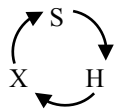
(10) *Tone sandhi with pronominal possessors*

		kɔ̃n 'head'	ɲá 'mother'	nǐ́ 'father'
3SG	à	à kɔ̃n	à ɲà	à ní
2SG	á	á kɔ̃n	á ɲà	á ní
1PL	mǐ́	mǐ́ kɔ̃n	mǐ́ ɲǎ	mǐ́ nǐ́

As these examples show, it is the head’s tone that changes, while the pronoun’s tone remains invariable in all but one cell: when an X-toned pronoun and an X-toned head come together in a sandhi domain, both tones raise to L (top left). For further discussion, see §9.2.

Looking at these tables, we can draw some generalizations about Seenku tone sandhi alternations. First, there is a pocket of regularity after S-toned arguments, which trigger S on the head regardless of its tonal class.⁶ The remaining cells, with the exception of X + X → L L, look like a circular chain shift, reminiscent of Taiwanese Southern Min sandhi. This tone circle is illustrated in (11):

(11) *Seenku’s pronominal tone sandhi circle*



This is seen most clearly after H-toned arguments, illustrated with the 2SG pronoun á in (10). After this pronoun, we find all three tones S, X, H, but not on the same roots as in the base form. After X-toned arguments, we see the effects of the circular chain shift with S- and H-toned heads (in the base tone), but with X-toned heads, we find the surface combination L L instead of *X S. In other words, in every environment except after S, the three-way tonal contrast on heads is maintained, but the surface tone categories are permuted.

5.1.2 Non-pronominal arguments

The alternations with non-pronominal arguments are very similar to those with pronominal arguments. The only exception is that H is never derived as a sandhi tone; the two configurations in (9) that create H, i.e. /X + S/ and /H + S/, instead surface as [X X] and [H X]. The table in (12) schematizes the sandhi alternations with non-pronominal arguments, adding in L-toned arguments (which can be derived through plural formation; see §7 below).

(12) *Tone sandhi with a non-pronominal argument*

Head tone		X	H	S
Argument tone	X	L	X	X
	L	L	L	L
	H	S	X	X
	S	S	S	S

⁶ Note that I am explicitly avoiding terms like “spread” which imply a particular autosegmental representation of the process. There is no evidence to decide whether the S on the head is indeed the result of spreading a single S tone or whether it is a distinct tone on the autosegmental tier.

As this table shows, H is never derived as a sandhi variant with a non-pronominal argument, resulting in a neutralization of H- and S-toned heads across the board. We can also see that L, like S, always displays spreading-like behavior onto the following head. The table is exemplified with actual Seenku forms in (13):

(13) *Tone sandhi with non-pronominal/complex pronominal possessors*

		k̀̀n 'head'	ɲá 'mother'	ní 'father'
'pig'	b̀̀ɛ	b̀̀ɛ k̀̀n	b̀̀ɛ ɲá	b̀̀ɛ ní
'pigs'	b̀̀ɛ	b̀̀ɛ k̀̀n	b̀̀ɛ ɲá	b̀̀ɛ ní
1SG.EMPH	mó	mó k̀̀n	mó ɲá	mó ní
'woman'	məní	məní k̀̀n	məní ɲá	məní ní

The complex pronoun *mó* is used as the H tone example here, since Seenku provides no level H-toned nouns in this context that could serve as an example. This is due to a tonotactic restriction in Seenku on H in noun-final position (McPherson 2017a; c); where we expect to see H-toned nouns, instead we find a large number of HX contour tones, such as *bí* 'goat', *gô* 'wood', or *təgê* 'chicken'. As §7.1 below will show, these behave like level H-toned roots for the purposes of plural formation. Sandhi, on the other hand, is sensitive to the final surface tone of the preceding argument. Thus, the final X of a noun like *bí* 'goat' is the sandhi trigger, as illustrated in the following forms:

- (14) a. *bí k̀̀n* 'goat's head'
 b. *bí ɲá* 'goat's mother'
 c. *bí ní* 'goat's father'

With an X-toned head, the HX contour becomes HL. This contour lacks a single diacritic marking in the transcription system used here, since the circumflex is already used to represent the far more common lexical HX contour. The L diacritic off the end of the word should be understood as part of a surface contour tone rather than a floating tone (which are largely unattested in Seenku).⁷

It is unclear whether the lack of H-toned sandhi variants after nouns is related to the tonotactic ban on final H. As can be seen in (9), however, the ban does not extend to derived H tones, since the sandhi variant of 'father' in *à ní* 'his father' is level H-toned (i.e. it does not surface as HX-toned *ní*), though see §5.2.3 for a possibly related case with post-verbal particles.

5.1.3 Non-undergoers

The preceding subsections described the application of sandhi to heads with both pronominal and non-pronominal arguments. However, not all heads participate in sandhi. We can define two classes of non-undergoers: a systematic class of multi-tonal heads and a class of exceptions.

Multi-tonal heads are impervious to sandhi, as illustrated with the following examples:

⁷ The only way to capture HL with a single diacritic would be to appeal to contour diacritics that contain M, such as *â*; since I use no M tones in the description of Seenku tone, and since HL is relatively infrequent and non-contrastive, I have chosen to simply use the sequence *ââ*, even though this means leaving a dangling diacritic when the vowel is short.

- (15) a. à d̀d̀d̀ó ‘his thigh’
 mó d̀d̀d̀ó ‘my thigh’
 mí d̀d̀d̀ó ‘our thigh’
- b. à d̀ǎǎ ‘flatter her’
 mó d̀ǎǎ ‘flatter me’
 mí d̀ǎǎ ‘flatter ‘us’

The inalienable noun ‘thigh’ is uniformly X-H in tone, while the irrealis verb ‘flatter’ retains LS regardless of the tone of the pronoun preceding it. Here morphological structure matters: if a head is morphologically complex, resulting in a multi-tonal head but where each individual morpheme carries just a single tone, then sandhi usually still applies from left to right. We can see this below with the compound /tṣín-ŋm̀ǎ/ ‘hip’:

- (16) à tṣín-ŋm̀ǎ ‘his hip’
 mó tṣín-ŋm̀ǎ ‘my hip’
 mí tṣín-ŋm̀ǎ ‘our hip’

In the case of the 3SG, the sequence X + S + X is calculated from left to right, with X + S first becoming X H, then H + X becoming H S:

- (17) à + tṣín → à tṣín + ŋm̀ǎ → à tṣín-ŋm̀ǎ

In the case of the 1SG, H + S is first calculated, resulting in H X, then the sequence X + X raises to L L:

- (18) mó + tṣín → mó tṣín + ŋm̀ǎ → mó tṣín-ŋm̀ǎ

In the case of the 1PL, everything after S will become S. I will return to cyclic sandhi application with complex heads in §7.4 below.

We must say that sandhi “usually” applies in complex heads, since we also find cases where the compound head is impervious to sandhi. For instance, *ḳ̀n-ḳ̀s* ‘skull’ surfaces with this X-H tone pattern, regardless of the argument (e.g. à *ḳ̀n-ḳ̀s* ‘his skull’, mó *ḳ̀n-ḳ̀s* ‘my skull’). This is despite the fact that both stems are, on their own, sandhi undergoers (e.g. à *ḳ̀n* ‘his head’, mó *ḳ̀n* ‘my head’; à *ḳ̀* ‘his bone’, mó *ḳ̀* ‘my bone’). There is thus lexical specificity as to whether a compound will be an undergoer or an exception, independent of whether its component stems would undergo sandhi or not.

Finally, a small number of exceptional stems are also attested, both verbal and nominal, that remain invariant in sandhi environments. We find both H- and S-toned exceptions, as shown in (19):

- (19) a. à jábí ‘respond to him’
 mó jábí ‘respond to me’
 mí jábí ‘respond to us’
- b. à tṣǐǐ ‘its stalk’
 mó tṣǐǐ ‘my stalk’
 mí tṣǐǐ ‘our stalk’

The verb *jábí* is a loanword from Jula, which may contribute to its exceptional behavior, but there is no indication that *tṣǐǐ* is non-native. Note that exceptional H-toned stems like *jábí* are particularly important, because they show that there are exceptions even to what looks like a phonologically general pattern of S spreading.

However, it is important to note a large degree of interspeaker variation in whether or not stems are treated exceptionally. Certain speakers display quite a few exceptions like these, while others are likely to apply sandhi across the board. Though my current sample size is small, we find that younger and more urban speakers are more likely to have

exceptions than older speakers who came of age in Seenku-speaking villages. This may be evidence of a break-down in the system and decreased productivity.

5.2 Domains

The question of domains of sandhi application is not without complication. I will first identify what I consider to be the core domains and sketch out two possible approaches to formally defining them for sandhi application. I will then turn to domains in which sandhi does not occur, showing that these present challenges to both approaches. Finally, I turn to other domains where sandhi occurs, which are likely derived (synchronically or diachronically) from these core domains.

5.2.1 Core domains of application

Argument-head tone sandhi, in its most canonical application, occurs between a head and its preceding internal argument. There are three such domains where sandhi is attested:

- i. Possessive DP + inalienable/relational noun
- ii. Object DP + transitive verb
- iii. DP + postposition

Examples of possession were given in tables (10) and (13) above; comparison tables for OV and PP environments are given in (20) using pronominal arguments:

(20) a. *Tone sandhi with pronominal objects of transitive verbs*

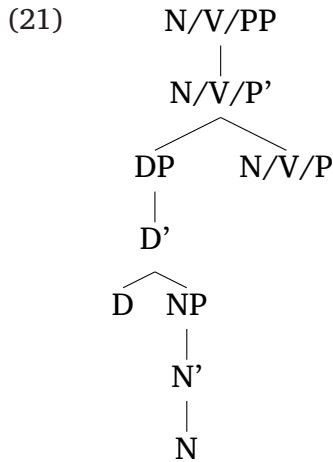
		sà 'buy'	sɔɔ 'sell'	bǎ 'hit'
3SG	à	à sà	à sɔɔ	à bǎ
2SG	á	á sǎ	á sɔɔ	á bǎ
1PL	mí	mí sǎ	mí sɔɔ	mí bǎ

b. *Tone sandhi with pronominal complements to postpositions*

		wè ASSOCIATIVE	né LOCATIVE	lé DATIVE
3SG	à	à wè	à nè	à lé
2SG	á	á wé	á nè	á lè
1PL	mí	mí wé	mí nè	mí lè

Verbal and postpositional heads display identical sandhi behavior, but they differ from the inalienable nouns in (10) in that they have an X-toned allomorph after H-toned pronouns, regardless of whether the pronoun is simplex or complex (emphatic). All heads behave identically with non-pronominal arguments, where H-toned allomorphs are never derived.

If we wish to generalize about the domain of sandhi application, we have two possibilities. The first is that the domain is defined with direct reference to the syntax (e.g. Pak 2008). In this approach, we could argue that the core environments in which sandhi occurs share a parallel syntactic structure, shown in the tree in (21):



In this tree, a relational NP, a VP, and a PP all take an internal DP argument that is the complement to the head. For VPs and PPs, this structure is relatively uncontroversial, but for relational or inalienable nouns, it is more commonly argued that possessors are generated in the specifier of NP rather than as a complement to N (see e.g. Abney 1987; Stowell 1989; Vergnaud and Zubizarreta 1992; Español-Echevarria 1997). However, structures like that in (21) have also been proposed (see e.g. Yoon 1990; Ura 1996). In this approach, a head X plus a DP internal argument would form the domain for sandhi application.

In an indirect reference approach (e.g. Nespor and Vogel 1986; Selkirk 2011, among many others), prosodic constituents are built off syntactic structure but are not necessarily isomorphic with it. Given the small size of sandhi domains, the most likely prosodic constituent would be the phonological phrase (ϕ).⁸ If we assume a Match Theory approach to prosodic constituent building (Selkirk 2011), we could propose that the left and right edge of an XP match the left and right edge of a phonological phrase. For the tree structure in (21), this would create the following recursive structure:



In other words, the noun and its NP forms one phonological phrase, the DP layer forms another one, and both of these are embedded within a larger phonological phrase for the whole XP. The domain for sandhi would be any phonological phrase, whether minimal or maximal.

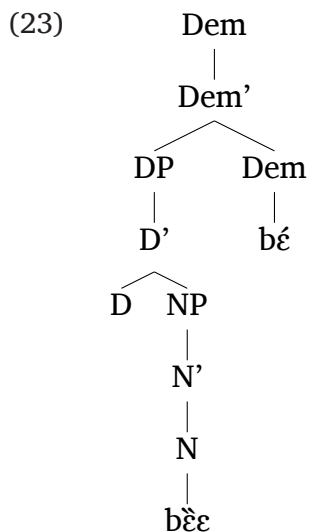
5.2.2 Domains where sandhi does not occur

Both approaches suffer from problems when we consider where sandhi *doesn't* apply. Domains without sandhi include:

- i. Noun + Adjective (*bû* 'grass' + *cərǎ* 'fresh' → *bû cərǎ* 'fresh grass')
- ii. Noun + Demonstrative (*bëë* 'pig' + *bé* 'this' → *bëë bé* 'this pig')
- iii. Definite + Noun (*ǎ* DEF + *mənĩ* 'woman' → *ǎ mənĩ* 'the woman')
- iv. Subject + Predicate marker (*ǎ lé* '3SG PST', *mó lé* '1SG PST', *mĩ lé* '1PL PST')
- v. Possessive DP + Genitive + Alienable noun (*mĩ té bëë* 'our pig')

⁸ Another possibility would be the prosodic word, but in fact a different set of tonal changes take place in compound nouns. For example, a compound whose underlying root tones are /S + H/ will surface as [H-H(X)], e.g. /mənĩ + bɔɔ/ → [mənĩ-bɔɔ] 'old woman'. This is the most likely Seenku equivalent of *compacité tonale*, a kind of replacive tone found in many Mande languages; for a thorough summary and typology, see Green (2018).

I will return to the case of alienable possession shortly. For now, let us consider the configuration N + Dem, assuming the syntactic structure in (23):



The demonstrative is the head of a projection DemP, which can combine with a definite determiner, suggesting the need for both DP and DemP. As (23) clearly shows, the syntactic phrasing is identical to (21), creating issues for the direct reference approach and also to the indirect reference approach which would build a phonological phrase from this syntactic structure in the same way, unless we could appeal specifically to the semantics of the complement also being an argument; the analysis proposed below avoids the need for such a controversial link between phonology and semantics. Of course, as a reviewer points out, not all syntactic frameworks assume a D or Dem head, and in such a framework, the difference in behavior between something like Dem and P could fall out from the fact that P is a head and Dem is not.

Even more challenging are cases involving determiners. There are two pre-nominal determiners in Seenku, both homophonous with pronouns: the basic definite determiner *ǎ* and the discourse definite *kú*. Both determiners occur in the same location as an inalienable possessor, i.e. immediately before the noun. I assume that they occupy the D position in (23) (though see footnote 16 for a possible complication). As mentioned in the list of non-sandhi domains above, the definite determiner *ǎ* does not trigger sandhi. It is contrasted in (24) with a nearly phonologically identical case of inalienable possession, which does involve sandhi:

- (24)
- | | | |
|----|--------------|------------------|
| a. | <i>ǎ</i> kɔ̀ | (isolation: kɔ̀) |
| | DEF hole | |
| | ‘the hole’ | |
| b. | <i>ǎ</i> kɔ̀ | (X-toned class) |
| | 3SG handle | |
| | ‘its handle’ | |

If we assume an abstract underlying form for inalienable nouns (see §6 below for reasons avoid doing so), then ‘hole’ and ‘handle’ would be homophonous: *kɔ̀*. But ‘hole’ is an alienable noun, and with it, *ǎ* indicates the definite—no sandhi occurs. On the other hand, ‘handle’ is inalienable, requiring an internal argument to be expressed, and *ǎ* here represents that argument—sandhi takes place, raising both putative Xs to L; see §9.2 for further discussion.

While it is tempting to think that the difference between sandhi applying and not applying comes down to the different position of *à* the determiner versus *à* the possessive pronoun, we see that this cannot be the full story when we consider the discourse definite, which is a sandhi trigger. The definite and discourse definite are contrasted in (25), both followed by the demonstrative *bé*:

- (25) a. *à məní bé* (isolation: *məní*, no sandhi)
 DEF woman DEM
 ‘that woman’
- b. *kú mənì bé* (isolation: *məní*, sandhi)
 D.DEF woman DEM
 ‘that woman (I was talking about)’

The isolation tone S of *məní* ‘woman’ surfaces with the regular definite in (25a) but is turned into its sandhi variant X with the discourse definite in (25b). Note that the discourse definite obligatorily co-occurs with the demonstrative, but (25a) shows that this is not itself a sandhi trigger or undergoer.

In a similar vein, even the core domains have conditions under which sandhi does not apply, despite putatively having the same syntactic structure. Specifically, O + V configurations are sandhi domains only when the verb uses its irrealis stem (see McPherson 2017b for more on the irrealis/realis distinction Seenku). There is no word order change between the realis and the irrealis, but still sandhi does not apply (note: *à nǎ* 3SG PROSP, *à lé* 3SG PST):

- | | | |
|------|---------------------------|----------------------------|
| (26) | <u>Irrealis (sandhi):</u> | <u>Realis (no sandhi):</u> |
| | <i>à nǎ à sǎ</i> | <i>à lé à sǎ</i> |
| | ‘she will buy it’ | ‘she bought it’ |
| | <i>à nǎ mó sǎ</i> | <i>à lé mó sǎ</i> |
| | ‘she will buy me’ | ‘she bought me’ |
| | <i>à nǎ mí sǎ</i> | <i>à lé mí sǎ</i> |
| | ‘she will buy us’ | ‘she bought us’ |

The word order in both cases is the same; in the irrealis, the prospective auxiliary *nǎ* is used indicating the future, while in the realis, the post-subject predicate marker *lé* is used indicating past tense. The object remains adjacent to the verb, which undergoes sandhi in the irrealis but remains impervious in the realis. It is important to note that perfective aspect is marked on the verb in the realis condition by a featural affix [–raised], which lowers S to H but leaves X unchanged (since it is already [–raised]). It may be possible to argue that this extra tonal marking plays a role in blocking the application of sandhi (at least from a functional perspective).

Regardless, it is clear that more than simple bracketing/syntactic structure is responsible for defining sandhi domains. The morphophonology needs to be able to draw upon argument structure (i.e. that the syntactic structure involves an argument-head relationship and not simply a complement-head one), morphosyntactic features like (ir)realis, and possibly even lexical identity (i.e. definite vs. discourse definite).

5.2.3 Other sandhi domains

We find three other sandhi domains that appear to be extensions of the core domains:

- i. Possessor + Dative + Alienable noun
- ii. Verb + Post-verbal aspect particles
- iii. Object + “Pre-verb” + Verb

In §5.2.2, we saw that alienable possession typically is not a sandhi domain. This is true when an independent genitive particle *tě* intervenes between the possessor and the possessed noun. Being a postposition, the genitive undergoes sandhi triggered by the possessor, but the alienable noun remains unaffected:⁹

- (27) a. *mí tě bɛɛ*
 1PL GEN pig
 ‘our pig’ /*bɛɛ*/
- b. *sân tɛ cí*
 rabbit GEN house
 ‘rabbit’s house’ /*cí*/
- c. *mó tɛ jəgɛ̀*
 1SG.EMPH GEN dog
 ‘my dog’ /*jəgɛ̀*/

However, what looks to be a lengthened version of the dative postposition can also be used in alienable possession (at least by some speakers); it too undergoes sandhi, but in this case, the alienable noun also participates in alternations. As in (16), sandhi is calculated from left to right, meaning the alienable noun’s trigger is the sandhi allomorph of the dative, not some kind of underlying form:

- (28) a. *mí lɛɛ bí*
 1PL DAT goat
 ‘our goat’ /*bí*/
- b. *sân lɛɛ cĩ*
 rabbit DAT house
 ‘rabbit’s house’ /*cĩ*/
- c. *mó lɛɛ jəgɛ̀*
 1SG.EMPH DAT dog
 ‘my dog’ /*jəgɛ̀*/

In (28a), *lɛɛ* (part of the S-toned class of sandhi undergoers) surfaces as *lɛɛ* after the S-toned pronoun; this S then triggers the possessed noun *bí* to raise to S as well. In (28b), the X-final noun *sân* triggers the sandhi variant *lɛɛ* on the dative. This X tone then triggers the underlying H of *cĩ* to lower to X. Finally, in (28c), the H-toned pronoun *mó* likewise takes the sandhi variant *lɛɛ*; when this X comes into contact with the X of the alienable noun, both raise to L.

More commonly, the dative postposition is absorbed into the preceding possessor, lengthening it and concatenating its tone to the end. This complex possessor triggers the same sandhi effects, and is often offered as interchangeable with the genitive construction illustrated in (27):

- (29) a. *mĩ bí*
 1PL.DAT goat
 ‘our goat’
- b. *môo bĩ*
 1SG.EMPH.DAT goat
 ‘my goat’

⁹ I show ‘house’ with the underlying form *cĩ*, since its behavior in plural formation suggests that the X is inserted on the surface to avoid a final H tone. See §7 for further discussion.

- c. ɛ́ɛ̀ b̀ì
 3SG.DAT goat
 ‘her goat’

This elision and lengthening is far more common with pronouns than with nouns, suggesting a degree of lexicalization; this is further bolstered by the fact that the 3SG dative (ostensibly from *à + lɛ́ɛ̀*) is [ɛ́ɛ̀] while the 2SG dative (ostensibly from *á + lɛ̀ɛ̀*) is [âa]—without the vowel change.

Again, it is clear that more is at play in determining the domains of sandhi than syntactic structure and bracketing, otherwise we might expect “genitive possessors” and “dative possessors” to pattern in the same way.

The other two sandhi domains are historically derived from postpositions but are now part of verbal expressions (a common diachronic trajectory in Mande languages; see e.g. Tröbs 2004). In two aspects, the progressive and the habitual, the verb stem is followed by what looks like a postposition (locative *nɛ́* and associative *wɛ̀*, respectively). In this environment, the verb stem is the sandhi trigger and the verbal particle is the target. Consider first data from the progressive:

- (30) a. à ṣɿ̀ cèrè̀ nɛ̀.
 3SG be sleep.RLS LOC
 ‘She is sleeping.’
 b. à ṣɿ̀ sá nɛ̀.
 3SG be cry.RLS LOC
 ‘She is crying.’
 c. à ṣɿ̀ ɲáǎ nɛ́.
 3SG be yawn.RLS LOC
 ‘She is yawning.’

The postposition *nɛ́*, part of the H-toned class of sandhi undergoers, shows its usual sandhi variants (X, X, S) after X-, H-, and S-toned verb stems. The progressive is a realis aspect, and hence the verb stem does not interact tonally with the preceding object. However, transitive verb stems take uniform S-final forms in the progressive, thus triggering a consistent S-toned allomorph *nɛ́*:

- (31) a. à ṣɿ̀ à sǎ nɛ́. [sǎ nɛ́]
 3SG be 3SG buy.RLS LOC
 ‘She is buying it.’
 b. à ṣɿ̀ à sɔ́ɔ nɛ́.
 3SG be 3SG sell.RLS LOC
 ‘She is selling it.’
 c. à ṣɿ̀ à bǎ nɛ́.
 3SG be 3SG hit.RLS LOC
 ‘She is hitting it.’

H- and S-toned transitive verbs neutralize to S, while X-toned verbs have a LS allomorph. This triggers S on the particle, creating a LS-S configuration, which in turn triggers tonal absorption (Hyman and Schuh 1974) and leaves simply L-S on the surface.

The progressive could still be plausibly analyzed as a nominal construction in the synchronic grammar, with the auxiliary ‘be’ acting as the main verb. It is harder to defend a nominal analysis of the habitual, which lacks an auxiliary verb (i.e. the verb stem must be

the main verb, otherwise we would need to posit a null copula or auxiliary, which lacks any independent support in the grammar):

- (32) a. à cèrè wè.
 3SG sleep HAB
 ‘She sleeps.’
 b. à jí wě.
 3SG laugh HAB
 ‘She laughs.’

The X-toned particle undergoes its regular sandhi changes after X- and S-toned verbs, as we can see in (32). Curiously, though, it does not become S after H, like the homophonous associative postposition does. Instead, it becomes L, as if the H tone were instead HX (i.e. à sá wè ‘she cries’, not * à sá wě). It is tempting to see this as related to the ban on final H, though verbs typically are not subject to this ban, as illustrated by the tolerance of final H when no post-verbal particle/sandhi undergoer follows, as in a negative phrase like à nǎ sá ηé ‘she will not cry’. The simplest explanation may be to treat the habitual particle as exceptional, with a divergent set of sandhi allomorphs, similar to the H-toned allomorphs of inalienable nouns after H-toned pronouns discussed in §5.1.1. See §6 below for how such exceptionality may be accounted for.

Finally, many Mande languages display a class of so-called “pre-verbs” (Keïta 1989; Vydrine 2009b; Khachaturyan 2017, etc.). Diachronically, these are postpositions or nouns that have developed into the initial element of a compound verb. In Seenku, at least, we find a bracketing mismatch, in that they phrase phonologically with the preceding object (acting like a postposition or inalienably possessed noun), but morphosyntactically, they are part of the verb.

Pre-verbs are both sandhi undergoers and sandhi triggers; they obligatorily undergo sandhi with the preceding object (obligatory, as pre-verbs are unattested in intransitive constructions), but they will also trigger sandhi on the following verb if the verb is irrealis. A realis and irrealis version of the same verb phrase are shown in (33), with the transitive preverb *né-* (likely derived from the locative postposition *né*):

- (33) a. à nǎ-fǎe
 3SG TRANS-winnow.RLS.PFV
 ‘winnowed it’
 b. à nǎ-fǎ
 3SG TRANS-winnow.IRLS
 ‘winnow it!’

In both examples, the X of 3SG à causes the H-toned transitive pre-verb to lower to X; the sandhi domain stops there in (33a), where the realis verb surfaces as H in the perfective. In (33b), the X-toned sandhi allomorph of the pre-verb causes the irrealis verb to lower to X as well.

6 Argument-head tone sandhi as allomorph selection

Both the tonal alternations and the domains in which they occur point to argument-head tone sandhi as a morphological process rather than a phonological one. In this paper, I follow Tsay and Myers (1996), Zhang and Lai (2008), Zhang, Lai and Sailor (2011) and others in treating complex phonetically arbitrary sandhi as allomorph selection. For brief discussions of alternative analyses, see §8.

The allomorph selection approach is based on the idea that both the base form and sandhi variant are stored in the lexicon as allomorphs. Taiwanese is a relatively simple case, in that each morpheme has just a single sandhi variant and sandhi domains are general across the language. Seenku, on the other hand, is more complex. First, each morpheme may have up to four distinct tonally-induced sandhi allomorphs in addition to a base (isolation) form. And second, even with the allomorphs accounted for, we are left with the question of domains, which we saw in §5.2 to be non-trivial to compute in any sort of general fashion.

Because allomorphs are tonally induced, the lexical entry must include phonological subcategorization frames (cf. Paster 2006 or recent work on prosodic subcategorization, Bennett, Harizanov and Henderson 2018). But given that this phonological environment is already specified in the lexical entry, it is a small additional piece of information to add the morphosyntactic context as well. Consider a lexical entry for the transitive verb *bǎ́*:¹⁰

- (34) HIT (*v. tr.*) *bǎ́* (realis), (irrealis/S__)
 bǎ́ (irrealis/X_{pro}__)
 bǎ́ (irrealis/L__)
 bǎ́ (irrealis/X__, H__)

This verb has four listed allomorphs, one for each of Seenku’s lexical level tones: a S-toned allomorph used in the realis and also in the irrealis following S-toned arguments, a H-toned allomorph used in the irrealis after X-toned pronouns specifically, a L-toned allomorph found in the irrealis after L-toned arguments, and an X-toned allomorph found in the irrealis after X- and H-toned arguments. In this lexical entry, all of the allomorphs have their environments fully specified, but it would also be possible to leave one as a default or elsewhere allomorph (likely the X- or S-toned allomorphs, which show the most general distribution).

I assume that these lexical entries are inserted after the syntax has built up, as in Distributed Morphology (e.g. Halle and Marantz 1993; Embick and Noyer 2007). The syntactic structure specifies whether a realis or an irrealis allomorph should be used in the Morphological/Lexical component. See §7 for further discussion of this interaction. As I will lay out below, the view of the lexicon taken here differs from Distributed Morphology in that the lexicon is itself generative; for a discussion of how the data would be handled in traditional Distributed Morphology, see §8.3 below.

Notice that for transitive verbs, the environment must include whether the verb is realis or irrealis, since realis verbs never tonally interact with the preceding object (i.e. they always surface as S, unless another tonal morpheme like the perfective [–raised] targets them and lowers them to H). But for the irrealis verbs, the only thing that is specified in the environment is the preceding tone. Thanks to Seenku’s rigid word order, this will always be either the object (the verb’s argument), or in some cases the transitive preverbs, both of which are sandhi triggers. In other words, we do not have to specify that it is a preceding X-toned argument.

As children are exposed to the language, they hear other verbs with the same distribution of allomorphs, such as the verb *dzǎ́* ‘put’:¹¹

¹⁰ A reviewer points out that it is always the preceding tone that triggers sandhi in Seenku and speculates why that should be. As they point it, this may be due to the direction of headedness in the language (head-final). Indeed, it has been suggested that most cases of phrasal tonal alternations target the head, rather than simply an initial or a final element regardless of its syntactic structure (Harry and Hyman 2014). I would not be surprised to find alternations triggered by both preceding and following tones as well, provided that the undergoer is the head.

¹¹ This is not to imply that they learn whole paradigms one at a time before moving on to the next paradigm, but rather that the distribution of hundreds of lexical items are being learned simultaneously, many of which are observed to follow the same pattern.

- (35) PUT (*v. tr.*) dzí (realis), (irrealis/S__)
 dzí (irrealis/X_{pro}__)
 dzì (irrealis/L__)
 dzì (irrealis/X__, H__)

With enough transitive verbs patterning in the same way, I argue that children may project a *meta-entry*, which is essentially a constructional template or schema (Booij 2010b) abstracting away from specific lexical items and capturing the behavior of a whole class of morphemes. For this transitive pattern, we could schematize it as follows:

- (36) *v.tr.III* S (realis), (irrealis/S__)
 H (irrealis/X_{pro}__)
 L (irrealis/L__)
 X (irrealis/X__, H__)

The label *v.tr.III* refers to Class III transitive verbs (X-toned being Class I and H-toned being Class II). Verbs in this class have the same allomorph distribution. Meta-entries like these may allow productive extension of patterns to novel forms (see also Bybee 1995; Booij 2010a, etc.). For instance, if a child hears a verb phrase like *à jú* ‘say it’, this would activate the X_{pro} cell of this meta-entry but none of the ones for other verb classes, and thus the child would know that the verb should be, for instance, S-toned in the realis. Of course, certain cells in the paradigm are more informative than others (cf. Albright 2002; 2010, etc.), so in many cases a child may have to guess class membership until more informative cases are heard.

The same process of lexical entry building is simultaneously going on for heads of other syntactic categories. For example, learners may build the following paradigm for the dative postposition *lě* in (37):

- (37) DAT (*p.*) lě (S__)
 lě (X_{pro}__)
 lè (L__)
 lè (X__, H__)

Similarly to transitive verbs, because postpositions cannot appear on their own, they will obligatorily follow their argument, which will end in one of the four tones; the phonological subcategorization in the lexical entry determines which allomorph is selected. Other postpositions pattern in largely the same way, for example the genitive *tě*:

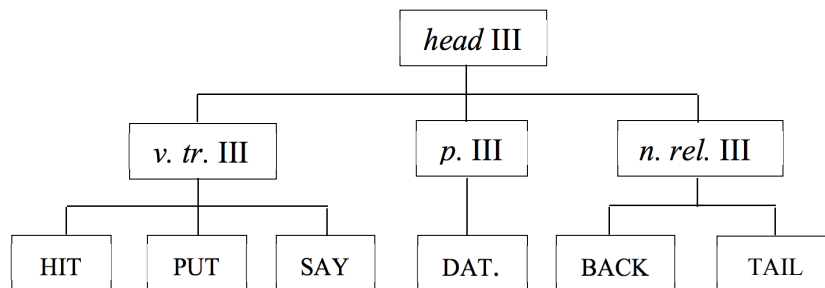
- (38) GEN (*p.*) tě (S__)
 tě (X_{pro}__)
 tè (L__)
 tè (X__, H__)

There is one subtle difference with the genitive, namely that where the dative has a H-toned allomorph (e.g. *à lé* ‘for him’), the genitive has a HX allomorph (e.g. *à tē* ‘his’). Irregularities like these can be accounted for, even if the meta-entry projects a regular H-toned allomorph, if we follow Pānini’s Principle, that a more specific alternation (HX of the genitive) will preempt a more general one (H of Class III postpositions). If a child has not heard a particular postposition after an X-toned pronoun, we would expect her to extend the more general H-toned pattern. This same principle could account for the aberrant L-toned allomorph of the habitual *wè* after H-toned heads (see §5.2.3); this specific subpattern preempts the usual S-toned allomorph that we would expect in this environment.

Inalienable or relational nouns function in much the same way; like transitive verbs and postpositions, they obligatorily appear with a possessor, and so if the subcategorization frame states a preceding tone, that tone will belong to the possessor (or another morpheme of a compound relational noun that is likewise a sandhi trigger). In the interest of space, I will not provide separate lexical entries for them here. The more challenging situation arises with alienable nouns that undergo sandhi only with dative possession or a discourse definite determiner. Unlike the categories described thus far, these nouns far more commonly occur either on their own or in non-sandhi domains, and hence it's unclear how frequently children would have encountered them in their sandhi allomorphs. The more likely case, as I see it, is that something about these constructions is treated as inalienable possession, hence tapping into the productive extension of inalienable meta-entries. These constructions would benefit from deeper syntactic and semantic study. For further discussion of one possible analysis of extension, see §9.1.

Just as learners project meta-entries for verbs or postpositions that follow the same patterns, I argue that the lexicon may take on further hierarchical organization, as similarities between different syntactic categories of heads are noted and form a higher level meta-entry. This situation is schematized in (39):

(39) *Hierarchical organization of the Seenku lexicon: Class III*



In other words, the lexicon is arranged into a series of ever more general constructional templates, which tie together commonalities across syntactic categories. These templates or schemas could even be viewed as general phrasal paradigms as in word-and-paradigm morphology (e.g. Ackerman, Blevins and Malouf 2009; Blevins 2016, etc.), pushing the boundaries of both wordhood and paradigmhood to include larger constituents. In principle, even words that do not alternate could project a meta-entry (e.g. a larger category of X-toned nouns), though it is unclear whether learners would have any motivation to build this layer of structure in the lexicon.

Under this view of the morphology, then, argument-head tone sandhi in Seenku is synchronically arbitrary. While there may have been phonetically or phonologically natural processes that gave rise to these alternations, language change has since obscured them, leaving speakers to memorize and generalize the patterns as they hear them. Non-undergoers can be accounted for in that they lack sandhi allomorphs in their lexical entry or they have a single listed allomorph that blocks the application of more general morphological patterns. It is interesting to note that there are even exceptions in Seenku to the phonetically natural patterns like S spreading (as shown in (19)), suggesting that even these cases may not be phonologized or fully productive (unlike what Zhang, Lai and Sailor 2011 argue for the more phonetically natural sandhi alternations in Taiwanese Southern Min).

An added benefit of this approach is that it alleviates the need for abstract underlying forms. Inalienable nouns and postpositions obligatorily occur with an argument (taking a generic 3SG pronoun *ã* in the absence of any overt argument in the discourse), meaning

they never surface with the “underlying form” that defines their class above (e.g. X-toned heads, H-toned heads, S-toned heads). A phonological account would force speakers to construct this abstract form as the computational base in order to determine the correct sandhi forms, but in the lexical approach, unless we define a default or elsewhere allomorph, all allomorphs are on equal footing; none stands out as the “underlying” form. For this reason, I give the lexical patterns abstract names like Class III rather than saying S-toned or X-toned since this tone is an analytical construct that may in fact rarely or even never surface.

This proposal is similar in spirit to two others in the literature: Pre-compiled Phrasal Phonology (Hayes 1990) and Emergent Phonology and Morphology (Archangeli and Pulleyblank 2012; 2016; 2017). First, pre-compiled phrasal phonology (or precompilation theory) was likewise proposed to deal with cases of phrasal allomorphy that are not properties of the postlexical phonological grammar as a whole. Like the approach advocated for here, such allomorphy is a lexical property, but one generated by phonological rules (precompilation rules) in the lexicon. Such rules alleviate the need for lexical listing of all allomorphs, and by referencing shared environments (“frames”), they can tie together commonalities between different processes. Precompilation theory and the framework proposed here are virtually identical in spirit but differ in the details. The current proposal shares the view that such alternations belong in the lexicon, but it differs in that alternations are extended to novel forms via analogical extension of meta-entries built from a network of stored allomorphs; phonological rules (or phonological grammar of any framework) are not duplicated in the lexicon and the phonological component proper, and syntax universally precedes the lexical component. As we will see in §7, both precompilation theory and the current proposal make the correct prediction that these sorts of alternations will precede even lexical phonological rules.

The approach I have laid out here most closely resembles the recent framework of Emergent Morphology (Archangeli and Pulleyblank 2016), and indeed could be seen as a notational variant of it. In both approaches, children build up morphemes by grouping together surface allomorphs that share morphosyntactic features. Archangeli and Pulleyblank (2016) give the example of the English plural, represented by the morpheme { -s -z -əz }. In Seenku, the morpheme for ‘head’ might look something like { k̀̀n k̀̀n } while the morpheme for ‘back’ would look like { b̀̀n b̀̀n b̀̀n }. Both frameworks do away with the notion of underlying form, instead appealing to a default form or elsewhere case; Emergent Morphology proposes that frequency plays a large role in determining this default, which I suspect would be the case for Seenku as well, though I have yet to explore the role of frequency in argument-head tone sandhi. The idea of meta-entries I have proposed here is a formalization of Archangeli and Pulleyblank’s “expressions of regularity” or “systematic relations”, such as those that hold between tonal allomorphs of Yoruba verbs. In short, both frameworks view the lexicon as a network of related forms, with children able to generalize patterns from exposure to surface forms. Archangeli and Pulleyblank themselves acknowledge the suitability of this framework for cases of complex sandhi like Taiwanese Southern Min without going into a detailed analysis, and the other examples they give do not involve the same degree of phonological, morphological, and especially syntactic conditioning as Seenku argument-head tone sandhi. I suspect that their Emergent Morphology analysis would look very much like what I have proposed here, making this sandhi pattern another prime example of the need for an emergent framework of the sort that they propose.

The difference between Emergent Morphology and the approach advocated here lies in the scope of allomorph selection in the grammar. According to Archangeli and Pulleyblank, all morphophonology, no matter how regular, is accounted for in the same

way. Jones (2016) pushes back against their analysis of Kinande tonal alternations, arguing that it not only misses clear generalizations about the data (that tone shifts once to left) but also that it fails to account for the full range of productive verbal alternations. Hyman (2018) likewise cautions against completely rejecting underlying representations, even if they are abstract, and suggests that even abstract URs could be “emergent” in the sense of Archangeli and Pulleyblank. I am sympathetic to these counterarguments. As I will argue again in the conclusion, I view surface allomorph tracking of the type I propose here as a step in morphophonological acquisition; learners will discover that most regular morphophonology can be captured through simple generalizations, such as “tone shifts once to the left”, or in the case of Archangeli and Pulleyblank’s Yoruba example, “L and H spread to the following syllable”. Some cases, though, like Seenku argument-head tone sandhi, defy such generalizations and remain in the lexicon as a network of allomorphs. Thus, I do not believe that appealing to an emergent system or allomorph selection in certain areas of the grammar precludes the construction of underlying forms or the use of regular phonology elsewhere; the learner’s toolkit may contain many tools. For more discussion, see §10.

In the next section, I will show how the allomorph selection approach to sandhi, combined with a cyclic spell out grammatical architecture (Uriagereka 1999; Chomsky 2000), allows us to account for ordering relations with other tonal processes in the language, such as plural formation.

7 Cyclic sandhi application

The previous section focused on simple sandhi domains, that is to say, domains with a single trigger and a single target, without any other complicating tone processes. However, it is often the case that tone sandhi interacts not only with itself in recursive domains but also with other phonological and grammatical tone processes in the language. The ways in which the tone processes interact give evidence for cyclicity. The question is, what is the locus of this cyclicity? I will show below that it cannot be phonological, as in a model like Lexical Phonology and Morphology (e.g. Kiparsky 1982), Stratal Optimality Theory (Bermúdez-Otero 1999; Kiparsky 2000), or even traditional Co-phonology Theory (Orgun 1996; Inkelas and Zoll 2005), where phonological form is computed each time a layer of morphological structure is added. Rather, the interleaving of word-level and phrase-level tone processes points to systemic cyclicity, with multiple passes through each stage of the grammar (syntax, morphology, phonology). I will couch the analysis that follows in the framework of cyclic spell-out, with syntactic structure sent to the morphological and phonological components in chunks known as phases (Uriagereka 1999; Chomsky 2000, etc.), though I will show that any approach with systemic cyclicity would fare equally well for these data. I first describe the patterns of interaction between sandhi and another morphophonological tone process, plural formation (§7.1), then lay out the cyclic analysis in §7.2. In §7.3, I show how the analysis can be extended to recursive sandhi domains (§7.3) and finally consider the non-recursive sandhi with compound heads (§7.4).

7.1 Sandhi and plural formation

Argument-head tone sandhi is by no means the only morphophonological tone process in Seenku. In some cases, sandhi can interact with these other processes, and these interactions provide us with evidence of timing of process application in the language. In this paper, I will focus specifically on the tone raising found in plural formation.

First, as outlined in McPherson (2017a), the plural in Seenku is formed by a combination of tone raising and vowel fronting (resulting in back-front diphthongs in stems with round vowels, (40c)); I will focus on the tonal effects here. Tone raising is argued to be

driven by the affixation of a [+raised] tonal feature, raising X to L and H to S, as shown in (40) (where slashes represent the form of the noun in the lexicon):

- (40) a. /bèɛ/ → bèɛ ‘pig(s)’
 b. /bí/ → bí ‘goat(s)’
 c. /sú/ → súi ‘antelope(s)’

S is the highest tone in the language, already specified as [+raised], and thus the plural has no tonal effect (40c). The fact that singular *bí* (with a HX contour) raises to S in the plural rather HL is one piece of evidence that these nouns are lexically level H-toned, with the X added in the phonological component to satisfy a tonotactic ban on final H in nouns.

The question is: Does the tone raising of plural formation apply before or after tone sandhi? The answer is both. If the argument is plural, its plural form is computed before it triggers sandhi on the head, as shown in (41):

- (41) a. bí_{PL} + SELL (Class II) → [bí sɔ̀ɔ̀]
 goat sell
 ‘sell goats’
 b. bèɛ_{PL} + HIT (Class III) → [bèɛ bə̀]
 pig hit
 ‘hit pigs’

I have shown the lexical heads in the input to sandhi in small caps, representing the fact that in the allomorph selection approach there is no single underlying form that we can put as the input to sandhi. Rather, the correct allomorph of the head is selected based on the form of the preceding argument, and here crucially, it is the raised tone of the plural (S in (41a) and L in (41b)) that serves as the sandhi trigger (selecting S- and L-toned allomorphs, respectively, rather than the X we would expect from their singular tones).

However, if the head is plural, tone raising applies to the output of tone sandhi:

- (42) a. mó + HAND_{PL} (Class II) → [mó cè̃]
 1SG.EMPH hand
 ‘my hands’
 b. í + HEAD_{PL} (Class I) → [í kɔ̀ɔ̀ɛ̃]
 2PL head
 ‘your heads’

Under the allomorph selection account proposed here, the head does not even have a phonological form that plural tone raising could apply to until the correct sandhi allomorph is selected. In (42a), a Class II noun will surface as X-toned after a H-toned argument, thus yielding the form *mó cè̃*; plural tone raising applies to this X tone, raising it to L and yielding the correct surface form *mó cè̃*. The same process applies in (42b), with H triggering the S-toned allomorph *kɔ̀n* of the Class I noun ‘head’. Plural marking applies to this form, yielding the surface form *í kɔ̀ɔ̀ɛ̃*.¹²

For the sake of argument, let us assume that these heads have abstract underlying forms, *cé̃* ‘hand’ and *kɔ̀n* ‘head’ respectively, as first presented in §5.1. If plural applied to the possessed noun before sandhi took place, it would derive *cé̃*, as in (43):

- (43) /cé̃/ + [+raised]_{PL} → [cé̃] ‘hands’

¹² Coda nasals are typically deleted in the plural. For further discussion, see McPherson (2017a).

This S-toned input to sandhi, when combined with a H-toned possessor, would then incorrectly derive *mó cè:

(44) /mó/ + /cɛ́/ → *[mó cè] ‘my hands’

Similarly, in the case of ‘your heads’ above, the plural would derive L-toned kǝ̀ɛ̀ if applied directly to the abstract underlying form kǝ̀n; unfortunately, since there are no underlying L-toned heads to which sandhi applies, we cannot say what the output would be in that case. Regardless, the surface form í kǝ̀ɛ̀ is consistent with the order Sandhi > Plural.

7.2 Cyclic spell-out

While this may seem to present an ordering paradox (Plural > Sandhi > Plural), it is perfectly consistent with a cyclic model of grammar. However, by cyclic, I do not mean cyclic computation within the morphophonological component (e.g. Stratal Phonology, Bermúdez-Otero 1999; forthcoming; Kiparsky 2000), since even the partial order Sandhi > Plural would require a phrasal process (sandhi) to apply before a word-level process (plural formation), running counter to the spirit of these frameworks. Rather, I use cyclic here to mean systemic cyclicality, where linguistic structure is built up incrementally, passing material through each component of grammar in turn. The specific framework I will adopt here is that of cyclic spell-out (Uriagereka 1999; Chomsky 2000), in which chunks known as “phases” are sent off to receive semantic interpretation and morphophonological form at various stages in the derivation. This systemic cyclicality is illustrated in Figure 2.¹³

Under this model, certain syntactic projections (commonly CP, vP, and DP) project phases, with the head of the phrase (C, v, D) known as phase heads.¹⁴ When a phase head is reached in the derivation, its complement (the computational unit, abbreviated here as CU) is sent to spell out, which consists of Morphology, Phonology and Semantics. The output of the phase is reinserted into the syntactic structure with only its phonological form and semantic interpretation; in other words, it crucially loses all internal syntactic structure, which accounts for a range of syntactic inalterability effects (see e.g. Chomsky 2000 on the Phase Impenetrability Condition).

A growing body of literature shows how phase-based spell-out interacts with and constrains morphophonological process application (e.g. Pak 2008; Newell and Piggott 2014; McPherson 2014; McPherson and Heath 2016; Sande 2017, among many others). While the morphological component in (44) is often implemented in Distributed Morphology (Halle and Marantz 1993; Embick and Noyer 2007), there is nothing inherent about this framework to the cyclic architecture of grammar; phase-based spell-out likewise places

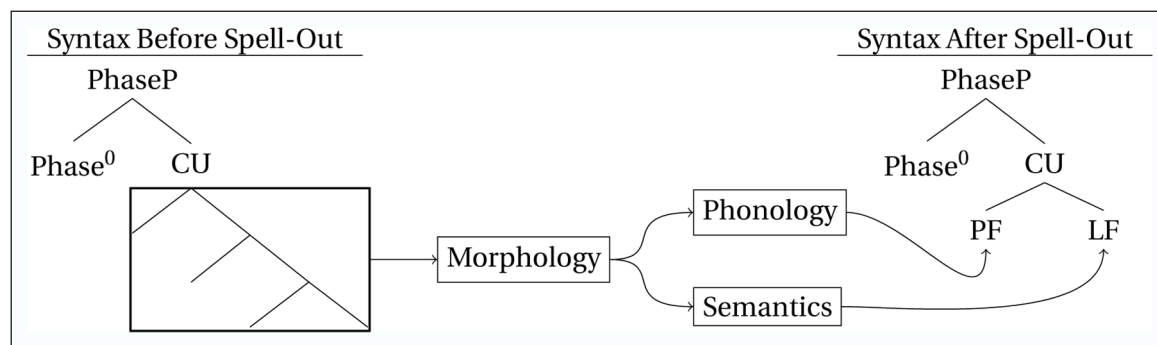


Figure 2: Cyclic spell-out of grammar.

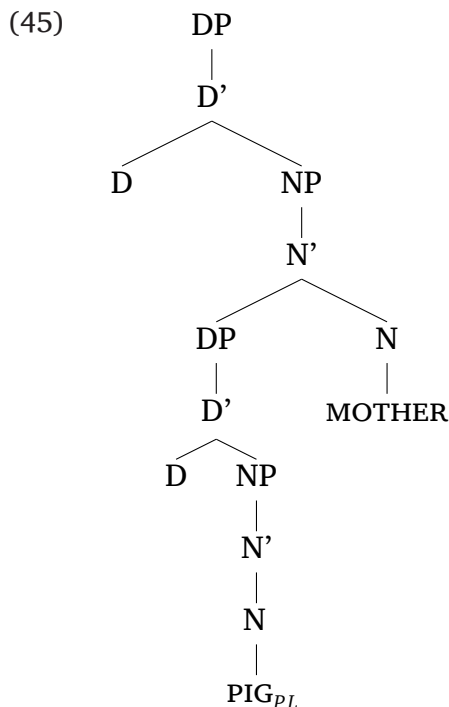
¹³ With thanks to Byron Ahn for this diagram.

¹⁴ For CP and vP, see Legate (2003), Rackowski and Richards (2005), Bošković (2007), van Urk and Richards (2015), etc. For DP, see Gutiérrez-Bravo (2001), Cinque (2011), Bošković (2014), etc.

no restrictions or demands on the phonological component, which could be rule-based or constraint-based, with ranked or weighted constraints.

As the analysis in §6 laid out (and following on work in McPherson in press, a), I argue that the morphological component in Seenku is firmly rooted in the lexicon, with lexical entries and meta-entries capable of generating novel forms. After syntactic structure is built in the syntactic component, the structure with its abstract lexical roots like $\sqrt{\text{HIT}}$ is matched with lexical entries, which could be as simple as the Seenku lexical items for a particular root or as complex as a lexicalized phrase consisting of an argument and a head.¹⁵ The forms pulled from the lexicon are then sent on to the phonology, where regular phonological operations like downstep or register assimilation take place. At the end of the cycle, internal syntactic boundaries are erased, and what remains is a chunk of structure with phonological form and semantic interpretation (essentially a lexical compound) that is then reinserted into the syntax and can be passed through subsequent cycles of spell-out.

Let us consider how these pieces combine to allow plural formation to apply to both the input and output of sandhi. First, I assume that D is a phase head in Seenku, which means that when it is reached, its complement (the NP and any other modifiers) is sent to spell-out.¹⁶ An inalienable possessive phrase consists of the possessor's DP embedded within the DP of the inalienable noun, as shown in (21). The NP (the complement of the phase head) of the more deeply embedded possessor will be sent to spell-out first and will receive its morphophonological form. This form will then be reinserted into the syntax and will undergo spell-out a second time when the higher DP is reached, triggering the spell-out of the NP headed by the possessed noun. We can illustrate this spell-out process with the phrase *bɛɛ nà* 'the pigs' mother':

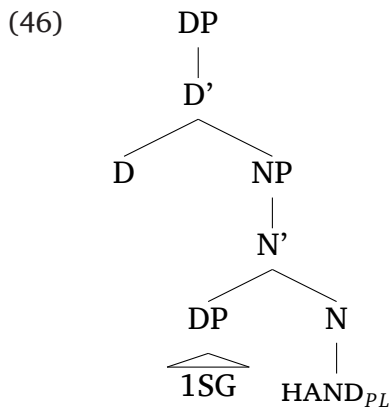


¹⁵ Indeed, they could be as complex as whole idiomatic phrases or sentences, which are lexicalized due to syntactic, semantic, or phonological idiosyncrasies.

¹⁶ This means that D would spell out in the next cycle and not with the DP that it heads. This is potentially an issue for the discourse definite, which triggers sandhi on the noun that follows. It may be that a more elaborate DP structure is present, such as the multilayered structure proposed by Zamparelli (2014), or it may be that the discourse definite is actually not treated as a D in Seenku but rather as a projection closer to the head. This area requires further work, including deeper investigation of DP syntax in the language.

I assume that the plural has its own lexical entry as a suffix consisting of two featural affixes, [+raised] and [+front]. Thus, when the embedded D is reached, the NP dominating PIG_{PL} is sent to spell-out. There, PIG matches the lexical entry $b\grave{\epsilon}\epsilon$ and the plural matches the lexical entry {[+raised][+front]}; when combined, the form $/b\grave{\epsilon}\epsilon$ [+raised, +front]/ is sent to the phonology, which governs the docking and realization of the floating features (McPherson 2017a). The form $[b\grave{\epsilon}\epsilon]$ is then reinserted into the syntactic structure under NP, which no longer has any internal syntactic structure (i.e. if there had been any word boundaries in a more complex NP, they would be erased at this stage). When the higher D phase head is reached, the NP headed by $MOTHER$ is sent to spell-out, taking with it the spelled-out material $[b\grave{\epsilon}\epsilon]$ as its complement. $MOTHER$ is an inalienable noun, and thus its lexical entry includes not only itself but also the tone of the preceding argument, which determines the allomorph. The L-tone on $[b\grave{\epsilon}\epsilon]$ triggers the use of the L-toned allomorph of $MOTHER$, $\eta\grave{\alpha}$. This form $b\grave{\epsilon}\epsilon \eta\grave{\alpha}$ is then sent to the phonology, which leaves it unaltered on the surface. Thus, here, plural applies before sandhi by virtue of the fact that the possessor has already passed through Morphology and Phonology on a previous cycle of spell-out.

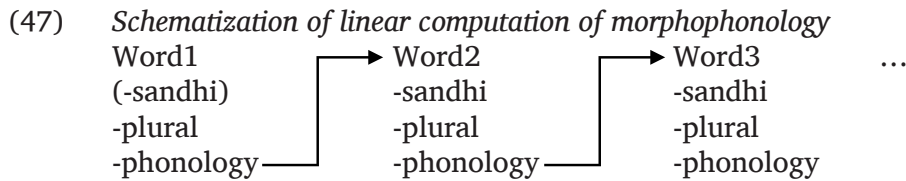
This architecture likewise explains how plural heads show the application of sandhi before plural formation. Consider the expression $m\acute{o} c\grave{\epsilon}$ ‘my hands’ in (42a) above, with syntactic structure as in (46):



The possessor DP for the 1SG is more deeply embedded and it defines the phase sent to spell out first, where the lexical item $m\acute{o}$ is selected. This form is then reinserted into the syntax. When the higher DP containing $HAND_{PL}$ is reached, the NP is sent to spell-out with $m\acute{o}$, where the lexical entry for ‘hand’ designates the allomorph $c\grave{\epsilon}$ for use after a H-toned argument. This is passed to the phonology with the plural morpheme as $/m\acute{o} c\grave{\epsilon}$ [+raised, +front]/, where [+raised] raises X to L. In other words, there is no opportunity for the plural to act on an “underlying” form of ‘hand’ before sandhi applies, since the very act of selecting an entry from the lexicon requires sandhi to apply.

The crucial facts of this analysis are simply that the grammar is cyclic, and that this cyclicity is not confined to a single component like the morphophonology; if it were, it would create an ordering paradox and also complicate the order of application between word-level and phrase-level processes. The phase-based approach I employ here avoids these issues through systemic cyclicity, allowing multiple passes through each component of grammar as the structure is built up. In principle, any framework with this property would fare equally well. For instance, the data could be accounted for with a morphophonological grammar that works on a linear string from left to right. The leftmost word would not have a sandhi form, since it is not preceded by a sandhi trigger, so it would be evaluated for plural and any other morphophonological processes, then the second

word would first be evaluated for its sandhi form based on the preceding tone, before the application of plural, and so on and so forth. This is schematized in (47):



This sort of linear application of morphophonology is reminiscent of recent work in computational phonology implemented using finite state transducers (e.g. Chandlee 2014; Chandlee, Eyraud, and Heinz 2014; Heinz 2018, etc.), and left-to-right linear structure building has been proposed in the realm of morphosyntax as well, e.g. in works like Phillips (1996; 2003). If we assume that each new word in the derivation first retrieves its appropriate allomorph from the lexicon, along with any other morphemes corresponding to its morphosyntactic features (e.g. plural) and then is sent on to phonological computation, then this strictly linear model would work equally well. Since I know of no cases of long distance or non-adjacent application of sandhi, the two models would make the same predictions. Further evidence, perhaps from purely syntactic phenomena, are required to test the predictions of each the linear versus phase-based models.

What is crucial for Seenku argument-head tone sandhi is that the grammar as a whole is cyclic.

7.3 Recursive sandhi domains

The cyclic approach laid out in §7.2 also naturally accounts for the recursive application of sandhi. Sandhi domains can be recursive, through recursive possession and/or having possessive DPs as objects or complements of a postposition. In both of these constructions, more deeply embedded DPs are on the left, with heads stacking out towards the right. Sandhi applies from left-to-right, which in this case matches the depth of embedding (inner to outer):

- (48) a. *mó* + MOTHER(II) + BACK(III) → [[*mó* *nà*] *bòn*]
 1SG.EMPH mother back
 ‘my mother’s back’
- b. *à* + BACK(III) + LOC(II) → [[*à* *bó*] *nè*]
 3SG back LOC
 ‘behind his back’
- c. *mó* + MOTHER(II) + BUY(I) → [[*mó* *nà*] *sà*]
 1SG.EMPH mother buy.IRLS
 ‘buy my mother’

As with the interaction of the plural and sandhi in §7.1, it is difficult to say what right-to-left application would look like, since the heads require the input of the argument’s tone in order to make an initial allomorph selection. Thus, in (48a), the H-toned pronoun *mó* triggers the selection of *nà* for the Class II noun ‘mother’, which in turn triggers the selection of *bòn* for the Class III noun ‘back’. In (48b), the X-toned pronoun *à* triggers the selection of the H-toned allomorph *bón* for the same Class III noun ‘back’, which triggers the X-toned allomorph *nè* for the Class II locative postposition. Finally, in (48c), the initial argument-head combination is the same as in (48a), but the X-toned allomorph of

‘mother’ *n̄à* triggers the selection of the L-toned allomorph *s̄à* of the Class I verb ‘buy’, which in turn raises the tone of ‘mother’ to L (see §9.2).

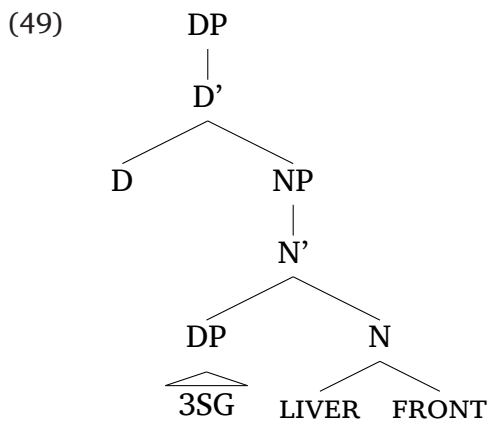
If we gave these heads abstract underlying forms, as in the table in (9) earlier in the paper, we would see that right-to-left application of sandhi would result in incorrect surface forms. For instance, in (48b), right-to-left application of sandhi in an abstract underlying sequence /*à bôn né*/ would yield incorrect **à bôn n̄é*, while the same order of application in (48c) on the abstract sequence /*mó pá s̄à*/ would yield **mó n̄à s̄á*. Left-to-right application both predicts the correct forms and avoids the need for abstract underlying forms.

These results follow directly from either of the cyclic approaches laid out in the last subsection. To take (48a) as an example with the phase-based approach, the possessor *mó* is the most deeply embedded DP, and hence the first to be sent to spell-out, where /*mó*/ is selected from the lexicon (or perhaps /*ń wó*/, which is transformed to [mó] in the phonology). This is reinserted into the syntax, and at the next deepest DP, *mó* + MOTHER is sent to spell-out, where the X-toned allomorph of ‘mother’ is selected since it is preceded by a H-toned argument; the output of this cycle is [món̄à], which is reinserted into the syntax (without its internal boundaries). Finally, the highest DP level is reached, and *món̄à* + BACK is sent to spell-out, where the X-toned allomorph of ‘back’ is selected because of the preceding X-final argument. The linear model predicts the same results; in other words, the application of recursive sandhi could be viewed as either a consequence of the syntactic structure or of the linear string passing through a left-to-right cyclic grammar.

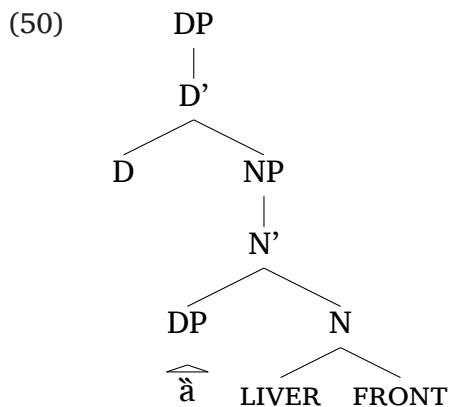
7.4 Complex heads

The recursive domains in the last subsection stacked sandhi domains by having the argument of a head be itself an argument + head combination. In this configuration, the left-to-right directionality mirrored the branching, meaning it could be naturally accounted for by either model of systemic cyclicity (phase-based or linear). However, it is also possible to have complex heads, and in this case, the bracketing would be [X [Y Z]] instead of [[X Y] Z]. In what order or direction would sandhi be applied?

The linear left-to-right account would of course predict left-to-right application, regardless of branching structure. While the phase-based account might seem to predict the opposite, recall that the compound noun would be sent to spell-out in the same cycle, together with the previously spelled out argument, leaving the morphological component to select the correct allomorphs corresponding to the syntactic structure in the same pass. Let us consider a concrete example with the compound noun ‘chest’ (lit. ‘liver-front’):



Under cyclic spell-out, the DP containing the 3SG possessor defines the first phase, and 3SG would spell out first, receiving the morphophonological form *à*. This would be reinserted into the syntax, leaving the following:



When the higher DP is reached, the NP consisting of {*à* LIVER FRONT} is sent to Morphology, where the lexicon looks to match the structure with lexical entries. As a compound noun, ‘chest’ is likely to be lexicalized rather than computed fresh each time a speaker wishes to utter it. And since the compound is an inalienable noun, as indicated by the syntactic structure, it too is likely to have listed allomorphs for different contexts (*br̃n-jěn* after S, *br̃n-jèn* elsewhere). In the context of the 3SG *à*, *br̃n-jèn* would be selected (causing *à* to raise to *â* in the phonology; see §9.2 below). Lexical listing of compounds would likewise account for exceptional compounds like *k̃n-kó* ‘skull’ that resist sandhi, as seen in §5.2.2.

Even if the tonal form of the compound were computed online from individual lexical entries, the result would be the same. For instance, the lexical entry of LIVER would be activated, with the correct allomorph chosen based on the tonal context to the left regardless of what tone follows; this would yield *br̃n*. The second stem is likewise inalienable, and Morphology is unable to select the correct allomorph until it has a tonal context to its left, requiring the leftmost stem to be computed first; once the allomorph *br̃n* is selected, then *jèn* can be inserted for ‘front’, and this sequence X X L would be L L L in the phonology (§9.2).

Thus, left-to-right application of sandhi with complex heads is consistent with either strictly linear cyclicity or with a phase-based approach, precisely because the lefthand context must be defined before the correct allomorph can be selected. The only difference is that the phase-based model predicts that spelled out material is resubmitted to phonological computation at each cycle, if it is embedded in a phase sent to spell-out, whereas the linear model may have to stipulate this separately in order to allow the later raising of X to L. I return to this point in §9.2.

8 Alternative approaches

Before concluding, I will briefly consider three alternative approaches to the data: a strictly phonological approach (§8.1), a Co-phonologies by Phase approach (§8.2), and a traditional Distributed Morphology approach (§8.3). In each case, I will show why the analysis laid out in §6–7 is to be preferred on grounds of naturalness and explanatory power.

8.1 Phonological approach

Those who advocate for an allomorph selection approach to Taiwanese tone sandhi state that the system is simply too opaque and phonetically unnatural to be a phonological in nature (see e.g. Moreton 1999 on the non-computability of circular chain shifts in OT), but phonological analyses have been proposed. Hsieh (2005) and Barrie (2006), for instance, use an anti-faithfulness constraint (Alderete 2001) –IDENT-IO(T) to motivate the sandhi alternations; in other words, tones should not remain the same as their underlying form in sandhi domains. To avoid all tones neutralizing to some unmarked sandhi tone, contrast

preservation (Lubowicz 2003) could be invoked. Set up correctly, this could go so far as to motivate a circular chain shift, but it requires the grammar to evaluate entire scenarios comparing input-output pairs rather than taking forms individually, adding a layer of complexity to the computation of surface forms.

For Seenku, we would additionally need a slew of markedness constraints to force sandhi tones away from unattested sequences, like *X S to force lowering after X, or *S→S to drive the S spreading pattern. The tone features [upper] and [raised] could likewise be invoked to force agreement between arguments and heads, such as agreement in [raised] between X and H (as opposed to between X and L, or X and S), which could help provide phonetic motivation for some of the avoided sequences. Note, however, that there is no independent motivation for a markedness constraint like *X S, as this sequence is tolerated in other environments.

As shown in McPherson (in pressa), even this complicated phonological grammar, with a whole toolkit of enhancements, cannot distinguish between the attested tone circle (S→H→X→S) and its reverse. In the interest of space, I do not lay out tableaux here, but refer readers to McPherson (in pressa). Even beyond the issue of motivating the correct alternations, this approach would suffer from further problems, including lexical exceptions, the imperviousness of multi-tonal heads, and the ordering between sandhi and plural formation, since now a phonological process (sandhi) would need to precede a morphological one (plural), even within a single cycle. That is, a form like *mó tõe* ‘my ears’ would need the phonology to choose the sandhi form [tõe], to which plural tone raising would apply. To maintain the phonological nature of sandhi, cyclicity would have to be introduced into the morphophonology to allow sandhi to precede plural formation, but this would mean a phrasal process would occur before a word-level process, which is far from the spirit of lexical phonology and morphology (Kiparsky 1982; 2000, etc.).

The allomorph selection approach advocated for here avoids this overly baroque phonological architecture while at the same time naturally accounting for process ordering and exceptions.

8.2 Co-phonologies by phase

A middle ground could be found between this purely lexical approach and a purely phonological approach. Recent work by Sande (2017; 2018) and Sande and Jenks (in press) take a similar approach to the (morpho)phonology-syntax interface, with the timing and domains of process application defined by cyclic spell-out, and lexically-, morphologically-, and syntactically-conditioned phonology implemented in co-phonology theory (Orgun 1996; Anttila 2002; Inkelas and Zoll 2005). This hybrid framework, Co-phonologies by Phase (CBP), formally implements construction-specific phonology by associating partial rankings of phonological constraints with particular lexical items (or Vocabulary Items, in the Distributed Morphology terms used in the approach). When a phase is sent to spell-out, any partial rankings of lexical items within the phase are percolated up to the top of the phase, and this new ranking is used to compute the phonological form of the spelled out material.

We would first have to decide where to associate the co-phonologies: to the inalienable nouns, post-positions, and verbs themselves? To the arguments? Or to some structural property of the construction, like an irrealis projection for verbs or some sort of inalienable possessive projection for nouns? The benefit of associating the co-phonologies with lexical items is that the entire system, with its circular chain shifts, need not be accounted for in the same phonological grammar. There could be a grammar for underlying X tones, which causes them to raise to L or S, another grammar that polarizes H to X or S, etc. The issue with associating partial rankings with the lexical items themselves, however, is

that they may not always find themselves in sandhi domains. This is especially true for regularly alienable nouns that wind up in dative possessive constructions, where they undergo sandhi (§5.2.3). The problem is worse if we associate the co-phonologies with the arguments, which likewise do not always trigger sandhi on a following word. If we associated the co-phonologies with a structural aspect, such as irrealis, we are left with the same complicated phonological grammar as we saw in §8.1.

The other issue with the CBP approach, assuming we could find the correct locus for co-phonologies, is that the partial rankings are inherited by the whole phase and apply to that domain. As we saw in §5.2.2, there are other elements in the spell-out domain of a sandhi undergoer that resist sandhi; adjectives and numerals, for instance, also occur within the DP but they resist sandhi. In other words, sandhi domains are not co-extensive with spell out domains in Seenku. Thus, we need an approach that allows us to target specific heads and not an entire spell out domain, which the allomorph selection approach allows us to do.

8.3 Distributed Morphology

As shown in §7.2, some assumptions of the analysis, such as Syntax before Morphology, are consistent with Distributed Morphology (Halle and Marantz 1993; Embick and Noyer 2007, etc.). Indeed, DM likewise allows for the listing of allomorphs in different subcategorization frames (phonological, morphological, or syntactic). However, in order for allomorph selection to work in DM, every noun, verb, and postposition would need to have listed allomorphs, since the Vocabulary in DM is nothing but a list of entries (Vocabulary Items); in other words, the lexicon in DM is not generative and cannot account for the productive extension of sandhi patterns if listed allomorphs are responsible.

For sandhi to productively extend to novel combinations or novel forms in DM, the tonal alternations would need to be the product of morphophonological rules applying between vocabulary insertion and the regular phonological component. This would require positing abstract underlying forms for sandhi undergoers (and diacritics for exceptional forms that resist sandhi). Taking the idea of “rule” literally, we could posit SPE-style rules like $S \rightarrow H/X_$, but if we assume some form of constraint-based phonological grammar (as many do in current phonological theory), this has the consequence of requiring two kinds of phonological computation (rules and constraints). If morphophonological rules are instead sets of ranked or weighted constraints, then we run into the same problems as we saw in the phonological approach in §8.1.

By giving the lexicon greater power to generate novel forms through the use of meta-entries, we avoid both the problem of having to list every allomorph for every possible sandhi undergoer and the issue of having to compute tonal alternations by rules or constraints.

9 Remaining issues

Before concluding, I briefly discuss two remaining issues in the analysis: productivity and leftward raising of an argument’s X tone to L.

9.1 Productivity: evidence from alienable nouns

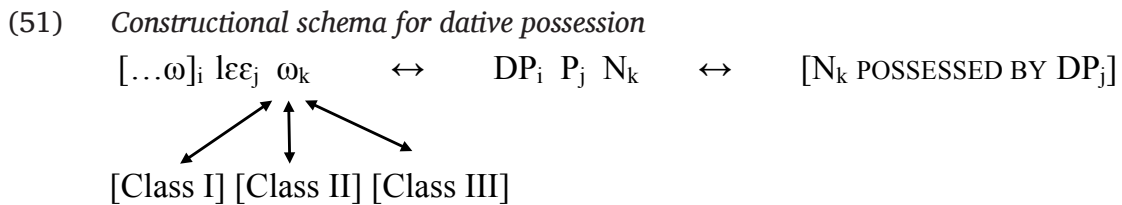
Recent studies of Chinese sandhi systems have been exploring the productivity of sandhi through nonce word (wug) testing (see e.g. Hsieh 1970; 1975; 1976; Zhang and Lai 2008; 2010; Zhang, Lai and Sailor 2009; 2011; Chuang, Chang, and Hsieh 2011; Zhang 2016; Zhang and Meng 2016, etc.), with varying results. For instance, studies on Taiwanese Min tone sandhi have shown only limited productivity of the opaque tone circle (Zhang, Lai and Sailor 2011), while in Mandarin, the phonetically natural half-third tone sandhi was

found to be more productive than the less natural third tone sandhi (Zhang and Lai 2010). We could argue that the productivity of a system should be directly inverse to its degree of lexicalization.

It would be enlightening to study the productivity of Seenku tone sandhi in this way, but unfortunately the methods do not translate well to the rural field setting where Seenku is spoken. First, Seenku is an unwritten language, so prompts would have to be oral. Unlike in the Chinese languages of these studies, there is often not a citation form that avoids sandhi application that could be presented orally. And finally, I have found wug testing to be a challenge in West African field situations, where speakers are unsure of what they are being asked to do or unwilling to consider the notion of a non-word (“But that’s not a word!”).

The closest we can get to wug testing Seenku argument-head tone sandhi is to apply it to words that do not regularly undergo sandhi, i.e. alienable nouns in the dative possessive context. I take this construction to be an extension of the regular inalienable construction (a sandhi environment) to nouns that would not otherwise have lexicalized allomorphs. In other words, the lexical entry for a word like ‘dog’ would be simply <DOG (n.) jəgè >, the independent form, rather than having listed allomorphs.

In the framework proposed here, the lexicon is a network of interrelated constructions, which may activate one another. We have seen the lexical entries for individual lexical items and their allomorphs, but there are likely higher level phrasal constructions for phrases with idiosyncratic properties (semantic idiosyncrasies in the form of idioms, Booij 2010b, or phonological idiosyncrasies, as in Dogon tonosyntax, McPherson 2014). Dative possession is likely to be one of these idiosyncratic constructions, treated like inalienable possession by the morphophonology despite taking alienable nouns (and no reported difference in meaning from the regular genitive alienable construction). I suggest that this construction might activate the paradigms for inalienable nouns with their sandhi alternations, which override the lexical tone of the alienable nouns. This configuration is schematized in (51):



In the phonological component on the left, the lengthened dative postposition *lεε* is unspecified for tone, since it will select its sandhi allomorph by virtue of being a postposition. The possessed noun, ω_k , is linked in the lexicon to the constructional templates for inalienable nouns, classes I, II, and III.

The one potential snag in assigning an alienable noun to the correct class returns to the question of underlying tones. Recall that inalienable nouns never surface without sandhi, so any underlying form is necessarily abstract. There are two possible solutions to this problem: the first is that there may be enough common alienable nouns lexicalized with sandhi variants (‘thing’, ‘person’, ‘woman’, ‘man’, etc.) that these can provide the clues for class membership. The second is that the networks of sandhi forms in the lexicon extend beyond inalienable nouns and include postpositions and verbs as well, the latter of which provide better clues to an underlying or citation form, since they do not undergo sandhi in realis environments.

Returning to the question of productivity, we could use the measure of how many alienable nouns have this pattern extended to them as a rough approximation. More systematic

testing is required, but based on data gathered so far, I have found no exceptions among monotonal native Seenku roots (like *bɛɛ* ‘pig’, *cí /cí/* ‘house’, *məní* ‘woman’, etc.); all of these follow the expected pattern of sandhi. The only avoidance I see of this construction is when sandhi would neutralize the distinction between singular and plural (e.g. *móò bɛɛ* ‘my pig(s)’), in which case speakers will sometimes revert to the genitive plural where the two are distinct (e.g. *mó tɛ bɛɛ* ‘my pig’ vs. *mó tɛ bɛɛ* ‘my pigs’). The other area of interest would be loanwords, which would be less likely to have multiple lexicalized allomorphs. While we could design a study asking speakers to produce possessive expressions with loanwords, there would likely be a priming effect, such that once speakers start producing sandhi variants in this context they are likely to continue producing them. More telling would be a corpus study, looking at natural behavior. The current corpus does not contain enough examples of this possessive construction, especially with loanwords, to draw any conclusions. I leave productivity testing to future work.

9.2 Raising of the argument to L

The final question to address is the mechanics of the retroactive change of X-toned arguments (which have already spelled out) to L before an X-toned head. We can say with certainty that this is not the result of a local change, such as a left-docking floating [+raised] feature from the L-toned sandhi variant, since X to L raising effects the entire domain. This is the case even in recursive sandhi domains, where multiple preceding morphemes in a complex argument all raise to L:

- (52) a. à ɲà
3SG mother
‘her mother’
- b. à ɲà kɔ̀n
3SG mother head
‘her mother’s head’

There is reason to believe that this is not a lexical/morphological process but rather a more general phonological one sensitive to phonological phrasing. For instance, we find the same X to L raising of possessive arguments when the head is marked for plural, a tone raising process that I have argued to be implemented in the phonology by docking a floating feature:

- (53) a. à cɛ̀n
3SG breast
‘her breast’
- b. à cɛ̀
3SG breast.PL
‘her breasts’

In (53a), we can see that the sandhi allomorph of breast is X-toned, and the possessor likewise retains its X. When [+raised] docks to this X tone as in (53b), the effect of raising is felt in the possessor as well, despite the fact that [+raised] of the plural usually just affects the final tone (i.e. it is a suffix; see McPherson 2017a). While this looks like a case where perhaps the X tone of the possessor has spread onto the head noun, leaving just a single X autosegment to raise with the addition of [+raised], other sandhi combinations do not involve spreading (H-X, X-H, etc.), so I hesitate to posit phonological spreading in only those cases where the tones are identical.

In fact, evidence suggests that this raising is a more general phonological process in the language, targeting phonological phrases with the underlying sequence X-L. In the two examples in (54), we see a definite article *à* raising to L before a L-toned plural noun, as well as a singular noun *jù* ‘year’ raising to L before a L-toned numeral:

- (54) a. *à m̀ɛ̀ t̀è*
 DEF person.PL GEN
 ‘for the people’ (cf. *à* ‘DEF’)
- b. *j̀ù ǹò*
 year five
 ‘five years’ (cf. *j̀ù* ‘year’)

The definite article *à* is X-toned in front of all other tones (*à b̀ɛ̀ɛ̀* ‘the pig’, *à b̀î* ‘the goat’, *à m̀aǹí* ‘the woman’), but with a following L created by plural formation, it raises. In (54b), it is tempting to view the L on *j̀ù* as being the result of plural formation—the phrase, after all, has a plural meaning. But nouns are not obligatorily plural before cardinal numerals, and further, the plural form of ‘year’ involves vowel fronting: *j̀ùí* ‘years’. Thus, this L tone is likely phonological in nature, the result of a markedness constraint against the sequence X-L within a phonological phrase. Note that the process must be phrase-bounded, since we do not see raising between e.g. a subject and an intransitive verb (see for example (32a)).

One last point here deserves mention: the fact that previously spelled out possessive DPs can raise from X to L, one or more cycles later, shows that there can be no “phonological impenetrability condition”. In other words, spelled out material can be altered phonologically to meet phonological demands. This is contra previous work, such as Piggott and Newell (2006), Dobler (2008), or Lowenstamm (2010), where the phase impenetrability condition for syntax is extended wholesale to phonology. Rather, I assume, following Michaels (2013), Šurkalović (2013), McPherson (2014), and McPherson and Heath (2016), that the tension between phases apparently blocking the application of morphophonology and cases like Seenku where they do not can be resolved with a violable output-to-output faithfulness constraint IDENT(phase), which languages can rank or weight in different ways. In Seenku, it must be lowly ranked.

10 Conclusion

This paper has provided a deep dive into Seenku argument-head tone sandhi. I have shown that this complex system is constrained by morphosyntactic and lexical factors, and that the opaque tonal alternations themselves defy simple phonological explanation. However, the patterns can be naturally accounted for in a lexical approach, with sandhi allomorphs stored in lexical entries with subcategorization frames for phonological and/or morphosyntactic context. These “lexical paradigms” combine into ever more general lexical templates, giving the lexicon a hierarchical structure which can be leveraged to productively extend sandhi patterns by analogy. The apparent ordering paradox between plural formation and sandhi application is resolved by couching the system in a cyclic model of grammar, with syntactic structure built up and evaluated in phases.

Future work will target the productivity and learnability of the system, including the predictions made about first language acquisition under the allomorph selection model. Specifically, I propose that all phonological learning begins as a process of allomorph distribution tracking, with children learning allomorphs and their contexts until the point at which generalizations can be drawn. If allomorph distribution is regular and phonetically natural enough, it may be phonologized, but certain alternations may “get stuck” at

the lexical level, as I argue Seenku sandhi has. We are likely to see these systems go one of two ways in language change: either they become too opaque to learn and undergo restructuring (as in Odawa, Bowers 2015), or they remain lexicalized and eventually start accumulating more and more exceptions as sandhi is not extended to novel words and forms are learned without sandhi allomorphs. A pilot study on first language acquisition planned for summer 2019 may begin to shed light on these questions.

Finally, I view the Seenku alternations as inhabitants of what Moreton (1999: 30) has called “the thinly populated twilight zone between syntax, morphology, and phonology,” the sorts of data that seem all too willing to slip from one component of grammar to another. I suspect that this twilight zone is far more densely populated than we might think, and the allomorph selection approach advocated for in this paper is able to account these data. In short, the lexicon likely plays a much stronger role in the transition from phonology to morphology and the productive extension of patterns than has been previously assumed.

Abbreviations

DAT = dative, DEF = definite, D.DDEF = discourse definite, DEM = demonstrative, EMPH = emphatic, GEN = genitive, HAB = habitual, IRLS = irrealis, LOC = locative, NEG = negative, PERF = perfect, PFV = perfective, PL = plural, PROSP = prospective, PST = past, REL.SUB = relative subject, RLS = realis, SG = singular, SUBJ = subjunctive, TRANS = transitive

Additional File

The additional file for this article can be found as follows:

- **Appendix.** Summary of sandhi patterns, with cross-references. DOI: <https://doi.org/10.5334/gjgl.798.s1>

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Competing Interests

The author has no competing interests to declare.

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