Complexity, Naturalness, and Explanatory Power: The Case of Seenku Argument-Head Tone Sandhi

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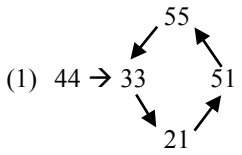
1. Introduction

When faced with complex alternations, linguists are faced with a dilemma: Given that complex phenomena rarely lend themselves to simple analyses, where is the analytical complexity best justified? Is it better supported in the phonology proper, in the morphology, or in some combination of grammatical components? With phrasal alternations, the question becomes more complicated still, as the role of syntax must also be considered.

This paper probes the question of analytical complexity using data from argument-head tone sandhi in Seenku (Western Mande, Burkina Faso). These complex tonal changes occur phrasally, between a head and its internal argument, and depend on phonological, morphological, and syntactic factors. I compare a phonological and lexical approach to the data, arguing that the lexical approach is to be preferred on the grounds of naturalness and explanatory power, and it allows the phonological component to remain restrictive.

The Seenku case is reminiscent of another famous tone sandhi debate in the literature, the infamous Taiwanese Min tone circle (Chen 1987, Tsay and Myers 1996, Zhang and Lai 2008, etc.). The basic data are shown in (1):

(1) 

In Taiwanese, base tones (T) become their sandhi variants (T') in non-final position, where domains are determined by syntactic structure (Chen 1987, Hsiao 1991). The data present a challenge to phonological accounts due to the presence of a circular chain shift (counterfeeding opacity). Nevertheless, phonological analyses have been proposed, deploying modifications to regular markedness-based phonology such as contrast preservation (Lubowicz 2003), anti-faithfulness (Alderete 2001), or both; see Horwood (2000), Hsieh (2005), Barrie (2006), and Thomas (2008). At the same time, others have argued that the phonetically arbitrary changes seen in Taiwanese, coupled with low levels of productivity, point to an allomorph selection approach, with both base tones and sandhi tones listed as allomorphs of a lexical item (Tsay and Myers 1996, Zhang and Lai 2008, Zhang et al. 2011, etc.).

The Seenku data are even more complex than Taiwanese in a number of ways: first, while each Taiwanese base tone has just one sandhi allomorph (determined by phrasal position), Seenku displays up to three **sandhi** variants, with alternations determined by the combination of the argument's triggering tone and the head's undergoing tone. Second, while Taiwanese sandhi domains are broadly defined by the syntax, Seenku domains rely on specific morphosyntactic information, including syntactic category

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and even inflectional categories; see §3 for further discussion. Drawing on categories from Zhang's (2014) typology of Chinese tone sandhi, we can say that Seenku tone sandhi is both tonally and positionally induced, left dominant, and yet paradigmatic in its tone changes, presenting what could be considered the missing "mirror image" of Taiwanese tone sandhi (Hsieh 2005).

To account for these complexities, I outline an allomorph selection approach to the data, drawing together aspects of constructional templates (Booij 2010) and word-and-paradigm morphology (Ackerman et al. 2009, Blevins 2016), with a hierarchical lexicon. I show that this approach can fully account for the data, including domains, lexical exceptions, and process ordering, which the phonological approach fails to account for. Further, I sketch out a view of phonological acquisition in which such an approach is a stage that all phonological alternations pass through on their way to regular phonology—but some, like Seenku sandhi, get stuck.

2. Background on Seenku

Seenku is a Western Mande language of the Samogo group spoken in southwestern Burkina Faso by about 17,000 speakers. There are two primary dialects; Northern Seenku, spoken by 5000 speakers, was the subject of a sketch grammar (Prost 1971). Southern Seenku has about 12,000 speakers; it is the focus of my ongoing fieldwork and forthcoming reference grammar (McPherson in prep). All data in this paper are drawn from my primary notes, gathered in the field since 2013.

The language has a highly complex tone system, with four contrastive levels. The naming and marking conventions for these tones are as follows: extra-low (X, ä), low (L, à), high (H, á), and super-high (S, ǎ). The primary acoustic correlate of the four levels is f0, as shown in the following normalized plot from a female speaker.

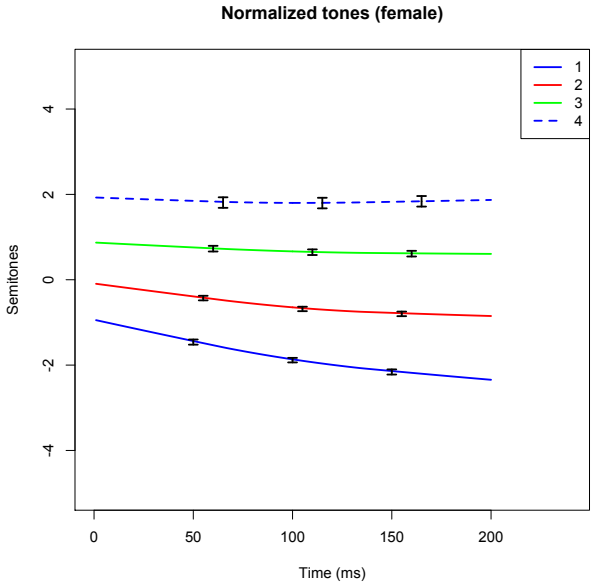


Figure 1: Normalized level tones (in semitones) from a female speaker.

Of the four tones, the second lowest L is lexically rare; it is likely the newest tone in the inventory and is typically created through grammatical processes such as plural formation (McPherson 2017a), though the presence of morphologically simplex L-toned words demonstrates the need to treat it as a phonemic category. Additionally, these four tone levels can combine to create numerous two- and three-tone contours, which may be underlying and lexical or created through morphological processes.

I have argued (McPherson 2017b) that Seenku's four tones arise from two binary tone features, following proposals by Yip (1980), Pulleyblank (1986), and others. Table 1 shows the representations of the four tones. Evidence for tone features can be found in the morphology, including plural formation and perfective inflection, but I will show below how these features could be used in a phonological account of tone sandhi.

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

Table 1: Tone features account for Seenku's four tonal primitives.

Beyond tone, the vast majority of Seenku vocabulary is either monosyllabic or "sesquisyllabic" (Matisoff 1990), in other words a full syllable preceded by a half or minor syllable, e.g. *təgə̂* 'chicken', *kərù* 'hyena', etc. The half syllable is not an independent tone-bearing unit, so the tonal behavior of monosyllabic and sesquisyllabic words is the same both in terms of lexical melodies and sandhi patterns.

3. Argument-head tone sandhi

As the name indicates, sandhi takes place in Seenku between a head and its preceding internal argument. Under most circumstances, it is the head that undergoes sandhi, but in one cell of the paradigm, both may undergo; see below. The configuration is schematized in (2):

(2) Argument + Head → Argument + Head'

The relevant domains subsumed by "argument-head" include inalienable possession (Possessor + Noun), a verb and its preceding direct object, and a postposition with a preceding DP. In the verbal case, however, sandhi only occurs if the verb uses its irrealis stem, despite no changes in word order in the realis. For example, sandhi occurs in the left-hand examples in (3) when the verb is irrealis (here, in the prospective) but fails to apply in the right-hand when the verb is realis (here, in the perfective); the word order in each case is the same.[1]

(3) a. à nă à **bą́**
3SG PROSP 3SG hit.IRREAL
'He will hit him.'

à lɛ̋ à **bą́**
3SG PST 3SG hit.REAL.PFV
'He hit him.'

b. à nă mó **bą̀**
3SG PROSP 1SG hit.IRREAL
'He will hit me.'

à lɛ̋ mó **bą́**
3SG PST 1SG hit.REAL.PFV
'He hit me.'

c. à nă mí **bą̋**
3SG PROSP 1PL hit.IRREAL
'He will hit us.'

à lɛ̋ mí **bą́**
3SG PST 1PL hit.REAL.PFV
'He hit us.'

In the left-hand column, the irrealis verb alternates, with sandhi variants dependent upon the preceding argument's tone; in the right-hand column, the realis verb remains an invariant H, indicative of perfective aspect. Thus, as we can see, the definition of sandhi domains relies on more than general syntactic phrasing. For more on (ir)realis in Seenku, see McPherson (2017c).

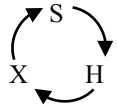
The alternations in argument-head tone sandhi are likewise more complex than in Taiwanese. Rather than each base tone having a single sandhi variant, alternations depend on the combination of the head's underlying tone and the tone of the preceding argument. Furthermore, alternations may differ depending on whether the argument is pronominal or non-pronominal. Table 2 summarizes the alternations with pronominal arguments. Note that only the most common lexical tones X, H, and S are considered, since sandhi-undergoing heads are never underlyingly L-toned.

[1] In some cases, realis verbs are marked with a high vowel infix before the nucleus, which creates a diphthong and palatalizes the initial consonant. For example, nɔ̋ 'eat (IRREALIS)' vs. ɲɔ́ɔ 'eat (REALIS)'. In other cases like (3), the only difference is tonal behavior. Note also in these examples that nasalization is marked under the vowel to avoid diacritic stacking.

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

Table 2: Sandhi alternations with pronominal arguments

Argument tones are listed along the left-hand side, and underlying head tones along the top. Cells in the middle of the table show the resulting sandhi form of the head. The only consistent pattern is a pocket of spreading behavior, where S-toned arguments always spread S to the head regardless of its underlying tone. With X- and H-toned arguments, the alternations appear at first to be largely random, but closer inspection reveals a possible circular chain shift, with some minor tweaks:

(4) 

S drops to H, which drops to X, which then raises back up to S. This chain shift is illustrated in the following genitive examples:

(5) a. /nǐ/ ‘father’ á ní ‘your father’
b. /ɲá/ ‘mother’ á ɲà ‘your mother’
c. /kə̰n/ ‘head’ á kə̰̋n ‘your head’

There are two exceptional cells that do not follow this pattern. First, when an X-toned argument is followed by an X-toned head, the head does not raise to S; instead, **both** the argument and the head raise to L. For instance, *à̈ + kə̰n* becomes *à kə̰n* ‘his head’ rather than **à̈ kə̰̋*.

Second, H-toned pronominal arguments divide into two classes with differing sandhi-triggering behavior. Simplex pronouns like 1sg *ń* and 2sg *á* (illustrated above) trigger the chain-shift lowering of S to H, but complex “emphatic” pronouns, consisting of these same pronouns and an emphatic particle *wó* (merging in the 1sg case to produce *mó*), cause S to lower to X:

(6) a. ń ní ‘my father’
b. mó nï̀ ‘my (emph.) father’

Despite the fact that both *ń* and *mó* are pronouns indicating the 1sg, they trigger different alternations on the head.

This foreshadows another complication in Seenku sandhi alternations: the fact that non-pronominal arguments trigger slightly different alternations than pronominal arguments. The table of alternations is repeated below for non-pronominal arguments, with the differences highlighted in boldface.

Head tone:		**X**	**H**	**S**
Argument tone	**X**	L	X	**X**
	H	S	X	**X**
	S	S	S	S

Table 3: Sandhi alternations with non-pronominal arguments

Specifically, non-pronominal arguments never create H-toned sandhi allomorphs; S instead becomes X after X- and H-toned heads. This is illustrated in (7), where the same verb is placed after an X-toned noun and pronoun:

(7) a. ä bą́ ‘hit him’
b. bɛ̈ɛ bą̈ ‘hit a pig!’

Whether or not the emphatic pronouns are treated as non-pronominal for the purposes of sandhi alternations, the process must have access to morphological information about the argument and not just its phonological form.[2]

To summarize, Seenku argument-head tone sandhi occurs in specific syntactic configurations of heads and their internal DP arguments, with domains sensitive to details of inflection (irrealis vs. realis). Alternations with (simplex) pronominal arguments consist of a general circular chain shift, with two more specific processes taking priority: an exceptionless S spreading process and a rule whereby X + X → L L. With non-pronominal arguments, S and H neutralize to X, and underlying X retains the same behavior of raising to either L or S.

4. A phonological approach?

Seenku argument-head tone sandhi presents a challenge to regular markedness-based phonology. First, these tone processes are restricted to specific morphosyntactic contexts and do not apply to any sequence of tones matching the structural description of the rules (see the right-hand column of 3 above). This challenge can be easily overcome by proposing co-phonologies for the sandhi domains (Inkelas 1998, Inkelas and Zoll 2005, Sande 2017, etc.), but the alternations themselves are more problematic. Moreton (1999) has proven that circular chain shifts are non-computable functions in traditional markedness-based Optimality Theory, so any constraint-based analysis would need to draw on a larger set of analytical tools.

Following similar proposals from Hsieh (2005) and Barrie (2006) for Taiwanese sandhi, we could motivate sandhi alternations with an anti-faithfulness constraint (Alderete 2001), ¬IDENT-IO(T); unlike Taiwanese, there is no phonetically-motivated markedness reduction to kick off the circular chain shift. This counterfeeding opacity could be accounted for by relying on contrast preservation constraints (Lubowicz 2003), which militate against neutralizations. These require the grammar to evaluate whole scenarios rather than single input-output pairs, adding a layer of complication to the computation of surface forms. To motivate these particular changes as opposed to any others, we would need a slew of markedness and faithfulness constraints, including a markedness constraint *S¬S to drive the S spreading pattern and AGREE constraints requiring the argument and head to agree in at least one feature; ganging of AGREE(upper) and AGREE(raised) would rule out combinations like X+S or H+L that disagree in both features, accounting for one of the deviations (X+X → L L) from the regular tone circle. As we will see, though, even with all of these constraints, the phonological account still runs into problems.

To make the example tableau in Table 4 more readable, I have included only the scenario with a H-toned (pronominal) argument, which allows us to see the whole circular chain shift with no modifications. Ganging is shown using local constraint conjunction (Smolensky 2006) but in a weighted constraint grammar, it would be accounted for with simple cumulativity.

High-ranked ¬IDENT(T) rules out candidates in which one or more base tones remain unchanged; for instance, candidate (a) is a scenario in which the base tones S, H, and X remain as they are, and candidate (b) is a scenario with a chain shift whereby S has the sandhi variant H, H has the sandhi variant X, but X remains unchanged. PRESERVECONTRAST demands that the three base tones remain distinct in sandhi environments; candidate (b) violates this constraint because the contrast between H and X is neutralized, while candidate (c) (which incurs no violations of anti-faithfulness) violates it by neutralizing the contrast between S and H, both of which use the sandhi variant X. By the combination of these two constraints, then, we need a sandhi system in which all three base tones change and there are three distinct sandhi variants. Candidate (d) offers a scenario with a non-circular chain shift (in fact, the one found after X-toned arguments). It is ruled out by the requirement that arguments and heads

[2] It may be possible to account for the different triggering behavior by phonological form alone if we take into account the segmental form of the bare pronouns, i.e. the fact that both are simple onsetless nuclei. Nouns may consist of a single mora but they obligatorily carry an onset. Why this should have any bearing on tone sandhi alternations remains unexplained.

agree in at least one tone feature; since H is [+upper, -raised] and L is [-upper, +raised], the sequence H+L violates the conjoined constraint and is ruled out. This takes L out of the running, leaving just the same three tones as the base tones, S, H, and X, which must form a circular chain shift. The problem is that there is no way for the phonology to naturally distinguish between the attested tone circle (e), which involves lowering base tones until the lowest tone X is flipped back to S, and the unattested tone circle (f), which is an inverse raising system. The same tones are involved, the same features changing, only the direction of the change (+ → - or - → +) differs.

Input: T/ H__	AGR(rsd)&AGR(upr)	¬ID(T)	PRESCONT	AGR(rsd)	AGR(upr)
a. S H X		*!**		*	*
b. S→H→X		*!	*		**
c. S→X↔H			*!		**
d. S→H→X→L	*!			*	**
☞e. S→H ↖ ↙ X				*	*
💣f. S←H ↘ ↗ X				*	*

Table 4: Tableau for the scenario of head after a H-toned pronominal argument.

Even assuming we find the right set of constraints to motivate the lowering direction (arguably more phonetically natural), the phonological account is left with unresolved issues. First, though the high-ranked anti-faithfulness constraint appears to require tones to change in sandhi environments, multi-tonal morphemes are impervious to tone sandhi and remain unchanged. For example, *dɔ̀dɔ́* 'thigh' remains *dɔ̀dɔ́* regardless of the argument that precedes it (*à dɔ̀dɔ́* 'his thigh', *mó dɔ̀dɔ́* 'my thigh', *mǐ dɔ̀dɔ́* 'our thigh'), but polymorphemic multi-tonal heads like *tsɨ̌-ŋmà* 'hip' undergo sandhi iteratively left-to-right (*à tsɨ́-ŋmā́* 'his hip, *mó tsɨ̀-ŋmà* 'my hip', *mǐ tsɨ̌-ŋmā́* 'our hip'). In a similar vein, there are a number of lexical exceptions that have invariant tonal forms (e.g. *à tsɨ̏ɻ̀* 'its stalk', *mó tsɨ̏ɻ̀* 'my stalk', or *mó jábí* 'reply to me!', *mǐ jábí* 'reply to us!'), suggesting less than perfect productivity. Finally, the ordering of sandhi with respect to other tonal processes suggests that is morphological rather than phonological. In particular, plural formation, which involves tone raising and/or vowel fronting (McPherson 2017a), takes the sandhi allomorph as its base. This is illustrated in (8) with the H-toned noun /tóo/ 'ear'.

(8) mó + tóo → mó tɔ̀o *Argument-head tone sandhi*
mó tɔ̀o + PL → mó tòee *Plural formation*

-not-

tóo + PL → tőee *Plural formation*
mó + tőee → *mó tɔ̀ee *Argument-head tone sandhi*

The correct order is shown first, where tone sandhi derives an X-toned allomorph of 'ear'. Tone raising applies to this derived X, yielding L. If the processes were applied in the other order, tone raising of H would yield S, and this S would lower to X in argument-head tone sandhi.

In conclusion, treating argument-head tone sandhi as regular phonology appears to be untenable. It involves opaque and non-computable circular chain shifts in highly constrained morphosyntacic environments, is riddled with exceptions, and is an instance of a structure-preserving phrasal alternation

occurring before word-level morphology. To bend the phonological component to fit these data would represent a serious loss in phonological restrictiveness.

5. An allomorph selection approach

For the reasons discussed in the last section, I follow Zhang and Lai (2008) and Zhang et al. (2011) in treating such complex tone sandhi as allomorph selection. In the analysis of Taiwanese, for instance, both base and sandhi allomorphs are stored in the lexicon. The appropriate allomorph is selected for the environment (base form for XP-final position, sandhi form for non-final positions). The greater complexity of Seenku's tone sandhi means a more elaborate lexical entry for each word. Up to three distinct sandhi allomorphs may be required (in addition to the base allomorph), and the environments for each require not only specific morphosyntactic criteria (preceded by a pronominal or non-pronominal argument, inflected for irrealis, etc.), but also phonological subcategorization (cf. Paster 2006). To illustrate, consider a possible lexical entry for the verb 'hit':

(9)	HIT (*v. tr.*)	bā̋	(realis), (irrealis / S__)
		bā̌	(irrealis / X_{pro}__)
		bā̏	(irrealis/ X__, H__)

This transitive verb has three allomorphs: a S-toned allomorph used for both the realis and the irrealis when following S-toned arguments, a H-toned irrealis allomorph used after X-tone pronominal arguments, and an X-toned irrealis allomorph used after X- and H-toned arguments; either the S- or X-toned allomorphs could also be considered the elsewhere allomorphs. The learner tracks the distribution of these allomorphs and lists the information in the lexical entry, which allows them to select the correct allomorph during vocabulary insertion.

In the acquisition process, the learner will hear many verbs that follow the same pattern. For instance, PUT in (10) follows the same pattern as HIT in (9):

(10)	PUT (*v. tr.*)	dzī̋	(realis), (irrealis / S__)
		dzī̌	(irrealis / X_{pro}__)
		dzī̏	(irrealis/ X__, H__)

I propose that once enough individual cases of these verbs begin accumulating in the lexicon, learners may project a **meta-entry**, generalizing the pattern and allowing them to productively extend sandhi to previously unheard forms:

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

These meta-entries can be thought of as constructional templates (e.g. Booij 2010) or even as general phrasal paradigms as in word-and-paradigm morphology (e.g. Ackerman et al. 2009, Blevins 2016, etc.). When a learner hears a form of a novel verb in context, such as the imperative *ā́ jú* 'say it!', she will be able to identify the allomorph cell for H after an X-toned pronoun, and from this form, could calculate that the same verb should be pronounced with a S-toned allomorph in the realis. In this sense, there is not necessarily a privileged "base" form (Albright 2002), but rather all cells of the paradigm provide information on how to pronounce other cells, though some may be more informative than others (e.g. an S-toned allomorph after S could belong to any verbal pattern, I, II, or III, since S-toned arguments neutralize contrasts between base tones).

At the same time as the learner is hearing new verbs and constructing meta-entries for them, she is also hearing nouns and postpositions that follow the same distributional patterns of allomorphy (excepting verbal inflectional categories like reality status, of course). These meta-entries may come together in increasingly general schemata to create a hierarchically linked lexicon:

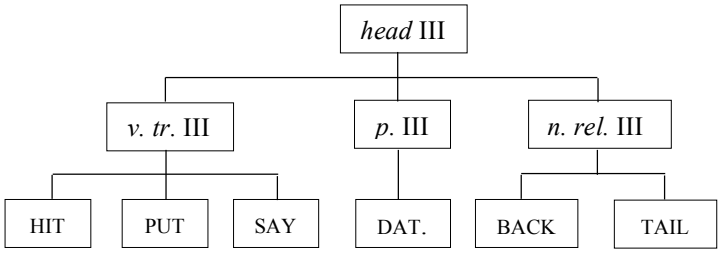


Figure 2: Hierarchically organized entries and meta-entries.

Under the allomorph selection approach, the alternations are synchronically arbitrary, the result of a series of sound changes from likely phonetically natural origins. Non-alternators, be they multi-tonal heads or simple lexical exceptions, can be accounted for because they lack sandhi allomorphs or have a single listed elsewhere allomorph that blocks productive extension of the pattern from the meta-entries.[3] Note that there are even exceptions to the phonetically natural and transparent S spreading pattern, suggesting that even putative sub-cases of phonological patterning may not be fully productive (cf. Taiwanese, Zhang et al. 2011). The allomorph selection approach likewise accounts for the domains of sandhi application without needing to posit co-phonologies, as the environment for each allomorph is part of the lexical entry.

By adopting an allomorph selection approach, the ordering dilemma between sandhi and plural formation is resolved: the sandhi variant is the natural base for plural formation since it is the first form selected from the lexicon. If the plural noun is possessed, the non-sandhi allomorph of that noun is never inserted and hence never has the opportunity for its tone to be raised via plural formation. In other words, if we treat sandhi as morphological rather than phonological, there is no aberrant case of phrasal phonology before morphology; both processes are morphological, sandhi involving listed allomorphs and plural formation involving featural affixation to the allomorph selected from the lexicon.

A last unexpected benefit of this approach is that it alleviates the need to set up abstract underlying representations as bases for sandhi. Postpositions and inalienable nouns obligatorily appear with their internal argument; if none is available, or a consultant is asked to provide a citation form, the 3sg pronoun *ā* is used. This means that these categories obligatorily surface with a sandhi allomorph and never with a base form. In the phonological approach in §4, an input form like *wɛ̀* for the associative postposition was required to compute the sandhi variants, but in fact an X-toned allomorph is unattested.[4] In a lexical entry like (10) or (11), on the other hand, there is no single privileged base form; instead, surface allomorphs are listed, including both those found in sandhi environments and those found elsewhere, if applicable. For postpositions and inalienable nouns, all listed allomorphs are sandhi allomorphs.

In sum, a lexical approach to the sandhi patterns can account for all of the sandhi data (undergoers and exceptional non-undergoers) while at the same time addressing issues of domains, process ordering, and abstract underlying forms. With a hierarchical lexicon linking increasingly general schemas, we can capture parallels between different sandhi constructions and account for productivity via paradigmatic extension.

6. Conclusions

This paper has described the complex tone sandhi patterns in Seenku, which are sensitive to syntactic structure (the argument-head relationship), inflectional morphology (realis vs. irrealis), and phonological form of both the trigger and undergoer. I have shown how a more complex hierarchically

[3] So far all known exceptions are non-alternators, i.e. they have just a single invariant form. This is not a prediction of the model, which could just as easily account for lexical items with one exceptional cell in the paradigm. Why this should be the case is the subject of ongoing work.

[4] The underlying forms of nouns and postpositions were decided based on verbal patterns, where realis forms fail to undergo sandhi and reveal some information about underlying forms, though neutralizations still occur.

organized lexicon is to be preferred to a phonological account, which requires a variety of theoretical machinery and still fails to account for the data.

Under the approach I have proposed, sandhi alternations are synchronically arbitrary, but they almost certainly have arisen from regular phrasal phonology that has drifted away from natural alternations via a series of sound changes. Nevertheless, Seenku speakers still learn the alternations and can productively extend them (though the data still await wug testing). This is perfectly unsurprising if we assume that the phonological acquisition process for any alternation begins as an allomorph distribution problem for the learner: different allomorphs are heard and their environments are logged. If the alternations or phonotactic principles are robustly attested across the language, as is the case for English obstruent devoicing, the phonological grammar is amended to account for them. If no broader phonological principles are at play, however, as is the case for Seenku sandhi, the alternations may get stuck at the lexical level with listed allomorphs. In this view of grammar, all phonological alternations pass through the lexicon, but allomorphs may stop being listed once the phonological grammar can account for them, and already listed allomorphs may lose their activation strength.[5]

Seenku argument-head tone sandhi and other arbitrary phrasal alternations are inhabitants of what Moreton (1999) calls "the thinly populated twilight zone between syntax, morphology, and phonology" (30). I suspect this zone is far more densely populated than we might admit. The allomorph selection approach argued for in this paper can account for these kinds of data, including how an alternation might transition from regular phonology to listed allomorphs, all while maintaining a phonetically natural and restrictive phonological component. In short, the lexicon may play a far more complex and powerful role in acquisition and production than is often assumed.

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[5] Or they may remain active. Under a dual route model (Baayen and Schreuder 1999, Eddington 2000), the listed allomorph would compete with the productive alternation. Experimental work could bring evidence to bear on this question. For instance, see Kerkhoff (2007) for a comparison of frameworks in the acquisition of Dutch morphophonology.

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