Children's Acquisition of Argument-Head Tone Sandhi in Seenku (Mande, Burkina Faso)

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1. Introduction

L1 acquisition of tone remains critically understudied, especially in languages outside of East Asia (Demuth 1995, Singh and Fu 2016, McPherson 2025). Given the typologically diverse nature of tone systems, this areal bias has meant that we know very little about how children acquire certain kinds of tone processes, especially those that are grammatically conditioned, which are common in languages of Africa and Mesoamerica but rare in East Asia. One study on the acquisition of Mandarin tone sandhi found that it was productively applied by the age of 3, though differences in branching in longer sandhi phrases took longer to acquire (Tang et al. 2019). However, Mandarin tone sandhi lacks the sensitivity to morphosyntactic structure seen in many African tone languages. Demuth (1989, 1993) explored the acquisition of tone in Sesotho, including grammatical and postlexical processes, finding that the more complex alternations with postlexical tone are still not acquired by the age of 3, suggesting that the interaction of phonological and morphosyntactic information may slow down acquisition.

This work aims to help fill this lacuna with a preliminary study of children's acquisition of a grammatically-conditioned tone sandhi process in Seenku, a Mande language spoken by about 15,000 people in southwestern Burkina Faso. As I will show, by the age of 2;0, children are approximating these sometimes idiosyncratic and phonologically unnatural tonal alternations, but their precise f0 is still not adult-like even by the age of 4;0, echoing findings by Wong et al. (2005) and Wong (2012) that tone acquisition is both early and late with respect to segments.

The paper is structured as follows. In Section 2, I provide background on the Seenku language and the argument-head tone sandhi alternations. Section 3

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discusses the methodology used in this acquisition study. Section 4 provides results, while Section 5 closes with discussion and areas for future work.

2. Background

2.1. Seenku

Seenku is a member of the Samogo group of Mande languages (McPherson 2020). It has two varieties, northern Seenku and southern Seenku, and this study focuses on the latter, specifically the dialect spoken in the village of Bouende (Gbéné-gʉ̀). Like most Mande languages, it has an S-Aux-O-V-X word order, where the X slot can be filled by adverbs and postpositional phrases (including indirect objects).

The language has a complex tone system, with four contrastive level tones, called Extra-low/X <ä>, Low/L <à>, High/H <á>, and Super-high/S <a̋> in all previous publications on Seenku. For ease of comprehension in this paper, the tone levels will instead be numbered, from 1 (Extra-low) to 4 (Super-high). A four-way minimal set for level tones is shown in Table 1.

Table 1: Seenku's four contrastive tone levels

Extra-low (1)	sì	'water jar'
Low (2)	Sì	'first son' (proper name)
High (3)	(í) sí	reciprocal
Super-high (4)	sa̋	'tree sp.'

These four tone levels can combine to create nearly every possible combination of two-tone contours, with the most common lexical contours being a 31 falling tone <â> and a 24 rising tone <ǎ>; most others are created grammatically through a range of processes. Three-tone contours like 131 and 241 are also attested. For deeper discussion and description of the tone system, see McPherson (2019a, 2020).

2.2. Argument-head tone sandhi

In certain grammatical constructions, heads (nouns, verbs, postpositions) undergo tonal alternations triggered by their preceding internal argument (McPherson 2019b). The three constructions include inalienable possession (Possessor + Noun), irrealis transitive verbs (Object + Verb), and postpositional phrases (NP + Postposition); in each case, the head of the construction is underlined, and it is this head whose tone changes.

The tonal alternations themselves depend upon: 1. The lexical tone of the head; 2. The surface tone of the argument (i.e. the resulting tone after any other grammatical tone changes); 3. The syntactic category of the head (slight differences are found between nouns, verbs, and postpositions); 4. Whether the

argument is phonological light (having the shape V or N) or heavy (CV+).[1] Finally, for verbs, sandhi only occurs when the verb is in an irrealis form (prospective, imperative, subjunctive).

Alternations with an irrealis verb and a light (pronominal) argument are shown in Table 2, where the cells represent the tonal output of the verb. Note that there are no verbs (or inalienable nouns or postpositions) with lexical tone 2, and the closed class of light pronouns listed in Footnote 1 all have either tone 1 or 3.

Table 2: Verbal head with phonologically light (pronominal) argument

Verb tone: Object tone:	/1/	/3/	/4/
/1/	2	1	3
/3/	4	1	3

In other words, a verb with lexical tone 4 (super-high) like *bǫ́* 'hit' surfaces as tone 3 (high) after a pronoun with either tone 1 (extra-low) or tone 3 (high), as in *ə̀ bǫ́* 'hit him/her' and *ń bǫ́* 'hit me'; a verb with lexical tone 3 (high) like *sɔ́ɔ* 'sell' surfaces as tone 1 (extra-low) in these same environments, as in *ə̀ sɔ̏ɔ̏* 'sell him/her' or *ń sɔ̏ɔ* 'sell me'. Verbs with lexical tone 1 (extra-low) like *sə̏* 'buy' are more complex, surfacing as tone 4 (super-high) after tone 3, as in *ń sə̋* 'buy me', but as tone 2 (low) after a pronoun with the same tone 1. In this case only is the tone of the argument affected, also raising to tone 2. Thus, we can say that /1 + 1/ → [2 2], as in *à sə̀* 'buy him/her'. Note that the tonal alternations after light arguments with tone 3 form a tone circle (Barrie 2006, Łubowicz 2011): 4 → 3 → 1 → 4, a phonological configuration that eschews simple analysis and one that thus forms an interesting test case for children's acquisition.

Table 3: Verbal head with phonologically heavy argument

Verb tone: Object tone:	/1/	/3/	/4/
/1/	2	1	1
/2/	2	2	2
/3/	4	1	1
/4/	4	4	4

These same verbal heads with phonologically heavy arguments undergo a slightly different set of alternations, shown in Table 3; here, we add arguments

[1] Previous work treated this latter distinction as pronominal vs. non-pronominal, but since phonologically heavy pronouns like *mɪ̋* '1pl' behave like non-pronominal arguments, the distinction is better understood as one based on phonological shape rather than morphosyntactic type. The closed set of light pronouns are: *ə̀* '3sg', *á* '2sg', *ɪ̀* '3pl', *í* '2pl/logophoric', and *ń* '1sg'.

with tone 2 and tone 4 (both of which simply spread their tone onto the verb), while verbs with tone 4 otherwise become tone 1 rather than tone 3. These cells are grayed out to provide visual contrast with Table 2.

Inalienable nouns and verbs undergo the same alternations, but postpositions differ slightly with phonologically light arguments. The two 4-toned postpositions in the corpus are *tɛ̋* 'genitive' and *lɛ̋* 'dative', and each has unique behavior. First, the genitive is irregular in having a 31-toned variant after all light arguments, rather than a variant with tone 3 as above. Thus, we find *à tê* 'his/hers' with 31 but *à lɛ́* 'to him/her' with 3. The genitive likewise surfaces with tone 31 after an argument with tone 3, as in *ń tê* 'mine'. The dative *lɛ̋* diverges from nouns and verbs in this cell of the paradigm, surfacing instead with tone 1: *á lɛ̃̀* 'to you' and *ń nɛ̃̀* 'to me' (with nasalization of the /l/ after the syllabic nasal).

Finally, in addition to these three obligatory sandhi constructions (inalienable possession, irrealis transitive verbs, and postpositional phrases), there is one further optional sandhi context found in alienable possession. We find variation between two alienable possessive constructions, one with the genitive postposition after the possessor, in which case there is no sandhi (1a), and a nearly identical construction using the dative postposition, in which case the alienable noun undergoes the same set of sandhi alternations seen in Table 3 (1b):

(1)	a.	mó	tɛ̃̀	bî	/mó tɛ̋ bî/
		1SG.EMPH	GEN	goat	
		'my goat'			
	b.	mó	lɛ̃̀	bǐ	
		1SG.EMPH	DAT	goat	
		'my goat'			

The dative postposition in (1b) can also be segmentally elided, leaving its tone and compensatory lengthening on the preceding pronoun (i.e. *môo bǐ*).

Thus, children learning these alternations must pay attention to syntactic category and structure, morphological inflection (reality status of the verb), phonological shape of the argument, lexical tone categories, as well as sometimes idiosyncratic, lexically-specific information, such as the differences between the genitive and dative postpositions. Our research questions are as follows:

1. At what age do children acquire argument-head tone sandhi?
2. Does acquisition differ depending upon the grammatical construction (either between the three obligatory constructions, or between the obligatory vs. optional ones)?
3. Are children's errors characterizable (e.g. producing underlying tone rather than a sandhi form, over-applying one particular sandhi pattern), or are they random?
4. What can this tell us about the place of argument-head tone sandhi in adult grammar (i.e. as phonology, morphology, etc.)?

3. Methodology

The data in this paper are drawn from a cross-sectional and longitudinal study of acquisition in Seenku, in which ten children between the ages of 1;0 and 3;0 at the start of recording were recorded twice a month for a year interacting naturally with their primary caregiver for an hour. Here we look at a sample of four children of different ages, with three to four time points throughout the year for each child. Table 4 provides information on the children, including word type count per thirty minutes of speech at each age as a measure of their linguistic development (Vihman and Miller 1988), since age alone is not indicative of linguistic maturity.

Table 4: Subjects and their genders, ages, and number of word types per 30 minutes of speech

Child code	Ages transcribed; number of word types in 30 minutes			
DET (M)	1;8	2;0	2;4	
	41	73	106	
SRDT (M)	2;1	2;4	2;8	3;0
	111	138	149	171
DEMT (F)	2;6	2;8	3;0	3;6
	48	67	78	170
WAT (M)	3;6	3;8	4;0	
	148	140	202	

For each session, at least thirty minutes were transcribed, including phonetic transcriptions of children's tone productions using Chao tone numbers 1 to 5, in order to capture more phonetic detail and to avoid overfitting the adult four tone system when it is unclear whether children have fully acquired it yet. All sandhi environments were extracted and tagged for their construction (PP, Irrealis O+V, POSS), underlying tones of the argument and head, and whether the argument is light or heavy. Next, children's phonetic tone productions were matched to the closest adult target, meaning that both [5] and [45] could be realizations of the super-high tone (here, 4), [2] could correspond to either Low (2) or Extra-low (1), etc. From these mappings, productions were categorized as Fully correct (i.e. adult-like f0), Partially correct (i.e. correct half of the tonal space, approximating the adult target but whose exact pitch contour is not adult-like), or Incorrect (i.e. no sandhi, wrong sandhi output, etc.). To illustrate, (2a) provides an example of a fully correct production with 4-toned *bőn*, (2b) of a partially correct production, and (2c) of an incorrect production. All were produced by DEMT at 2;6.

(2) a. í bón [3 3] Fully correct
LOG back
'(own) back'

b. ń bón [3 32] Partially correct
1SG back
'my back'

c. í bo̍n [3 1] Incorrect
LOG back
'(own) back'

For further discussion of the challenges in handling and classifying children's tone productions in such a dense tone system, see McPherson (2025).

These classifications thus yield two measures of acquisition: a conservative measure, consisting only of fully correct productions, and a liberal measure, consisting of both fully and partially correct productions.

4. Results

4.1. General trends

As a first observation, we found no systematic differences between the three obligatory constructions for any child. That is, it was not the case that possessive sandhi progressed at a faster rate than PPs or irrealis verbs, for instance. This can be seen in Figure 1, comparing the liberal vs. conservative accuracy rates for the youngest child DET across the three constructions. While in the conservative bar graph on the right, verbs appear to lag behind possession (with PPs bouncing up and down, unsurprisingly given a low *n* for each category), the liberal view on the left (the sum of fully and partially correct pronunciations) paints a different picture, with no discernible trends. As such, we group together these three constructions in the remainder of this paper.

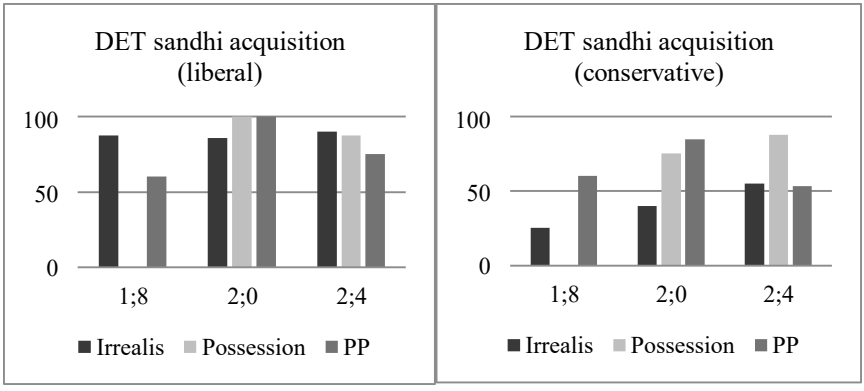

Figure 1: Liberal and conservative measures of accuracy for the three obligatory sandhi constructions by age

Figure 2 compares the liberal and conservative accuracies for all four subjects, collating all obligatory sandhi constructions. This has the added benefit of increasing the sample size for each age, making the improvements across the months clearer to see. As these graphs show, children are approximating the sandhi patterns at around 80% even at the age of 2;0. By the age of 3, this has increased to over 90% correct, an impressive grasp of these complex patterns. However, if we consider only adult-like f0 (the conservative measure), then this 80% measure is only hit at 3;5, and the younger ages show considerably less accuracy.

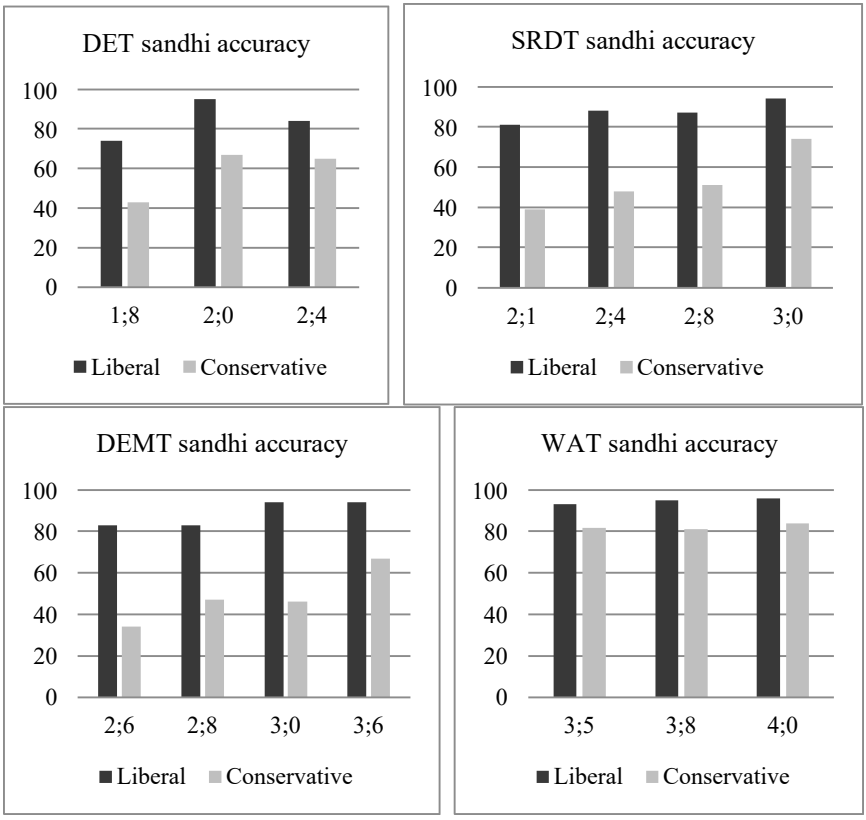

Figure 2: Average longitudinal accuracy by child (liberal + conservative)

It is important to note that all children, even at the age 2;0, produce active sandhi alternations.[2] That is, every child at every age produced at least one lexical item with more than one (correct) sandhi variant. For instance, at 2;0, DET

[2] DET at 1;8 produced so few utterances that there were no opportunities for the same lexical item in different sandhi contexts.

produced the following two utterances using the lexically tone 4 (super-high) verb *dzí̱* ‘put’:

(3) a. fôo dzì̱ [31 1]
‘put air’

b. ä̀ dzí̱ [1 3]
‘put it’

After tone 1 of the falling tone on *fôo* ‘air’, it surfaces with the expected tone 1 sandhi variant, while after a light pronoun with tone 1 *ä̀* ‘3sg’, it surfaces instead as tone 3 (high). Similar examples can be found for all children and all obligatory constructions (inalienable possession, irrealis verbs, PPs).

4.2. A more granular look

To address whether there are any significant trends in the errors that children make, we must take a more granular look at the data. Tables 5-8 summarize the percentages correct (liberal) for each cell in the sandhi paradigm (including both light and heavy arguments, whose surface forms may differ). I have omitted arguments with tone /2/, as there were never more than 3 tokens for any cell.

Table 5: Accuracy rates by paradigm cell for DET

Head tone: Argument tone:	/1/	/3/	/4/
/1/	82%	86%	83%
/3/	87%	93%	80%
/4/	100%	100%	100%

Table 6: Accuracy rates by paradigm cell for SRDT

Head tone: Argument tone:	/1/	/3/	/4/
/1/	70%	83%	90%
/3/	100%	95%	80%
/4/	91%	93%	89%

Table 7: Accuracy rates by paradigm cell for DEMT

Head tone: / Argument tone:	/1/	/3/	/4/
/1/	78%	86%	95%
/3/	89%	97%	73%
/4/	96%	100%	100%

Table 8: Accuracy rates by paradigm cell for WAT

Head tone: / Argument tone:	/1/	/3/	/4/
/1/	94%	100%	90%
/3/	100%	88%	92%
/4/	100%	100%	100%

In each table, the two cells with the lowest accuracy are highlighted in gray. For the three younger children, these are always the same: /1 + 1/ and /3 + 4/. Both of these cells are exceptional, and thus can help us understand why they would be the most challenging for children. First, /1 + 1/ is the only cell of the paradigm that alters the tone of both the head and its argument, raising both of them to tone 2. However, it should be noted that the low accuracy rates in the tables may also be an artefact of data coding, since /1 + 1/ → [2 2] is a subtle tone change; the difference between [1] and [2] is the difference of no sandhi vs. correct sandhi. For other tone combinations, a child's pronunciation of [3 2] rather than [3 1] would be coded as partially correct, whereas in these cells [1 1] rather than [2 2] was treated as incorrect. The density of Seenku's tone system and the nature of this alternation makes it very difficult to assess.

The cell /3 + 4/, on the other hand, is exceptional in that the sandhi variant for a head with tone 4 differs by whether the argument is light or heavy, and if light, by syntactic category and lexical item, as discussed in Section 2.2. Indeed, many of the errors children make are confusions between an exceptional form and another attested (and more frequent) sandhi output for this same cell. Examples like the following are a common source of /3 + 4/ errors:

(4) SRDT (3;0)
á tɛ̀ [3 1] (adult *á tê* [3 31])
2SG GEN
'yours' (cf. *á wó tɛ̀* [3 3 1] with heavy argument)

Here, the child uses the heavy output [1] rather than the expected (but irregular) output [31] after a light argument with tone 3. Reverse errors, where the irregular [31] is used instead of the expected [1], are not attested, suggesting that children may be over-regularizing the sandhi pattern. Similar errors of applying a heavy

output [1] rather than the light output [3] with a verb can be seen in the speech of DEMT (3;6), where she produces *á bą̈* [3 1] for 'hit you' rather than the expected *á bą́*. Note that *bą̈* is the correct output if the pronoun were instead the heavy (emphatic) form *á wó*. In another /3 + 4/ error rooted in the irregularity of this cell, DEMT (2;6) produces the genitive postposition with a level 3-toned variant **té* rather than its adult-like exceptional 31 fall (i.e. *á té* rather than *á tê*).

For WAT, in terms of percentages, the cell /3 + 3/ has the lowest accuracy level, but this is due to a smaller n and only two erroneous tokens of the same construction: at 3;5, he produces /ń + kṵ/ 'catch me' as *ń kṵ̋* [3 4] rather than adult-like *ń kṵ̀* [3 1]. This could be a lexical tone error, as a verb with tone 1 would become tone 4 in this context. In terms of raw numbers, and indeed diversity of errors, the cell /1 + 4/ has lower accuracy, with three distinct errors of the same type: after a light argument, the head takes on the sandhi variant [1], which is the expected output after a heavy argument—in the adult grammar, it should have tone [3] in this environment. An illustrative example is provided in (5):

(5) WAT (4;0)

ä̀	lɛ̃̀ [1 1]	(adult *ä̀ lé* [1 3])
3SG	DAT	
'to him/her'		(cf. *bɛ̃̀ɛ lɛ̃̀* 'to the pig' with a heavy argument)

Once again, exceptional cells, whether between light and pronominal arguments or between different lexical items, appear to be a common source of errors.

4.3. What about optional alienable sandhi?

So far, we have focused on the three common constructions in which sandhi is obligatory. Inalienable nouns, postpositions, and transitive irrealis verbs *always* surface with sandhi, meaning that that underlying forms are in fact abstract; children only hear a surface network of different sandhi variants. This stands in contrast to alienable nouns, which can (and typically do) occur without a possessor, and even when possessed, the default possessive construction involves the genitive postposition and no sandhi on the noun (see example 1 above). A secondary possessive construction using the dative instead of the genitive triggers sandhi on the noun, and in fact it is these forms that give us evidence of the abstract underlying representations of the obligatory sandhi undergoers. For instance, a noun with tone 1 like *bɛ̃̀ɛ* 'pig' will surface with tone 4 after a dative particle with tone 3, as in *ä̀ lé bɛ̋ɛ* 'his/her pig'; this points to a verb like 'buy', which also surfaces as tone 4 after a tone 3 argument (e.g. *mó są̋* 'buy me'), also being underlyingly tone 1.[3]

[3] This is further supported by its realis forms, which always have a low or extra-low-toned element.

In other words, for alienable nouns, children hear both an isolation form (representing its underlying form) as well as a sandhi variant. What happens to sandhi in these cases?

The corpus contains 10 tokens of the dative alienable possessive construction (n = 1 for DET, n = 6 for SRDT, and n = 3 for WAT). Interestingly, we find sandhi in none of these cases, even for WAT, our oldest child, who otherwise has reached nearly ceiling for sandhi application. For example, at 2;4, DET produces [móò bəgɵ̀] for 'my pants', with coalescence of the possessive pronoun *mó* and the dative postposition *lɛ̀*.[4] DET retains the lexical tone 1 of *bəgɵ̀* 'pants' rather than raising it to tone 2 *bəgò*, as an adult would. SRDT and WAT both use the noun *gɔ̂ɔ* 'wood', with a lexical 31 falling tone, in the dative possessive construction, and both retain the lexical tone. For SRDT at the age 3;0, we find *môo gɔ̂ɔ* 'my wood' rather than adult *môo gɔ̀ɔ*, and for WAT we find *mĩĩ gɔ̂ɔ* 'our wood' rather than adult *mĩĩ gɔ̂ɔ*. This latter example is especially interesting, as otherwise arguments with tone 4 (super-high) have the most transparent sandhi pattern of all, exceptionlessly spreading this tone 4 to the head, and indeed children are quite accurate with this pattern even at a very young age, as seen in Tables 5-8. Nevertheless, it is not extended to this productive sandhi environment.

5. Discussion

Returning to our initial research questions in Section 3, we can begin to sketch out some answers based on these pilot data. First, we find that despite the complexities of argument-head tone sandhi and its sensitivity to both lexical tone as well as morphosyntactic information, it is acquired in broad strokes at a very early age, even before the age of 2. However, even at the age of 4;0, children often deviate from adult-like f0, which echoes the findings of Wong (2012) and Wong et al. (2005) that the acquisition of tone is both early and late with respect to segments; young children are aware of and attempt to produce tonal categories in their input but they lack the laryngeal control to fully replicate them.

In terms of differences between sandhi constructions, we find no difference between the three obligatory constructions—inalienable possession, object with an irrealis verb, and postpositional phrases—but we find a stark contrast with the optional alienable possessive construction, where children systematically fail to apply sandhi. I would argue that this contrast is telling. McPherson (2019b) argues that heads with obligatory internal arguments (inalienable nouns, transitive verbs, and postpositions) are learned as a network of surface allomorphs, since the alternations defy straightforward phonological computation and are sensitive to factors beyond the phonology proper. At some point, this network of constructions produces generalizations that can extend productively to novel forms, but it is clear from the children's acquisition data that this productive extension must come

[4] The production *móò* [32] rather than *môo* [31] puts the pronoun closer to the expected sandhi form, since the /31 + 1/ would yield [32 2] in adult-like sandhi. Thus, the expected sandhi output for an adult would be *móò bəgò* from the input combination *môo bəgɵ̀*.

later, as it is never attested in any of our subjects' speech. The question thus remains: At what age does sandhi become productive and extend to lexical items that appear most frequently with their underlying lexical tone (i.e. in a non-sandhi environment)?

If the presence of a lexical item in a non-sandhi environment delays the acquisition of sandhi variants, then we might expect the irrealis verb construction to lag slightly behind postpositional phrases and inalienable possession, since children get another hint at their lexical tone from their realis counterparts. For example, while a tone 1 verb like *sɑ̀* 'buy' can surface as tone 2 or tone 4 in the irrealis (see Tables 2 and 3), it always surfaces as tone 1 in the perfective, regardless of the tone of the argument (*à mó sɑ̀* 's/he bought me', *à mɨ̄ sɑ̀* 's/he bought us). As I described in Section 4.1, there were no substantial trends; however, visual inspection of DET's conservative accuracy rates in Figure 1 does show verbs lagging behind the other two obligatory constructions, and similar observations can be made for other children. Future work will seek to determine whether any of these trends are statistically significant, as well as whether verbal constructions show more underapplication errors, which may suggest interference from the verb's lexical tone (which is purely abstract for inalienable nouns and postpositions).

In terms of common errors, the two biggest trends in the data were underapplication of /1 + 1/ → [2 2] (the one cell of the paradigm affecting both the argument and the head) and confusion of light and heavy sandhi patterns, especially for /3 + 4/, which can yield [3 3], [3 31], or [3 1] depending upon whether the argument is phonologically light or heavy, the syntactic category of the head, and even its lexical identity (as is the case for the genitive postposition *tɛ̋* vs. the dative postposition *lɛ̋*). More regular sandhi patterns, such as the spreading of an argument's tone 4 onto the head, showed far fewer errors for every child.

Since argument-head tone sandhi is sensitive to lexical tone, future work needs to determine a better baseline of lexical tone accuracy for children. McPherson (2025) provides a first analysis of verbal lexical tone in Seenku-speaking children, but to date there is no work on nominal or pronominal lexical tone that could deepen our understanding of, say, possessive constructions. The transcription of more data will help increase statistical power, as many of the cells of the paradigm have only a small number of tokens or none at all, especially when splitting up data by construction and whether the argument is light or heavy. Future analyses could also consider the role of frequency in children's acquisition, as well as coding the data for whether it is a repetition of adult speech or an independent production. Finally, a closer comparison to the study of Mandarin tone sandhi acquisition by Tang et al. (2019) might be a more purely phonological tonal alternation, such as rising tone simplification (McPherson 2019a, 2020). Curiously, preliminary work on this topic shows that it in fact lags behind the grammatical tone sandhi presented here, at least for some of the children.

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