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Word Prosody and Intonation of Sgaw Karen

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by

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ABSTRACT OF THE THESIS

Word Prosody and Intonation
of Sgaw Karen

by

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The prosodic, and specifically intonation, systems of Tibeto-Burman languages have received less attention in research than those of other families. This study investigates the word prosody and intonation of Sgaw Karen, a tonal Tibeto-Burman language of eastern Burma, and finds similarities to both closely related Tibeto-Burman languages and the more distant Sinitic languages like Mandarin. Sentences of varying lengths with controlled tonal environments were elicited from a total of 12 participants (5 male). In terms of word prosody, Sgaw Karen does not exhibit word stress cues, but does maintain a prosodic distinction between the more prominent *major* syllable and the phonologically reduced *minor* syllable. In terms of intonation, Sgaw Karen patterns like related Pwo Karen in its limited use of post-lexical tone, which is only present at Intonation Phrase (IP) boundaries. Unlike the intonation systems of Pwo Karen and Mandarin, however, Sgaw Karen exhibits downstep across its Accentual Phrases (AP), similarly to phenomena identified in Tibetan and Burmese.

The thesis of Luke West is approved.

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2017

Dedication

With gratitude to my committee chair Dr. Sun-Ah Jun, whose insight and guidance made the study possible, and to Professors Kie Zuraw and Robert Daland who each gave invaluable comments and suggestions.

Presented with thanks to my dear friends in the San Diego Karen community who participated in this study and gave insight and encouragement throughout the project. This research would not be possible without all of the help from the Karen Organization of San Diego. I am so thankful for the chance to meet everyone and learn more about the beautiful Karen culture and language.

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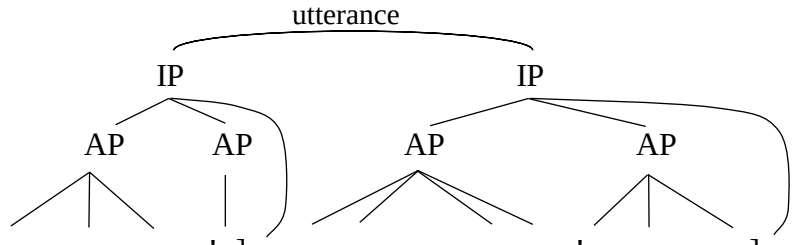
1 Introduction and Background

1.1 Goals

This study investigates the word prosody and intonation of Sgaw Karen, a Tibeto-Burman language, spoken in Southeastern Burma. Various experimental data have been collected and examined to determine prosodic characteristics of the language such as word-level stress, word formation, and syllable weight (§3), and to build a model of intonational phonology of the language in the Autosegmental-Metrical (AM) framework (Pierrehumbert 1980, Beckman and Pierrehumbert 1986, Ladd 1996/2008) (§4). In this model of intonation, a hierarchical structure of two prosodic units is proposed: an Intonational Phrase (IP) is the largest prosodic unit, whose right edge is optionally marked by a boundary tone (e.g., H% or L%), and can have more than one Accentual Phrase (AP). An AP is slightly larger than a word and is marked with AP-initial downstep (!) within an IP. Example (1) illustrates how a sentence can be parsed into IPs and APs. Here, each IP includes two APs, with a boundary tone (H or L) marking the right edge of each IP. In this case, the IP boundaries also match the syntactic boundaries, though they do not always do so.

(1)



"White panther[s] say three white lambs are wading."

In section 3, it is proposed that a major syllable consists of two morae while a minor syllable consists of one mora. This moraic distinction will play a key role in accounting for the

realization of an IP boundary tone (§4.4.4). It will be shown that a simple boundary tone such as L% and H% will be realized on the IP-final mora, thus preserving the lexical tone of a major syllable on its first mora while allowing the IP boundary tone to be realized on the second, final mora of the syllable. That is, when a bimoraic major syllable is the last syllable of an IP, the syllable will be realized as a sequence of the lexical tone followed by an IP boundary tone. On the other hand, when an IP boundary is complex such as LHL%, the IP boundary tone overrides any lexical tone on the IP-final syllable.

The word and phrase prosody in Tibeto-Burman languages is relatively understudied and intonational analyses are partial and scarce, especially those in the AM framework. Sgaw Karen is not an exception. The current study assesses the word prosody of Sgaw Karen based on experimental data and analyzes its intonation phonologically. The rest of the section will introduce the consonant and vowel inventories of Sgaw Karen as well as its lexical tone inventory. Section 2 provides background information on word prosody and phrasal prosody in Sgaw Karen and other related languages.

1.2 Language Overview

Sgaw Karen is one of the main members of the Karenic family. This family also includes Pwo Karen, spoken in Eastern Burma and parts of Thailand with representative Eastern (Hsieh 2012) and Western (Kato 1995) varieties. As Karenic languages, both Sgaw and Pwo Karen fall under the Western Tibeto-Burman group of languages, given in Figure 1 below.

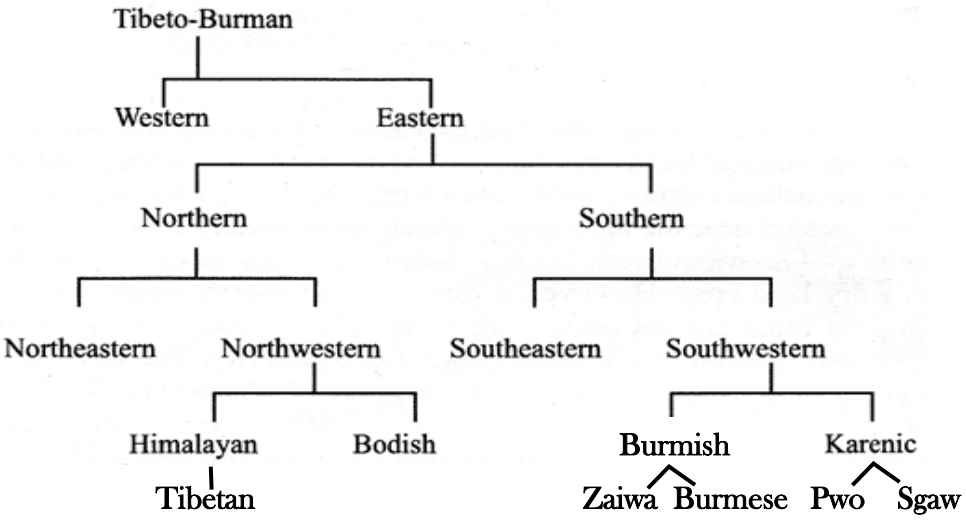


Figure 1: Adapted from Van Driem's Eastern Tibeto-Burman tree (1998:68)

As seen in Figure 1 above, the Karenic languages are a group of Tibeto-Burman tonal languages that share many features with other Sino-Tibetan languages except for word order—Karenic are SVO but all other Tibeto-Burman languages SOV (Sun, Thurgood, LaPolla 2003). In addition to the Karen State within Burma, there are large communities of Karen speakers in Northern Thailand. In total, there were an estimated 1,480,000 speakers as of 1983 (Lewis & Lewis 1984).

A few studies have been conducted on Sgaw Karen, ranging from general phonetic descriptions (Jones 1961; Rattanaporn 2012; Fischer 2013) with little to no description of word prosody, to specific topics in phonetics (Salgado et al. 2013 on fricative aspiration; Zhao 2014 and Griffin 2014 on tone), to tone perception (Brunelle, Finkeldey 2011; Finkeldey 2011). Some studies include portions on Sgaw Karen (Abramson 1992), while others focus exclusively on the related Pwo Karen (Kato 1995). Listed above are the studies most relevant to Sgaw Karen phonetics and phonology. For a more comprehensive list of linguistic research on Karen, see Ken Manson's bibliography of Sgaw Karen linguistics (Manson 2010).

1.2.1 Consonants

The inventory of consonant phonemes (Table 1) is based on recordings of 11 speakers producing 50 unique words during my fieldwork in San Diego (January-March 2017) as well as consulting other references such as Abramson's (1992) study of Sgaw plosives and Drum Publication's transliteration and sound files provided in their transliteration guide (Drum Publications). A three-way laryngeal distinction (voiceless, voiceless aspirated, voiced) is made for bilabial and alveolar plosives, while only voiceless and voiceless aspirated plosives are found for the velar position. The only voiced obstruent at velar place of articulation is voiced fricative, [ɣ].

Table 1: Sgaw Karen consonant and glide inventory

	bilabial	inter-dental	alveolar	post-alveolar	palatal	Velar	glottal
plosive	p pʰ b		t tʰ d	tʃ tʃʰ		k kʰ	ʔ
nasal	m		n		ɲ	ŋ	
fricative		θ	s sʰ	ʃ		x ɣ	h ɦ
approximant	w		l r		j		

1.2.2 Vowels

As in other Karenic languages (Jones 1961), the vowel system of Sgaw Karen is fairly large. There are 3 front vowels, 2 central vowels and 4 back vowels (Figure 2).

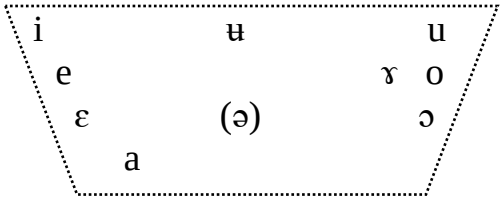


Figure 2: Sgaw Karen vowels

The schwa, unlike other vowels, only occurs in minor syllables (§2.1), and is realized as a mid vowel even when emphasized, though they are pronounced with a full vowel [a] when sung aloud. The schwa vowel is also used in epenthesis as in /pətrɣ̈/ → [pətərɣ̈ɬ] ‘to praise’.

1.2.3 Tones

The tone system of Sgaw is composed of 6 tones differing in height and direction of pitch movement, with an additional tone marked by short duration (Table 2). The tones are further distinguished by phonation type: modal, breathy, and creaky. Five of the six tones are explicitly marked with tone diacritics (tones 2 through 6). The numbering of the tones in Table 2 is based on Brunelle and Finkeldey’s analysis (2011). Tone 0 is used for reduced syllables (see §2.1).

Table 2: Number, contour and description of Sgaw Karen lexical tones

Tone #	IPA	Orth.	Gloss	Description
0	[mə]	ဓ	‘entirely’	Short, mid/low
1	[maɬ]	မါ	‘a wife’	Mid-rising modal
2	[mą̈ɣ]	မ်ၢ	‘aunt’	Mid falling breathy
3	[mą̰ɻ]	မ်ံ	‘son-in-law’	Low falling creaky
4	[mą̰ɣ]	မး	‘observe’	Low falling short creaky
5	[maɣ]	မ့်	‘alligator’	High falling modal
6	[mą̈ɬ]	မၤ	‘do, act’	Low breathy

Though Weidert (1987:217) describes Sgaw’s tones as level, he notes that contour tones may be present in varieties neighboring Tai languages. This is the case in the present study as all participants grew up near the Thai-Burmese border and most have had some contact with the Thai language. The number of tones identified by researchers varies across analyses, some claim six (Finkeldey 2011) and others only five (Griffin 2014), omitting the low creaky tone. Other tones cited in these studies align with those presented here, with the exception of tone 5 (modal

high) sometimes reported as low falling (Finkeldey 2011). Based on discussions with participants, this may be a dialect difference.

Multiple consultants pointed out that dialects of Sgaw Karen vary greatly in tone, and two main patterns emerged from the data. The varieties identified differ primarily in the realization of modal tone 5. The first variety features low falling pitch on tone 5 and tone 2 having the highest onset. It is considered slightly more erudite by some speakers and spoken by many speakers born and reared in Thailand's Mae La refugee camp, the largest of several along the Burmese border. The second variety features high falling pitch for tone 5 and a slightly lower falling contour for tone 2. This was shared by the 5 speakers contributing to the intonation patterns portion of the current study and is the variety investigated in this study. It is yet unclear exactly where each variety is spoken and whether any other differences exist, suggestive of a dialect distinction. One participant (F33) reports that she could code-switch between the two depending on whom she is addressing.

Average normalized f0 values for six lexical tone contours (tones 1-6) are given in Figure 3 for the 3 females and 2 males chosen to elicit intonation examples. F0 measurements are made at 4 points during the vowel of monosyllabic words of CV sequence /wi/, produced in six different tones, either phrase-initially in [**wi**^{T} l̰ɻ-keɬ tə ʔoʅ pʰɛɬneʅ baʅ] '(the) "wi^{T}" card not is at-there NEG' (="the "wi^{T}" card is not over there"; ^{T} indicates a lexical tone) or phrase-finally in [wi^{T} l̰ɻ-keɬ, waɬ ʔiɬ, **wi**^{T}] '(The) wi^{T} card, "w", "i", __' (saying the card name, spelling the target syllable's consonant and vowel, and then saying the whole target syllable). Pitch was normalized for each speaker by collecting the max and min f0 of all target sentences, subtracting the min from each midpoint f0 value and then dividing the difference by the speaker-specific range (max-min).

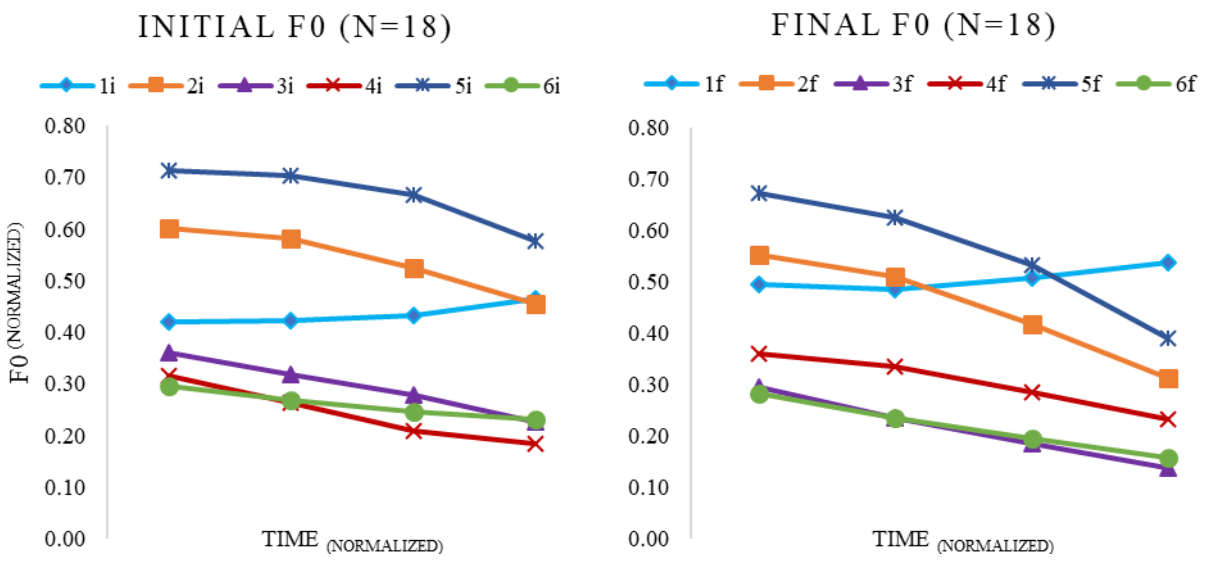


Figure 3: Average normalized f0 (y) at 4 points during the vowel (x); 5 speakers produced 3-4 repetitions of target words in phrase-initial (left) and phrase-final (right) position.

The shape of this tonal space resembles that of Sun (2016), the only exception being the tone 4's lower pitch when phrase-initial. These five participants showed very little difference in the arrangement of their tone space. All have consistent high falling tones 2 and 5, low creaky tones 3 and 4, and the lowest onset in breathy tone 6. Tone 1 is used as the high tone target in the intonation data. As seen in Figure 3, all tones are slightly falling except for tone 1 (T1), the modal high tone. For these speakers, T1 is realized phonetically as a mid-rising tone.

2 Background in prosody in Sgaw Karen and related languages

2.1 Word Prosody

2.1.1 Syllable types and syllable structure

There are two types of syllables in Sgaw Karen: major and minor. Major syllables make up the majority of lexical morphemes and many of the functional morphemes in the language. They also may have simple or complex onsets and may bear any of the 6 lexical tones. The maximal syllable structure of a major syllable in Sgaw Karen is CCV (Rattanaporn 2012), and possible syllable shapes are given in (2) (^{T} indicates lexical tone).

(2) a. CV^T **lɛ̰˩** ‘to go’

b. CGV^T **l^{w}ɛ̰˩** ‘color’

c. CCV^T **klɛ˥** ‘path’

In contrast, there also exists a *minor* class of syllables whose duration is shorter and phonotactics is substantially more limited. The onset of the minor syllable is never complex, except inconsistently in a few obscure loanwords (e.g., /tɹə xo̰˩ ne˥ tḭ˩/ ‘Trachonitis’). Marked with no diacritics in the orthography, minor syllables are never non-modally phonated and always bear a [ə] vowel, the quality of which is more central than the /ɤ/ vowel in major syllables. They are not phonemically tone-bearing in the way that major syllables are. For this reason they are transcribed here without tone, although their surface f0 is a bit more complex, arising from a combination of adjacent tone’s influence and their own default low pitch target (West 2015). The attested categories of Sgaw minor syllables are given in Table 3. The first three rows show functional morphemes. The last two rows show minor syllables which are not themselves morphemes but are part of a root.

Table 3: Types of minor syllables in Sgaw Karen

Grammatical particles:	**tə**	‘not’	**kə**	‘will’ (future prefix)	**mə** (prefix)
Nominal prefixes:	**tə**	‘one’	**kə**	noun-marker	
Pronominal prefixes:	**jə**	1SG ‘I’	**nə**	2SG ‘you’	**pə** 1PL ‘we’
Root-internal syllables:	**θə** in θəŋɛ̰˩ ‘plant’		**lə** in ləpɔ˥ ‘wave’		
Loanwords:	kɔ̰˩ **ʔə**mɛ˥**ɹə**kạ̰˩		country-America		‘USA’

As seen in the last row, unstressed English syllables are often borrowed into Sgaw Karen as minor syllables. The role of minor syllables in loanword adaptation is discussed in section 3.1. Minor syllables in Sgaw are limited to a few words of various morphological configurations, like Mandarin’s ‘light’ syllables bearing neutral tone (Chao 1968:36). The most common minor syllables are pronouns (jə- ‘I’, nə- ‘you’, pə- ‘we’) and clitic particles such as negation (tə) and

future tense (kə). Other minor syllables include nominalizing prefixes (*tə* as in **tə**ma˥ ‘alligator’ from ma˥ ‘black’), adjectival prefixes (**mə**kʰɛ̰˩ ‘brittle’ from kʰɛ̰˩ ‘small stick’) or parts of lexical stems (**θə**ra˥ ‘teacher’, **pə**lɔˀ˥ ‘bottle’, **lə**ra̰˩ ‘hell’ etc.).

Though phonetic research of closely related languages are rare, a few acoustic studies exist. Pwo Karen, for example, has been described as having minor syllables whose nucleus must be a schwa (Kato 1995:70) and whose onset has a more limited consonant inventory, never complex (Kato 1995:73). Furthermore, these minor syllables are described as brief and atonic (Kato 1995:70). These minor syllables are often functional morphemes, and cliticize to the following word (e.g., numerals; Kato 1995:72), and Sgaw cognates act identically. Sgaw minor syllables never occur word-finally. Sgaw minor syllables are also brief in duration and have been found to be low-mid pitch acoustically (West 2015).

The remainder of this section discusses previous research on word prosody in related languages to give context to the present analysis. Commentary on Sgaw minor syllables is scarce but the major-minor syllable distinction is well-analyzed in related languages. The difference between major and minor syllables has been analyzed as moraic for several related languages. In Burmese, major syllables are viewed as bimoraic and minor syllables as monomoraic, key evidence being that only major syllables may stand alone as a foot (Green 1995). Though a foot analysis of Sgaw Karen is not proposed here, similar evidence is found in Sgaw Karen as a major syllable, but not a minor syllable, may occur as a free-standing word (§3.3). This is also suggested to hold for Eastern Pwo Karen (Hsieh 2012:9). Another Tibeto-Burman language, Zaiwa, treats major syllables as bimoraic, monosyllables as monomoraic, and attributes the lack of stress on minor syllables to their monomoraicity (Wannemacher 1998:71). This type of

analysis is likely to hold for Sgaw as well, and can be represented as in (3): 'X' = a major syllable and 'o' a minor syllable.

(3)

Morae:	μμ	μ	μμ		μ	μμ		μ		μμ	μμ		μμ	μμ
Major/minor:	X	o	X		o	X		o		X	X		X	X
	doɬ-kə		-ʔoɬ		tə-dɯɬ			tə		kuɬ-wɛɬ			tʰiɬ	baˀɬ
	owl				1	CL		not		wade-ing			water	NEG

"One owl is not wading."

In short, related languages suggest, and findings from the current study support, that the major-minor syllable distinction is a lexically specified component in Sgaw Karen's prosodic hierarchy. This is to say that the schwa vowel quality, short duration, and lack of phonemic tone all fall out from a syllable being specified as *minor*.

2.1.2 Word

The current study finds a prosodic distinction between major and minor syllables, but no convincing evidence for word stress in Sgaw Karen; this section provides relevant background and section 3 explains why. Because the word stress of Karenic languages is largely unexplored, literature is discussed regarding word stress of related and neighboring languages to address whether the lexicon specifies syllable weight (major vs. minor) or prominence differences between major syllables (word stress). Descriptions of the related language Pwo Karen vary greatly—though Eastern dialects are suggested to lack stress (Hsieh 2012), Western Pwo Karen has been described as 'stress-timed' (Phillips 2000:100). Phillips also describes Pwo Karen as exhibiting a "typical" Sino-Tibetan stress on the first major syllable of a compound, and an iambic (unstressed-stressed) pattern (Phillips 2000:100). The "iambic" pattern most likely references the many words composed of a minor and major syllable. It is proposed that Pwo minor syllables are not inherently reduced morphemes, but are a product of a prosodically weak environment (Phillips 2000:100). Though this may be a factor in the historical development of

minor syllables, recent work on Sgaw minor syllables shows that many functional morphemes can be analyzed as lexically reduced and are now phonemically distinct from their tone-bearing major counterparts (West 2015).

One of the earliest studies on Sgaw Karen expressed the difference between these syllable types as levels of stress (Jones 1961). Two examples below in (4) illustrate this point.

(4) a. jə̆ˀ ˈlɛ
I go
'I went'

b. jə̆ˀ lɛ-ˈθə́
I go-can
'I can go'

The author notes that the initial minor syllable /jə/ 'I' in (a) and (b) is less stressed than the other syllables in the phrase, and the last syllable usually receives primary stress. Additionally, the morpheme /lɛ̤/ 'go' is stressed in (a) but not in (b), suggesting that word-final syllables are more prominent, even if they are functional suffixes. This is as opposed to clitic pronouns which appear in a particularly weak spot—beginning of a word.

While nearby languages like Thai and Khmer have been claimed to have iambic stress (Griffith 1991; Hayes 1995), many Tibeto-Burman languages like Burmese are argued to have trochaic stress. Though a sequence of a minor and major syllable might give listeners an impression of iambic stress, they do not form an iamb. Rather, the minor syllable is unfooted and the major syllable forms a single foot (Green 1995:79, 80). In terms of word shape, Sgaw Karen resembles Burmese in disallowing word-final minor syllables (§3), or a word comprising only two minor syllables (Green 1995:79) which suggests that minor syllables are not prosodically strong enough to stand alone. Whether Karenic languages pattern more like closely related Tibeto-Burman languages or the neighboring languages of Thailand is investigated in the current study.

2.2 Intonation

Sgaw Karen being a tonal language, this section highlights a few ways intonation is realized in a tone language. Considering that both lexical tone and post-lexical intonation are represented by changes in f0 (pitch), it is inevitable for a tone language to have a little room for varying f0 for intonation. Research on tonal languages shows that languages vary in their way to allow phrasal-level pitch variation. The strategies presented below are each seen in Sgaw Karen to some extent.

One possibility is to avoid intonationally defined phrasing and boundaries altogether where possible, remaining faithful to the pitch of lexical tones. In languages like Cantonese, the only phrase in the prosodic hierarchy larger than a Word is the IP, and the usual grammatical, pragmatic or emotive functions of intonation are conveyed using a wide inventory of final particles. It will be seen that Sgaw Karen follows this pattern to a large extent, making use of several final particles and reserving the IP-final position for the majority of its intonation phenomena.

Another strategy is to favor phrasal tones over lexical tones, leading to a change in shape of or overriding of lexical tone. In Burmese, for example, the lexical tone associated with the phrase-final or -initial syllables is obscured on the surface due to boundary tones, a potential hindrance to lexical information. This strategy is also found for Sgaw Karen in cases where multi-tonal boundary tones (e.g., LHL%) are present on a final syllable, though lexical tone is not completely overridden when bearing single boundary tones (e.g., H%).

Finally, pitch range of a phrase can change while maintaining lexical tone contrast. In focus constructions, for example, rather than changing the shape of lexical tones, the f0 range of a focused element may be expanded or raised while lexical tones of words that are redundant or

old information can be compressed, creating the effect of deaccenting postfocus words in English. Pitch range can also be manipulated to mark a prosodic unit while maintaining lexical tonal contrast. This is found in Sgaw Karen. In Sgaw Karen, an Intonational Phrase can be divided into smaller phrases marked by pitch range without changing lexical tones. The beginning of this phrase, called an Accentual Phrase (AP) is marked by lowering pitch range relative to the preceding word's pitch range, called 'f0 downstep' in this study (see section 4.1.2).

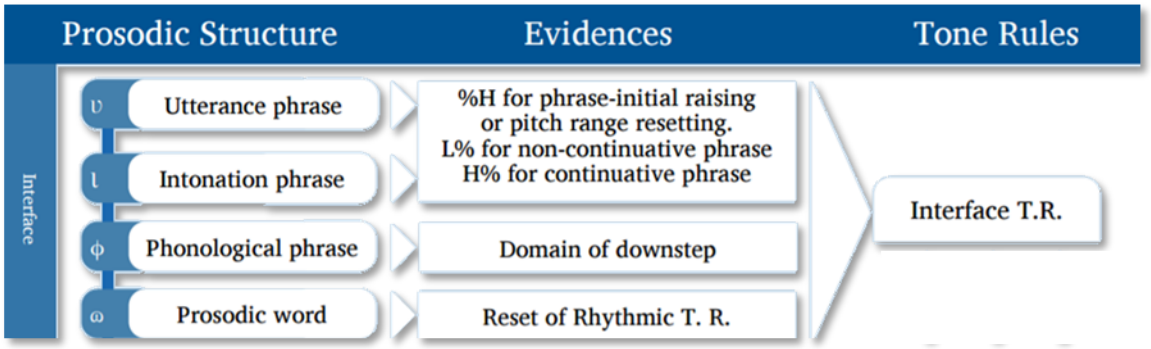
2.2.1 Tibeto-Burman Intonation

This section describes intonation of three Tibeto-Burman languages (Figure 1, §1.2) related to Sgaw Karen to support this study's claim that Sgaw Karen intonation resembles Burmese in terms of phrasing, Pwo Karen in terms of the location of post-lexical tones, and Tibetan in phonological downstep, to an extent. Brief overviews of intonation research on these languages provide context for interpreting results. Only studies with proposed levels of phrasing and intonational evidence are discussed here.

Tibetan

Sgaw Karen intonation will be seen to resemble Tibetan slightly in the role of downstep on the smallest prosodic units. This section briefly reviews one investigation of the intonation of Lhasa Tibetan (Lim 2014) which itself draws on several previous studies on Tibetan tonal phonology. Lim condenses previous work into a single analysis and argues for multiple levels of phrasing marked by either intonational tones (e.g., L%) or phonological domain boundaries (e.g., downstep). He proposes that Lhasa Tibetan has an Utterance, Intonational Phrase, Phonological Phrase and Prosodic Word, as shown in Table 4.

Table 4: Lhasa Tibetan prosodic structure and T.R./tone rules (Lim 2014)



Only the two highest phrases bear specific boundary tones while the two smaller are marked by either downstep or tone rule reset. In sum, as a tonal language with downstepping prosodic words, Tibetan serves as a good model for Sgaw Karen's downstepping accentual phrases. Sgaw Karen will be shown to differ, however, as it does not have an equivalent to the Utterance Phrase.

Burmese

Burmese being closely related to Sgaw Karen (*Figure 1*), this section briefly summarizes aspects of the language's intonation resembling Sgaw Karen, namely phrasing and downstep, as well as effects of stress on intonation warranting the careful investigation of Sgaw Karen word prosody made in section 3. For decades, description of Burmese intonation has been limited to a few comments in a phonology of the language, in which Armstrong and Tin (1923) describe some variation of lexical tone at a [phrase] boundary as well as some "stress"-like phenomena associated both with the sentence and lexical tones themselves (1923:27-28). A much later study looking specifically at news-reading speech made the first analysis of distinct prosodic domains (Watkins 2000). Watkins organizes prosodic domains hierarchically from the smallest phrase, *intonational word*, constituting larger *intonational phrases*, and several of these forming an *intonational sentence*. These three prosodic levels are summarized in the table below along with the unit they correspond to and any phonetic evidence cited by the author marking the boundary.

Table 5: Summary of prosodic levels proposed for Burmese (Watkins 2000)

Grouping	Corresponding to	Evidence
Intonational sentence	Sentence	Global pitch declination reset
Intonational phrase	Up to 3sec duration	0.5sec pause
Intonational word	Syntactic word	---

Watkins (2000) also found lexical tones to remain recoverable from surface f0, maintaining the integrity of the underlying tone in most positions. Finally, the last *intonational phrase* of an *intonational sentence* is described as deviant from the rest, marked with a sharp final rise.

In a more recent study, Ozerov (2017, manuscript) goes on to describe these intonational groupings in more detail. Looking at similar news-reading style data, Ozerov examines the characteristics of phrases constituting each sentence, including the sentence-final phrase. Results are summarized below. In short, two main contours that indicate information structure are described in Burmese: (1) initial mid contour rising on the first full syllable and declining to low pitch (MHL), and (2) steady decline from initial syllable (HL), which is presumably the most prominent (Ozerov, 2017:17).

Table 6: Summary of prosodic levels proposed for Burmese (Ozerov 2017)

Grouping	Corresponds to	Starts with	End with
Intonational sentence	Syntactic sentence	Reset from downstep	Sharp rise (paragraph-final L)
Intonational phrase	Syntactic phrase	Phrase-initial peak (L)H	L or LH tone
Intonational word	---	---	---

Ozerov makes no mention of an *intonational word* category but rather likens his *intonational phrase* to the consecutive short phrases that form the strong macrorhythm (Jun 2014:521) in "phrasal languages" (Féry 2010) like Korean or Bengali (Ozerov, 2017:8). Like Sgaw Karen's accentual phrase proposed in the present study, he considers the *intonational phrase* to be the most basic unit of Burmese intonation.

The phrase-initial peak, either LH or H, is shown to be realized on the first non-reduced syllable of a phrase (Ozerov, 2017:12), though data suggests that lexicalized compounds may have fixed word stress affecting accent docking (Ozerov, 2017:16). In light of this, analysis of Sgaw Karen intonation considers both effects of major-minor status of syllables, and word-prosody. Two points are noted concerning the lexical tone realization at a phrasal level. First, in terms of accent alignment, the breathy-high tone rises to reach its highest point at the end of the syllable, while the creaky tone's highest peak is at the syllable's onset (Ozerov, 2017:12). Second, it is noted that underlying lexical tone remains predictable from surface f0, despite the phrasal melody of post-lexical tones. Phonetic integrity of IP-medial lexical tones is similarly seen in Sgaw Karen.

It is important to note that both Tibetan and Burmese are verb-final SOV languages contrary to the SVO order of Sgaw Karen. Additionally, in the case of Burmese, studies to date approach intonation as a secondary objective and do not claim to give a full account of the language's system. The important message for the current study, however, is that a closely related language—Burmese—exhibits both lexical tone contrast and post-lexical phrasal melody reminiscent of Bengali or Korean. This possibility is something that should be considered for Sgaw Karen, a related tonal language, despite the unlikelihood that these two prosodic parameters (lexical tone contrast and post-lexical phrasal melody) co-occur. Finally, the effect of word stress on Burmese intonation motivates consideration of word stress in the current study for Sgaw Karen (§3).

Pwo Karen

One study of manual gestural alignment with prosody on Pwo Karen has proposed a prosodic transcription system (PK_ToBI) for the eastern variety spoken in Thailand (Hsieh 2012).

Hsieh chooses Pan-Mandarin ToBI (Peng et al. 2005) as the basis for Pwo Karen intonation (Hsieh 2012:11). She observes that intonation contours overlay pitch contours of lexical tones and "boundary tones, phrase accents, and pitch range effects all raise or lower the pitch of a lexical tone relative to its usual pitch range" (Hsieh 2012:11). Like Mandarin, Pwo Karen is suggested to use pitch range effects, as evidence of Intonational Sentence grouping, such as phrase-initial pitch register raising seen in echo questions (%q-raise), and indication of local prominence using long duration and pitch expansion of a prominent element (%e-prom) and post-focus pitch compression (%compression) (Hsieh 2012:15), summarized in Table 7.

Table 7: Summary of prosodic levels proposed for Pwo Karen

Grouping	Corresponds to	Evidence	Ends with
Intonational sentence	Syntactic sentence	Domain of %q-raise, %e-prom and %compression	H% or L%
Intonational phrase	Syntactic phrase	---	H- or L-

Two aspects of Pwo Karen findings are especially helpful to consider when approaching Sgaw Karen. First, contrary to intonational phrase proposed in Burmese, no reference to an initial phrase accent is made for Pwo Karen's intonational phrases, which are instead only marked by phrase-final L-/H- tones. Second, manual gestures of a native speaker narrating a story are shown to be aligned with the left-edge of focused words, even if the first syllable is minor (Hsieh 2012:33), suggesting that prominence is aligned with the word edge, rather than the first prominent syllable. If Eastern Pwo Karen had word-level stress attracting prominence, a minor syllable would be an unlikely candidate to receive prominence. Like Eastern Pwo Karen words, Sgaw words do not show consistent cues that would indicate word stress (§3).

2.2.2 Sgaw Karen Intonation

Presented in this section are a few studies which describe aspects of Sgaw Karen intonation along with predictions they make for the current model. One of the earliest studies on

Sgaw Karen makes two main observations concerning intonation. First, Jones (1961) describes a "steady lowering of pitch" across the utterance, particularly when adjacent syllables are of the same tone or are separated by a "weakly stressed syllable" (i.e. minor) (Jones, 13). Second, Jones points out short utterances where pitch "remain[s] relatively constant", like in (5) (1961:14).

(5) a. tɛ́ ˈbáʔ-wɛ̀ ˈkhwá:
say-compl-cont brother
'(I) told older brother'

b. jə̌ʔ lɛ-ˈθə́
I go-can
'I can go'

For longer sentences, it is likely that Jones is noticing something more than pitch declination over the utterance. The fact that sentences like (4a) and (4b) do not show pitch lowering but longer sentences do suggests that something like phonological weight (in terms of the number of syllables) contributes to whether this 'pitch lowering' occurs. Though pitch lowering is found to be abrupt more than 'steady' in the present study, the author's observations are largely confirmed and expanded (§4).

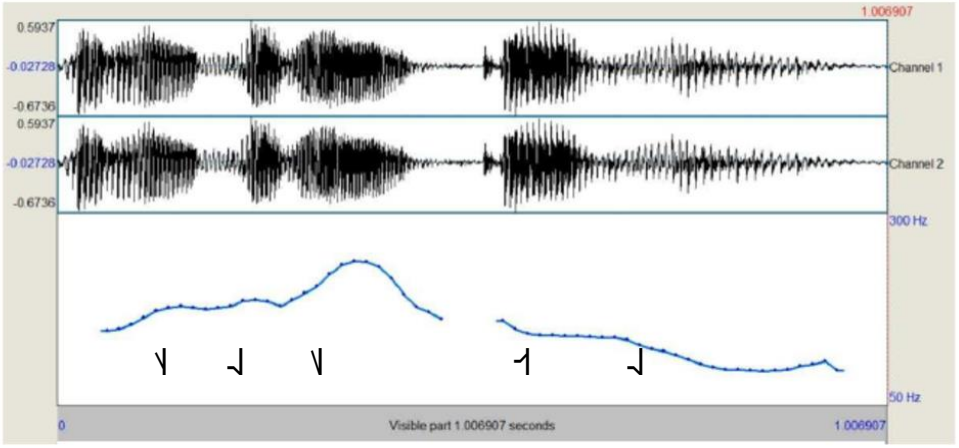
In a paper comparing f0 of tonal minimal pairs, some tones showed different f0 contours from citation forms when sentence-medial, and tone 1 (mid-high) showed a rising contour only when sentence-final (Griffin 2014). This resembles the rising variant of the mid-high tone observed in Pwo Karen at the "end of an intonational boundary" (Hsieh 2012:11) and in Burmese at the "end of a non-final sense-group" (Armstrong, Tin 1923). Data collected in a later study (West 2015) found similar variation between a flat and rising contour of Sgaw's mid-high modal tone (tone 1). As these observations all concern the mid-high tone, tonal allophony is expected for tone 1 here as well. The present study confirms this allophonic rise for tone 1 at sentence-medial boundaries as well (AP or IP).

Concerning minor syllables, research on Burmese gives insight into how the major-minor status of syllables might interact with intonation. Ozerov (2017), for example, notes that the

intonation phrase-initial H accent docks only to major syllables in Burmese, leaving minor syllables at a low pitch, as seen in Figure 4. The first major syllable of the sentence is found in the second syllable of [zəbĩ] ‘hair’ and is phonologically mid-level tone.

zəbĩ *di-lauʔ* *kã̆u-t̲a*
hair this-much good-R.NMLZ
‘Your hair is so beautiful!’ (Sa Oo 36.2)

UR tone:



z ə bi *di lau* *ʔk ã̆u* *t̲ a*

Figure 4: IP-initial minor syllable (Ozerov 2017:21, example 19)

The present study found that the most common pattern for IP-initial minor syllables in Sgaw Karen resembles the example above, with pitch of minor syllables lower than the first major syllable. However, phonetic work on Sgaw Karen minor syllables has found a default low f0 target on minor syllables (West 2015), suggesting no need for a phrase-initial L on minor syllables like in Burmese. Two example sentences from a native speaker of Sgaw Karen are given in Figure 5 below, the only difference being the minor syllable prefix [nə] ‘your’. As shown in the right panel of Figure 5, the minor syllable shows a low f0 target.

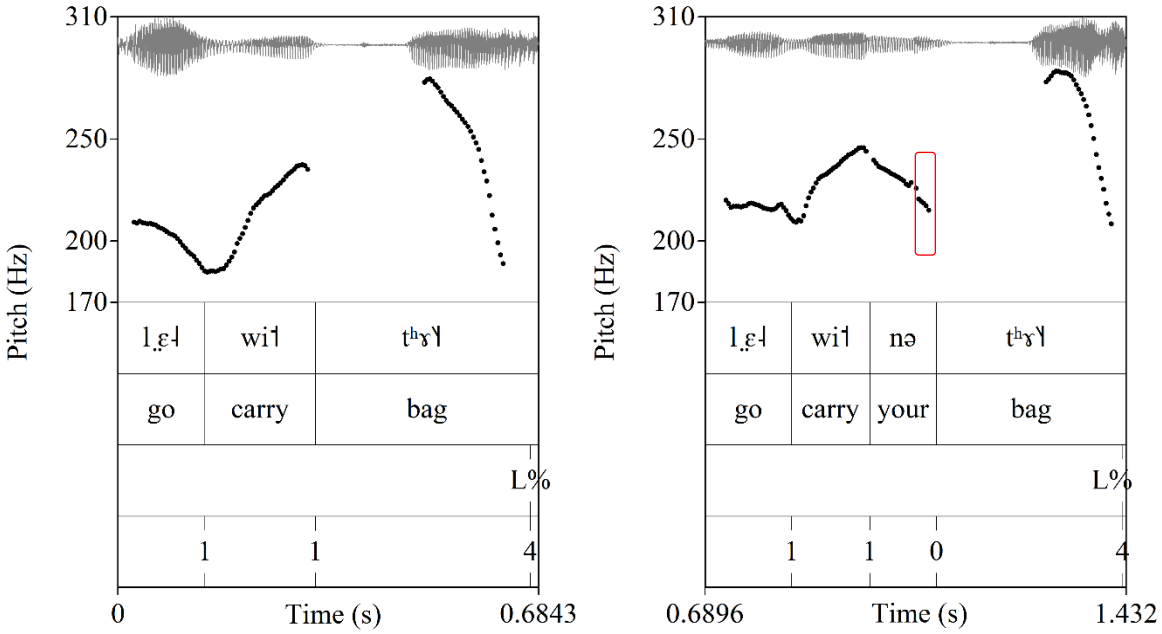


Figure 5: pitch tracks of sentences which differ only by the presence of a phrase-medial minor syllable

2.3 Background summary

Though understudied, the little research that is available on Tibeto-Burman suggests that intonation systems vary a great deal. Looking only at tonal languages in the Eastern Tibeto-Burman group, languages differ in the complexity of their prosodic hierarchy as well as the extent to which postlexical tone is used to mark phrase boundaries. Languages like Burmese make use of phrase accents in sentence-medial phrases, while languages like Pwo Karen, the language closest to Karen, are shown to be similar to Mandarin. The slightly more distant Tibetan language exemplifies a prosodic unit defined as a domain of downstep. In the sections that follow, it is shown that some prosodic aspects of each of these languages are relevant to Sgaw Karen intonation and prosody. Section 3 reports new findings on prosody at the word-level and section 4 on intonational phonology of Sgaw Karen.

3 Word Prosody of Sgaw Karen: New Findings

This section investigates Sgaw Karen word prosody from three perspectives. First, the question of whether word-level stress exists on major syllables is addressed by examining

potential acoustic correlates of stress (§3.2). Next, attested word shapes in the Sgaw Karen lexicon and core vocabulary are explored to determine the distribution of major and minor syllables in Sgaw Karen words (§3.3). Finally, phonological processes involving major and minor syllables (§3.4) and Sgaw Karen loanwords (§3.5) are investigated, and the last subsection summarizes findings on word-level stress and syllable weight (§3.6).

Stress reported in other tonal languages has been found to manifest through longer duration (Chávez-Peón 2008 on Zapotec) and sometimes intensity (Everett 1998 on Pirahã). Sometimes only stressed syllables bear tone and location in a word also factors in, as in the Iquito language of Peru (Michael 2011) where the author notes that penultimate syllables tend to bear high tones, not all syllables bear tone, feet are trochaic and parsed leftward, and a heavy syllable is always a single foot. Kurtöp, a tonal Tibeto-Burman language, also exhibits both stress accent and tone. Stress is always word-initial and acoustically correlated with duration (Hyslop 2010). In short, a tonal language may very well have word-level stress as well, and the two may interact.

3.1 Methods: word stress

Measurements testing for word stress are collected from 3 male and 3 female native speakers between ages 18 and 38. To address whether stress exists in Sgaw, potential acoustic correlates were measured for polysyllabic words. Words of either sS, SS, SsS, SSS or SsSS word shape ([kəɳɔ˧] ‘person’, [sɔ˧lɔ˧] ‘cockroach’, [do˧-kəʔo˧] ‘owl’, [kʰe˧-bʸe˧-pʰo˧] ‘panther cub’, and [do˧-kəʔo˧-pʰo˧] ‘owlet’, respectively) as well as nonce words of the same forms (e.g., SsSS [la˧-lə-la˧-la˧]) were elicited in phrase-initial position of SVO sentences comprising only high modal tone syllables. Words with syllables of equal vowel height and as sonorous onsets as possible were chosen to control for intensity and pitch, respectively. When possible, complex

onsets were disfavored to avoid affecting the inherent duration of syllables. Three repetitions were made for sentences bearing each target word. Examples of target words for each syllable shape are given in Table 8 below followed by the two morphosyntactically identical carrier phrases.

Target words				
Major syllables		Major and minor syllables		
SS	SSS	sS	SsS	SsSS
kʰɐ˧˥bɣɐ˧˥ panther 'panther'	kʰɐ˧˥bɣɐ˧˥ pʰo˧˥ panther-DIM 'panther cub'	kəŋɔ˧˥ person 'person'	do˧˥kəʔo˧˥ owl 'owl'	do˧˥kəʔo˧˥ pʰo˧˥ owl-DIM 'owlet'

Carrier phrases	
____ ʔɔ˧˥wɛ˧˥ tʰi˧˥ ____ drink-PROG water '(The) ___ is drinking water'	____ ku˧˥wɛ˧˥ tʰi˧˥ ____ wade-PROG water '(The) ___ is wading in the water'

Table 8: Target words for each word shape with carrier phrases

After annotating syllable breaks and vowels manually, measuring of intensity (dB), duration (ms), and pitch (f0), was done with an automated Praat script based on a Voicesauce (Shue 2010) imitator script by Bert Remijsen (http://www.ling.ed.ac.uk/~bert/praatscripts.html), modified further by myself.

3.2 Word-level stress

This section discusses the results of the word-stress experiment. Acoustic analysis of polysyllabic words in Sgaw Karen yielded the following results. Averages given below include only real words, though nonce words showed the same patterns. Average duration for major syllables (S) in the longest word shapes, SSS and SsSS, is given in Figure 6. These word shapes are the main ones analyzed and presented here because they are the longest words, have the most major syllables, and thus are the best environment for comparing major syllables in a single word. Patterns for disyllabic words are discussed next (Figure 7).

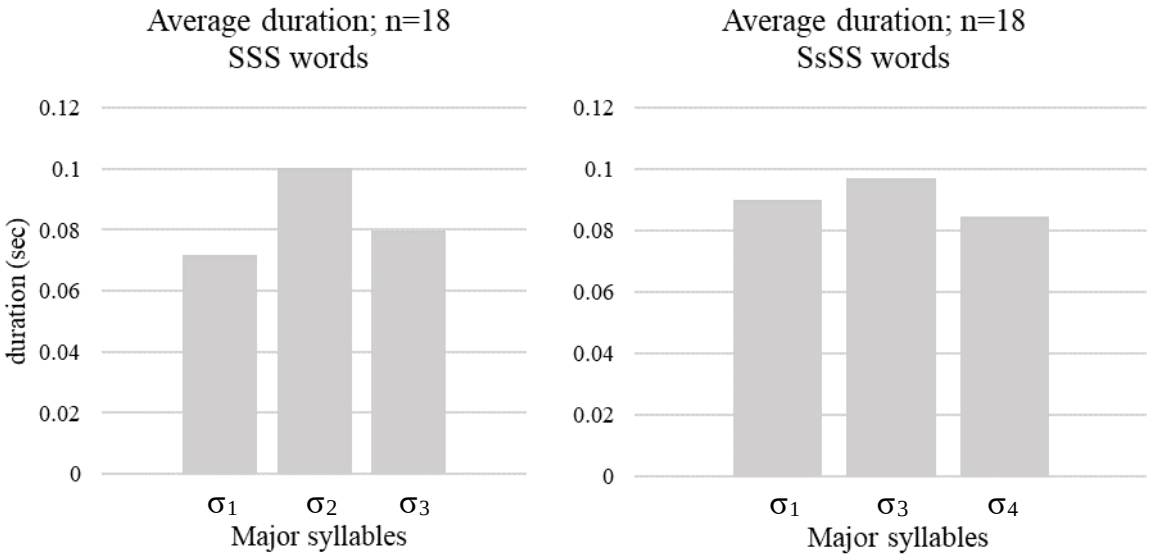
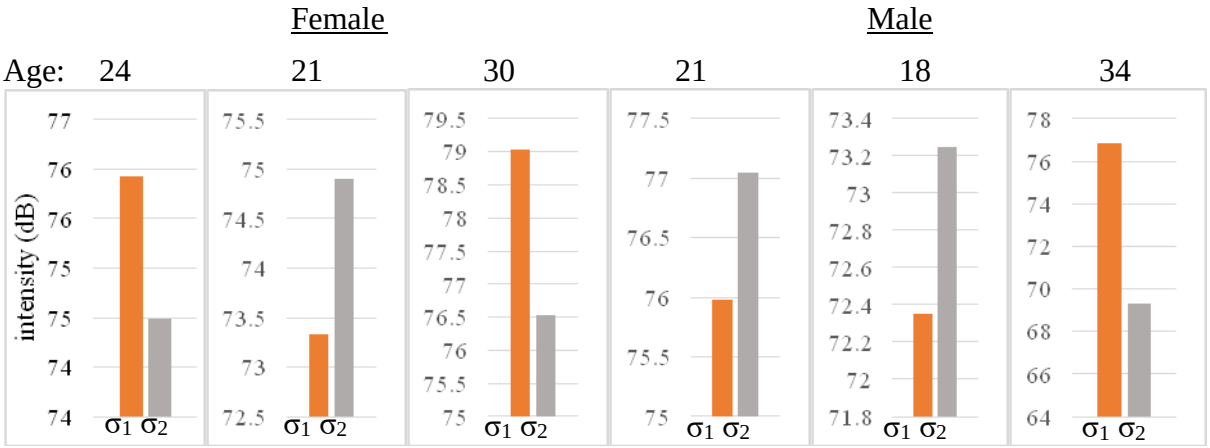


Figure 6: Duration of three major syllables' (x) average duration (y) in a word of SSS (left) or SsSS (right) shape (n=18 per syllable, from 6 speakers, 3 tokens each).

Figure 6 shows the duration of each major syllable of 18 repetitions of words of the SSS (left) or SsSS (right) word shape. While at first duration patterns hint at penultimate stress, this pattern does not seem to hold for other acoustic correlates or other word shapes. Average intensity and duration per syllable of the disyllabic word /sɔɬlɔɬ/ 'cockroach' for each speaker are given in Figure 7. Intensity measurements show high variability between some speakers (e.g., F24 vs. F21). Duration shows similar patterns for some speakers (e.g., F24 vs. F30), but not others (F21). Neither acoustic cue supports consistent penultimate stress.



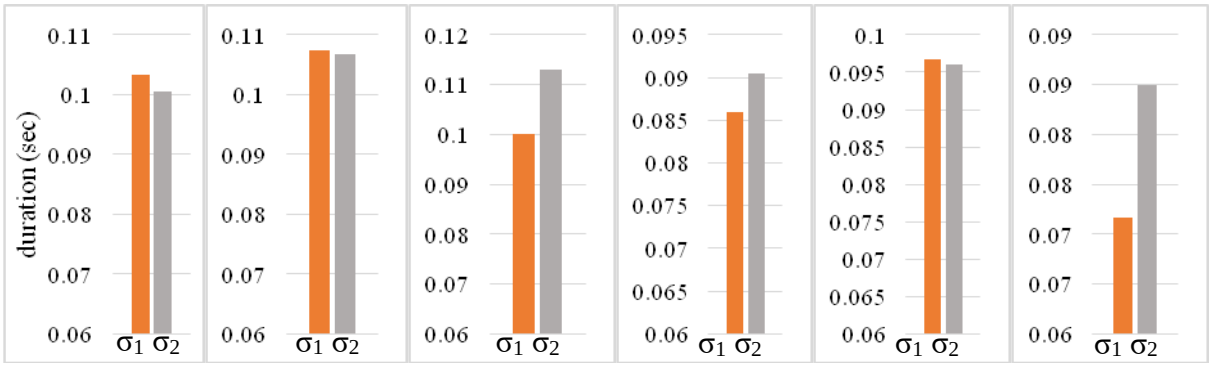


Figure 7: Average intensity (dB), duration (sec) of 3 repetitions of /sɔ˥ lɔ˩/ 'cockroach' for 6 speakers

In short, contrary to the stress correlates found in some tonal languages, intensity and duration in Sgaw Karen are not found to correlate to syllable position consistently. Moreover, duration and intensity patterns do not seem linked to the age or sex of the speaker. This section has presented the finding that neither intensity nor duration consistently distinguish major syllables within a word, suggesting that word-level stress is not a feature of Sgaw Karen. To support this claim, the following three sections investigate Sgaw word shape and prosody, specifically by examining which word shapes are most common and whether any syllabic position in a word is privileged by being favored over others for phonological processes, and whether positional constraints on major-minor syllable distribution is preserved in loanwords. The following three sections will cover (1) corpus description of core word shapes and (2) target syllables of partial reduplication in polysyllabic bases, and (3) Sgaw Karen loanwords.

3.3 Common word shapes in Sgaw Karen

This section investigates word shapes in Sgaw Karen to see (1) which word shapes are used in language's core vocabulary and (2) whether there are constraints on the distribution of minor and major syllables. To understand more about the word shape of Sgaw Karen, a corpus was constructed of Sgaw Karen text. Rather than checking the entire corpus for each entry, the corpus is divided into subsets corresponding roughly to genres or topics. This was done to avoid rare vocabulary occurring (1) many times in a single newspaper article as well as (2) in blog

posts with the same topic or author. Written Sgaw Karen data was queried using online resources (Drum Publications) divided into 6 subsets based on genre: science/math, health, culture, fiction, children's literature, online newsletters. While literature in the culture genre pertained almost exclusively to Karen culture, fiction primarily includes translated western literature or stories from non-Karen cultures of Burma. The last two literature styles were aimed at younger audiences, and online newsletters were chosen as a representative of more informal, blog-like writing—these were quarterly newsletters about world news, international cultural trivia, crafts, and game ideas designed to be both readable and entertaining. Each genre subset includes 5-10 separate pieces of literature (58 articles for the online newsletters) of approximately 40 pages each; page-lengths of samples varied greatly but more samples were added to genre subsets until total symbols filled at least 70 pages (standard margins; 12pt, Calibri font), most reaching 100-120 pages. Descriptions and contents of each genre group are given in appendix 6.4.

Entries which were detected in most or all subsets are considered common. Table 9 gives the number of unique words of a 6338-word lexicon found in each genre. A total of 441 words overlapped between all genres, and 1086 for the two literature subgroups.

Table 9: Number of unique words within each literature subgroup

	Per genre						**Overlap**	
Category	Fiction	Kids	Health	Culture	Article/ Newsletter	Science	All novels/stories (Fiction + Kids)	All genres
Unique words: (of 6338 in dict.)	1563	1512	1337	1323	1009	911	1086	441

As seen in Table 9, less unique words were found overall for the newsletter and science genres, possibly due to more formulaic writing styles. Next, each attested word shape was counted ('X' = major syllable, 'o' = minor). Table 10 shows the frequency of word shapes present in core vocabulary followed by all possible attested word shapes and rough frequencies of the most

common shapes in the dictionary. Firstly, X, XX and oX words make up 85.5% of core vocabulary.

Table 10: Word shapes of core vocabulary (n=441)

Word-shape	*X*	*XX*	*oX*	*XXX*	*oXX*	*XoX*	*XXXX*	*oXoX*	*XoXX*	*XXoX*	*oXXoX*	*oXXX*
raw count	194	142	41	23	11	9	9	4	3	3	1	1
percent	44.0	32.2	9.3	5.2	2.5	2.0	2.0	0.9	0.7	0.7	0.2	0.2

Second, among core vocabulary (Table 10) and even across all dictionary entries (Table 11), no minor syllables are found word-finally suggesting that the location of minor syllables is prosodically determined. In terms of morae, this would mean monomoraic minor syllables may not occur word-finally—the word-final position is reserved for strong syllables of two morae. Also noteworthy is the paucity of minor syllables preceding other minor syllables—none were found in the core vocabulary and only 29 word shapes with adjacent minor syllables were found in the whole dictionary.

Table 11: Word shapes in dictionary (n=5011); y=syllable amount, z=relative frequency (dark=frequent)

Syl. **1-4**	**5-6**	**6**	**6-7**	**7**	**7-8**	**8**	**9-10**
X	XXXXX	XXXoXX	oXXooX	XXoXooX	oXoXoXX	XoXXXXXX	XXXXXXXXX
XX	XXXoX	XXXooX	oXoXXX	XXooXoX	ooXoXoX	XoXXXXoX	XXXXXoXoX
oX	XXoXX	XXoXXX	oXoXoX	XoXXXXX	XXXXXXXX	XoXXXoXX	XXXXoXXoX
XXX	XXooX	XXoXoX	ooXXXX	XoXXXoX	XXXXXXoX	XoXXoXXX	XXXoooXXX
XoX	XoXXX	XXooXX	ooXXoX	XoXXoXX	XXXXXoXX	XoXXoXoX	XXoXXXXXX
oXX	XoXoX	XoXXXX	XXXXXXX	XoXXooX	XXXXoXXX	XoXoXXXX	XoXXoXXoX
ooX	XooXX	XoXXoX	XXXXXoX	XoXoXXX	XXXXoXoX	XoXoXXoX	XoXXooXXX
XXXX	oXXXX	XoXoXX	XXXXoXX	XoXoXoX	XXXoXXXX	XoXoXoXX	XoXoXXXXX
XXoX	oXXoX	XoXooX	XXXoXXX	XooXXXX	XXXoXXoX	XoXooXoX	XoXoXXoXX
XoXX	oXoXX	XooXXX	XXXoXoX	XooXoXX	XXXoXoXX	XooXXXXX	XoXoXooXX
XooX	ooXXX	XooXoX	XXXooXX	XoooXoX	XXoXXXXX	XooXXoXX	XooXXXXoX
oXXX	ooXoX	oXXXXX	XXoXXXX	oXXXXXX	XXoXXXoX	oXXXXoXX	XXXXXXoXoX
oXoX	XXXXXX	oXXXoX	XXoXXoX	oXXoXoX	XXoXoXoX	oXXoXoXX	XXXXXoXXoX
ooXX	XXXXoX	oXXoXX	XXoXoXX	oXoXXoX	XXooXooX	oXXooXXX	XooXoXoXoX

Even when including the 5011 entries in the dictionary (Table 11), with 112 attested word-shapes, the only entries ending with a minor syllable were clitic pronouns, prefixes like /nɔˀ tə-/ ‘not any _’, and clitic modals like /kə-/ ‘will’, all of which cannot stand alone as words. Another unattested word shape is ‘oo’, suggesting that 2 minor syllables cannot stand alone as a word—at least one major syllable is needed. In summary, word shape distributions in Sgaw Karen suggest that the positional constraint prohibiting word-final minor syllables holds across the lexicon.

3.4 Phonological processes

Two phonological processes in Sgaw Karen, (1) partial reduplication and (2) compound-initial reduction, will be discussed in this section to address whether prominence differences exist at the word or foot (major vs. minor syllable) level. First, Sgaw Karen has a partial vowel reduplication process where the base is copied faithfully except for the vowel and/or tone of one syllable, as in [buˀ jʷa̤ɬ baˀ jʷa̤ɬ] ‘praise God’ from the base /baˀ jʷa̤ɬ/ of the same meaning. This type of reduplication in Sgaw Karen is a case of *reduplicative fixed segmentism*, defined as “invariant segments (or tones or features) that appear where copying might have been expected” (Alderete et al. 1999). In Sgaw Karen it is a phonological process where vowel height of the second component (often the reduplicant) must be equal to or lower than that of the preceding component (usually the base) to the end that vowel height lowers and/or centralizes across the compound (West manuscript). In stressed languages like English, the similar process of ablaut reduplication (Minkova 2002) appears to target stressed syllables (e.g., pitter-patter, bibbidy-bobbidy-boo) consistently.

If the reduplication process occurring in Sgaw Karen is similar, and a certain syllable is consistently targeted, that syllable could be more prominent than others. As potential instances of partial reduplication, strings with adjacent halves differing only in vowel were extracted from the

dictionary and assessed as reduplication based on their definitions. These are given in Table 12 indicating the position of the partially reduplicated vowel (1 or 2) and the direction of the reduplication (right/left). The altered vowel is bolded.

Table 12: Disyllabic reduplication

Word form	Syll.	RED Direction	Example
[verb]+obj.	1	Left	**bu**˦ jʷạ˧ ba˦ jʷạ˧ ‘praise god’
[verb]+ ‘up’/‘down’	1	Left	**ku**˦ tʰɔ˧ kạ˧ tʰɔ˧ ‘dress/put on’
‘make’+__	2	Right	mạ˧ xe˦ mạ˧ **x a̰**˧ ‘preserve food’
[nom. prefix]+__	2	Right	tạ˧ mɛ˦ tạ˧ **ma**˦ ‘vegetation’
[noun]+__	2	Right	sʉ˦ de˦ sʉ˦ **da**˦ ‘hand’
(monomorphemic)	2	-	w ḭ˧ n o̰˧ w ḭ˧ **na**˦ ‘sneer’

These disyllabic examples show that vowel change does not consistently fall on the first or second syllable, but apparently depends on the morphology. The more common pattern seems to be vowel change on the final syllable. This holds for all but verb+object or verb+directional (e.g., up, down) complement. Vowel change on the final syllable is also seen for trisyllabic reduplication (Table 13).

Table 13: Trisyllabic reduplication

Word form	Syll.	RED Direction	Example	English meaning
[N prefix]+V+‘up’	2	Right	tạ˧-kəwɛ̰˧ tʰɔ˦ ta˧-kə**wạ̰**˧ tʰɔ˦ [thing-clear-up]+RED	‘clearing horizon’
[N prefix]+V	3	Right	tạ˧ -kɔ˦nɤ˦ tạ˧-kɔ˦**nʷa**˦ [thing-fence] +RED	‘fence-making’
[noun]+V+V	3	Right	tʰo˦ -klɤ̰˧ -θʷḭ˧ tʰo˦ klɤ̰˧ **θʷạ̰**˧ [bird-cover-shut]+RED	‘type of bird’
[noun]+V	3	Right	tʰa˦kʰo˦-sụ˧ tʰa˦kʰo˦-**sạ̰**˧ [mouth -yearn]+RED	‘crave’

The first example in Table 13 follows the same pattern where a non-final verbal morpheme /kəwɛ̰˧/ ‘clear’ changes vowels instead of the final directional complement /tʰɔ˦/ ‘up’. The third example shows that in serial constructions with two verbs (/klɤ̰˧/ ‘cover’ and /θʷḭ˧/ ‘shut’), the second undergoes vowel alteration (θʷḭ˧ → **θʷạ̰**˧), and the last example shows the preference for partially reduplicating the final syllable (tʰa˦kʰo˦-sụ˧-tʰa˦kʰo˦-**sạ̰**˧ ‘crave’). While these data hint

at a systematic pattern, it is still unclear whether the vowel alteration is indicative of word-stress. In terms of morphemes which would be naturally prominent (e.g., compound heads), the data is inconclusive. Vowel alteration occurs on the verb in [**ku**˥ tʰɔ˥ kạ̈˩ tʰɔ˥] ‘dress/put on’ but on the final component of a serial verb in [tʰo˥-klɤ̈˥-θʷi̱˩ tʰo˥-klɤ̈˥-**θʷạ̈**˩] ‘type of bird’—in this morpheme sequence (‘bird’+‘cover’+‘shut’, describing a bird that covers its nest tightly) one would expect the first component /klɤ̈˥/ ‘cover’ to be more prominent. In terms of word edges, the word-final pattern in the data from this phonological process is not perfectly consistent, but may suggest that the right edge of a word is favored, if any.

Turning now to the second phonological process, Compound-initial Reduction involves a major syllable reducing to a minor syllable when forming a compound word, often yielding a distinct meaning to the regular compound. This second process suggests both that minor syllables are phonologically distinct and that the left edge of a word is prosodically weaker. Because these compounds are highly frequent words, it is likely that this reduction is occurring due to rapid speech, the prosodically weakest elements being reduced. The fact that the reduced forms now have slightly different meanings also suggests minor syllables are phonologically contrastive. For example, the major syllable /tɤ˥/ means the number ‘1’, but in compounds with classifiers it is reduced to /tə/, as in /tə-kə-kwɛ˥/ ‘a 10 million’. Similarly, while the word /pʸạ̈˩ kə-ɳɔ˥/ human-person/Karen can mean ‘person’, ‘Karen person’ or ‘the Karen people’, the reduced form /pə-kə-ɳɔ/ expressly means ‘person’. That phonological reduction is occurring here is evident by the loss of breathy phonation (◌̤), onset complexity (-ʸ) and low vowel. This process could be the same one producing reduced forms of non-final pronouns (Table 14).

Table 14: Pronominal reduction triggered in non-final position

	Pre-verbal, pre-nominal	Post-verbal	Compound (reflexive)
1SG	jə	jạɬ	jə-kəsạɬ
2SG	nə	nạɬ	nə-kəsạɬ
3SG	ʔə	ʔạɬ	ʔə-kəsạɬ
1PL	pə	pʸạɬ	pə-kəsạɬ

That word-initial and not final syllables undergo reduction also aligns with the language's prohibition of word-final minor syllables and supports final prominence, or at least not initial. In terms of morae, final prominence can be understood as requiring two morae in final position.

3.5 Sgaw Karen loanwords

Positional constraints on major-minor syllable distribution hold for loanwords as well. This section presents evidence that (1) minor syllables may not occur word-finally, and (2) reduced syllables in English are mapped to Sgaw Karen minor syllables based not on vowel quality but on light prosodic weight (being unstressed in English). First, as seen in native words (§3.3), loanwords never allow a word-final minor syllable. Reduced syllables in English are generally borrowed as minor syllables in Sgaw Karen. The only exception is when a word would be left with a word-final minor syllable. Examples are given in (6) below:

		Sgaw Karen		English	Unattested
(6)	1a.	ə mɛɬ ɹə kạɬ	'America'	[ə.ˈmɛ.ɹɪ.kə]	*ə mɛɬ ɹə **kə**
	1b.	ɛɬ ɹə jạɬ	'area'	[ˈɛ.ɹi.jə]	*ɛɬ ɹə**jə**
	1c.	kʰɛɬ mə rạɬ	'camera'	[ˈkʰæ.mə.ɹə]	*kʰɛɬmə**rə**
	1d.	kə̤ɬ-ʔeɬ də jaɬ country-India	'India'	[ˈɪn.di.ə]	*ʔeɬ də**jə**
	2a.	ɛɬ tɐə nə jɤ̤ɬ	'engineer'	[ˌɛn.dʒə.ˈniɹ]	*ʔɛɬ tɐə niɬ **jə**
	2b.	θə məɬ miɬ tʰɤɬ	'thermometer'	[θəɹ.ˈmɑ.mə.təɹ]	* θə məɬ mə **tʰə**
	3a.	tɛɤɬ mə niɬ	'Germany'	[ˈdʒɜɹ.mə.ni]	*tɛɤɬ mə **nə**
	3b.	pʰɛɬ niɬ	'penny'	[ˈpʰɛ.ni]	*pʰɛ **nə**

One could argue here that minor syllables are simply distinguished by their schwa-like vowel quality—perhaps they are not truly of a lighter prosodic weight (i.e. shorter duration, intensity or other stress correlate) compared to other syllables. Loanword patterns cast some doubt on this notion, however. First, the language apparently has no problem mapping fully reduced vowels onto Sgaw Karen full vowels—English [ə] map to /a/ in (*6*.1a–d) and [əɹ] to /ɤ/ in (*6*.2a) and ((*6*.2b) and yet non-final reduced syllables are borrowed as minor syllables (e.g., ɛl̥ɹəjạ̈ɬ ‘area’). Second, one would expect reduced vowels without mid-central quality to map to other vowels if quality is an important factor, but English reduced front vowels map to a Sgaw Karen [ə] in unstressed positions, i.e., (*6*.1a)—[ɹɪ]→[ɹə]—and (*6*.1b)—[ɹi]→[ɹə], except where it would produce a word-final minor syllables, as shown in (6.3a) and (6.3b).

One can also look from the perspective of positional constraints on minor syllables to test if they are weaker than major ones. If /ə/ syllables were equally prominent with other syllables, and weight is not a factor in their distribution, then there should not be any consistent position restrictions. However, there is consistent restriction of minor syllables word-finally across all domains of the lexicon. Example (6.2a) above is particularly intriguing as it shows the English sequence /…niɹ/ in *engineer*, presumably interpreted as strong-weak /ni.əɹ/, borrowed as weak-strong /nə jɤ̈ɬ/ to avoid a final minor syllable. Earlier loanwords into the language, namely Biblical proper names, are explored in (7).

(7)	a.	ʔə moˀ	‘Amos’	nə ʔuˀ	‘Nahum’
	b.	nə xɛˀ mə jạ̈ɬ	‘Nehemiah’	sə pʰaˀ nə jaɬ	‘Zephaniah’
		sə kạ̈ɬ rə jạ̈ɬ	‘Zechariah’		
	c.	jɨ̈ɬ rə miˀ jạ̈ɬ	‘Jeremiah’	dɛ̰ɬ kạ̈ɬ pə liˀ	‘Decapolis’

It is unclear exactly through which language these words entered Sgaw Karen, but examples show mapping to a minor syllable regardless of vowel quality: English orthographic “a” in (*7*a)

and “e” in (*7*b). Like earlier cases, these appear to be avoiding final minor syllables. Examples in (*7*b) show a /σ̀σσ́σ/ → [oXoX] change from English, following similar restrictions. Unlike modern loanwords, however, which correspond closely to the original language stress, once the final syllable is borrowed as a major syllable to avoid a final minor syllable, footing continues in a minor-major pattern. The result is an output form with syllable weight that does not line up with the stress patterns of the English input. Examples in (*7*c), however, are cases where the initial syllable could have been reduced but was not, suggesting these patterns are less consistent for early loans. What is consistent is the positional constraint on minor syllables—of the 58 Biblical words found with minor syllables, none were word-final. In terms of morae, this may be because minor syllables count for one mora, insufficient for final position in Sgaw Karen.

In short, two pieces of evidence from loanwords suggest the mapping of reduced English syllables to Sgaw Karen minor syllables is prosody-based. First, the mapping onto minor syllables is not predictable by vowel quality alone, but by prosodic prominence of the original form in English. Second, minor syllables are positionally constrained, prohibited in word-final position in both early and modern loanwords. This pattern is also supported by the absence of final minor syllables in word shapes of core vocabulary and even the entire dictionary (§3.3). Though this study does not assert that a word-final monomoraic constraint is most typologically justified per se, it is congruous with studies on related languages to interpret the distribution of a minor syllable in terms of bearing a single mora. Future comparative study is needed to investigate whether the word-final minor syllable prohibition holds in related languages.

3.6 Word prosody summary

Although there is no consistent marking of stress between major syllables, a reduced status of minor syllables and strong status of word-final position is supported by word-shape

distribution (§3.3), reduction in compounds (§3.4), and loanword patterns (§3.5). Present findings will support the notion that minor syllables are monomoraic and major syllables bimoraic (see §4.4.4). In this view, minor syllables can be prohibited from word-final position (§3.5) by requiring that final syllables be bimoraic. Similarly, a major syllable is more positionally free than a minor syllable (§3.5, §2.1) and may bear different vowel and phonation types (§2.1) because it is bimoraic. In sum, though evidence is insufficient for word-level stress between major syllables, Sgaw's major and minor syllables differ in their phonotactics and a moraic distinction is proposed to account for this. Viewing the major-minor syllable distinction as bimoraic-monomoraic will also help explain patterns of boundary tone realization in Section §4.4.3.

4 Intonation of Sgaw Karen

This section aims to propose an intonational phonology model of Sgaw Karen in the Autosegmental-Metrical (AM) phonology framework (Pierrehumbert 1980, Beckman & Pierrehumbert 1986, Pierrehumbert & Beckman 1988, Ladd 1996/2008), first giving an introduction to the model (§4.1) and then laying out the proposed transcription conventions for Sgaw Karen (§4.2), and giving the methods and materials of collecting the intonation data (§4.3) along with the results (§4.4).

4.1 Introduction to AM model

The AM model of intonational phonology analyzes surface f0 contour as a sequence of pitch targets. These targets correspond to relative H and L levels and may combine to produce a complex contour (e.g., HL for falling f0 or LH for rising f0). Though surface f0 ideally reflects underlying tonal targets, factors such as phonological interaction of tones, phonetic rules,

pragmatic or even paralinguistic effects can cause variation. In addition to these factors, prosodic alignment and prominence relations between words influence how tonal targets surface.

A distinction is made on the types of tones in the AM model based on their function. A head-marking tone associates to a prominent position such as a stressed syllable, whereas an edge-marking tone associates with a prosodic boundary, like a word or phrase edge. These tonal elements form the tune of the utterance. That is, a tune is aligned to text at either heads or edges, depending on the tone type. Also essential to the AM model is a hierarchical organization of prosodic units representing a grouping of words and relative prominence between words and syllables. A language may have multiple levels of prosodic phrases marked by tone, final-lengthening, or segmental realizations. In the model, three prosodic units above the Word have been posited based on data across languages (Jun 2005). The largest unit is an Intonational Phrase (IP), which roughly corresponds to a clause (though any size, even one syllable, can form one IP). The prosodic unit smaller than an IP is an Intermediate Phrase (ip). Finally, the prosodic unit smaller than an ip and larger than a Word is an Accentual Phrase (AP). An AP often includes clitics and function words in addition to a content word. This unit is especially common in languages without word-prosody or languages where word prosody is realized weak phonetically (Jun 2014). Languages differ in how each prosodic unit is tonally marked. To distinguish the three prosodic units, the boundary tone of each prosodic unit is marked by a different diacritic: an IP boundary tone by a '%' sign (e.g., H% for IP-final and %H for IP-initial edge), an ip boundary tone by a '-' sign (e.g., H- or L-), and an AP boundary by a 'a' sign (e.g., Ha or La) (Jun & Fletcher 2014).

4.2 Sgaw Karen ToBI

This section prepares the reader for understanding the intonation transcription used in this study. The principles of Tones and Break Indices (ToBI) transcription conventions based on the AM model of intonational phonology (Beckman & Ayers 1994; Beckman, Hirschberg, Shattuck-Hufnagel 2005) are used for transcribing Sgaw Karen intonation in this paper. Pitch track figures shown in this paper show four tiers below a pitch track. They are words, English gloss, tones, and break indices (See Figure 8 as an example). The words tier is used to mark the acoustic boundary of each word or morpheme in a sentence, and the English gloss tier provides English gloss for each Sgaw Karen morpheme or a word. The tones tier will include IP boundary tones at the end of an IP (e.g., H%, LHL%) and a symbol marking the beginning of an AP, i.e., "!a[". Unlike other languages where an AP is marked by a local boundary tone, Sgaw Karen's AP is defined as the domain of downstep. This means the top line of pitch range is distinctly lowered after an AP boundary, lower than what is expected by regular declination of pitch range (see §4.3).

In addition to the tones tier (To), a tier for break indices (BI) is included in transcription to mark the degree of juncture between each pair of consecutive words. Types of BI and their functions used in this analysis are given in Table 15 below. BI3 would mark a juncture corresponding to an Intermediate Phrase (ip), but is skipped here because this prosodic unit has not been confirmed in the present study though it exists in the closely related Pwo Karen language. Further studies examining syntactically more complex sentences would be needed to confirm the status of an ip in Sgaw Karen.

Table 15: Break indices used in Sgaw Karen ToBI transcription

Degree of juncture	Description	BIs for mismatch	Description
0	Minor syllable, Reduction of following onset	1m	Juncture size of Wd, but pitch movement like AP or IP boundary tone
1	Word-boundary, No pause	2m	Juncture size of AP, but pitch movement like IP-final boundary tone
2	AP-boundary, No / very short pause	4m	Juncture size of IP, but with no IP-final pitch movement
4	IP-boundary, Large pause (usually)		

4.3 Methods

4.3.1 Recording

Audio recording was done in quiet rooms on various days according to the availability of speakers. The location of elicitation was a Karen culture center in San Diego, California. Due to the availability and logistical constraints of participants, sound-proof or attenuated rooms were unavailable, and solitary office spaces were chosen to minimize ambient noise. Because f0 information is the crucial acoustic measurement under analysis in this study, a lower-end omnidirectional lapel microphone was used for portability and minimal encumbrance on participants (Insignia; 65Hz - 18kHz frequency response).

4.3.2 Subjects

All participants were recruited in and currently reside in San Diego, California. Participants are native speakers of Sgaw Karen between age 18 and 49, and currently live in a community where Sgaw Karen is the primary language used, though English is the primary language of education, and English or Spanish are frequently heard in the workplace. Specific exclusion criteria pertain to (1) early language use in the home: Sgaw must have been the primary language for communication with at least one parent; (2) sustained language use: Sgaw must be the main social language spoken at home, church, social gatherings; (3) region where

language was acquired: Sgaw must have been acquired in or near one of the main villages or refugee camps along the Thai-Burma border. Criteria (1) and (2) were not to recruit speakers with dominant language competence in Burmese, Thai, English, or other Karenic languages. Criterion (3) aimed to control for dialectal variation within Sgaw, particularly as characteristics of certain dialects are largely uncertain, and presupposes that participants be born in either the Karen state of Burma or a Karen refugee camp in Thailand.

Data from two main speaker groups is used for the intonation study. The IP data described in this study are collected from 5 participants who are between ages 18-40 and share the same lexical tone space. Each speaker's tone space is provided in appendix 6.3. Data to assess AP boundaries were collected from both the participants in the IP data and those in the Word-stress data and one more speaker, ML (F49), who was included to check patterns across generations. As seen below, there are a total of 7 female and 5 male participants.

Table 16: Sgaw Karen speaker information for AP, IP and word stress investigation

	AP data												
	IP data					Word Stress data						other
Speaker code	NU	UX	XE	ME	NT	FF	BN	II	FC	MH	LM	ML
Gender	F	F	F	M	M	F	F	F	M	M	M	F
Age	18	35	40	19	40	23	24	30	18	21	38	49

4.3.3 Intonation

The intonation example sentences in this section are chosen to exemplify each component of the intonational system and give motivation for the hierarchical levels proposed in this model. Though the main dataset consists of a sequence of tone 1 (mid-level, slight rising), an example is given of different lexical tones at the IP boundary. Because this dataset is only comprehensive concerning tone 1, other tones are presented as exploratory looks at the behavior of lexical and post-lexical tone. Future research should confirm the intonational patterns proposed here for all six lexical tones.

IP data

Initially, 3 male and 3 female speakers were consulted, but data from 1 male speaker was excluded as tone 5 (high modal) differed from other speakers, surfacing as low falling modal. The materials collected to examine IP breaks are also used to examine AP boundaries in the following section, with the exception of a few longer phrases including relative clauses, PP adjuncts, and conjunction in order to test sentence-medial IP boundaries. The common materials shared between IP and AP data sets are SVO sentences with nouns and verbs of different lengths. All sentences used are given below (also found in Appendices 6.2 and 6.3).

Table 17: Target sentences for IP data

(a) Basic SVO sentences (5 to 9 syllables long)

Set 1	(expected to form a single IP)
	doɬ kə ʔoɬ-pʰoɬ ʔɔɬ -wɛɬ tʰiɬ owl -DIM drink-ing water ‘(the) owl is drinking water’
	sɔɬ lɔɬ ʔɔɬ -wɛɬ tʰiɬ cockroach drink-ing water ‘(the) cockroach is drinking water’
	laɬ waɬ ʔɔɬ -wɛɬ tʰiɬ Lawa drink-ing water ‘Lawa is drinking water’
Set 2	(expected to form a single IP, possibly two IPs when sentence length is increased)
	kʰeɬ bʸeɬ -pʰoɬ waɬ kʰiɬ dɯɬ ʔɔɬ -wɛɬ tʰiɬ panther -DIM white 2 -CL drink-ing water ‘two white panther cubs are drinking water’
	θoɬ -pʰoɬ waɬ kʰiɬ dɯɬ kuɬ -wɛɬ tʰiɬ sheep -DIM white 2 -CL wade-ing water ‘two white lambs are wading (in) water’

(b) Complex sentences with conjunction or relative clauses

Set 1	(conjunction)
	kʰeɬ bʸeɬ -waɬ dɔɻ sɔɬ lɔɬ -bɔɬ jaɬ blaɬ θoɬ-pʰoɬ lɤɬ haɬ lɔɻ kʰɔɬ panther -white and cockroach-yellow heal sheep-DIM in afternoon “The white panther and the yellow cockroach heal the lamb in the afternoon.”
	blaɬ dɔɻ kʰeɬ bʸeɬ dɔɻ sɔɬ lɔɬ -waɬ meɻ kə-θiɬ-θə-raɬ bat and panther and cockroach-white be doctor “The bat and the panther and the white cockroach are doctors.”
Set 2	(relative clauses)
	kʰeɬ bʸeɬ lɤɬ ʔə kuɬ-wɛɬ tʰiɬ jaɬ blaɬ sɔɬ lɔɬ panther that 3SG wade-ing water heals cockroach “The panther that is wading in the water heals the cockroach.”
	sʰaɬ-pʰoɬ-kɔɻ-pʰoɬ lɤɬ ʔə tə-sʰuɬ-tə-kʰleɬ ʔaɬ lɔɻ animals that 3SG not-well-not-healthy many SFP “Animals that are sick are many.”

AP boundary data

To investigate whether there is a prosodic unit smaller than an Intonational Phrase, i.e., Accentual Phrase (AP), f0 contours of sentences in Table 18 were examined. Informal observations of f0 contours for the word stress data suggested that there might be a phrase boundary between a subject and a verb. To confirm this observation and determine the f0 shape of AP boundaries, SVO sentences were examined. Midpoint f0 of the two syllables preceding and following the S-V boundary was extracted and averaged per speaker, approximately 8-9 tokens each. All target words were high modal tone (marked by ‘ ˥ ’ after each syllable) and in subject position of SVO sentences, repeated 3 times per speaker. Sentences with subjects of different lengths were included to ensure the pattern holds in heavier/longer sentences—the 6 target utterances analyzed are given below (a full set of data collected during elicitation is given in Appendices §6.1 through §6.3).

Table 18: AP boundary test sentences

Examined syllables: σ^1 σ^2] AP [σ^3 σ^4		
Set 1	do˥ kə ʔo˥-pʰo˥ ʔɔ˥-wɛ˥ tʰi˥ owl -DIM drink-ing water	‘(the) owl is drinking water’
	sɔ˥ lɔ˥ ʔɔ˥-wɛ˥ tʰi˥ cockroach drink-ing water	‘(the) cockroach is drinking water’
	la˥ wa˥ ʔɔ˥-wɛ˥ tʰi˥ Lawa drink-ing water	‘Lawa is drinking water’
Set 2	kʰe˥ bʸe˥ -pʰo˥ wa˥ θɤ˥ dɯ˥ ʔɔ˥-wɛ˥ tʰi˥ panther -DIM white 3 -CL drink-ing water	‘three white panther cubs are drinking water’
	θo˥ -pʰo˥ wa˥ kʰi˥ dɯ˥ ku˥-wɛ˥ tʰi˥ sheep -DIM white 2 -CL wade-ing water	‘two white lambs are wading (in) water’
	sɔ˥ lɔ˥ ʔɔ˥-wɛ˥ tʰi˥ cockroach drink-ing water	‘(the) cockroach is drinking water’

VO predicates were morphologically equivalent, either [__ ʔɔ˥-wɛ˥ tʰi˥] ‘__ drink-ing water’ or [__ ku˥-wɛ˥ tʰi˥] ‘__ wade-ing water’. To assess the male and female data together, pitch was normalized for each speaker (§1.2.3). The sentence-final syllable, /tʰi/ ‘water’, was excluded when calculating f0 maximum to avoid exaggerated boundary tone pitch. Max and min f0 per

speaker were located manually to avoid artificial peaks and valleys from microprosody and Praat's f0 detection errors.

4.4 Results

4.4.1 Accentual Phrase

This section describes the smallest prosodic unit in Sgaw Karen, arguing for a size slightly larger than the word. This is called an Accentual Phrase (AP) and is defined as the domain of downstep. A sequence of words can also have multiple AP phrasing options. Long phrases can form one or multiple APs, and AP boundaries can also be eliminated altogether after a focused word in a sentence, known as 'dephrasing'. Sequences of words with multiple possible AP phrasings will be shown for Sgaw Karen.

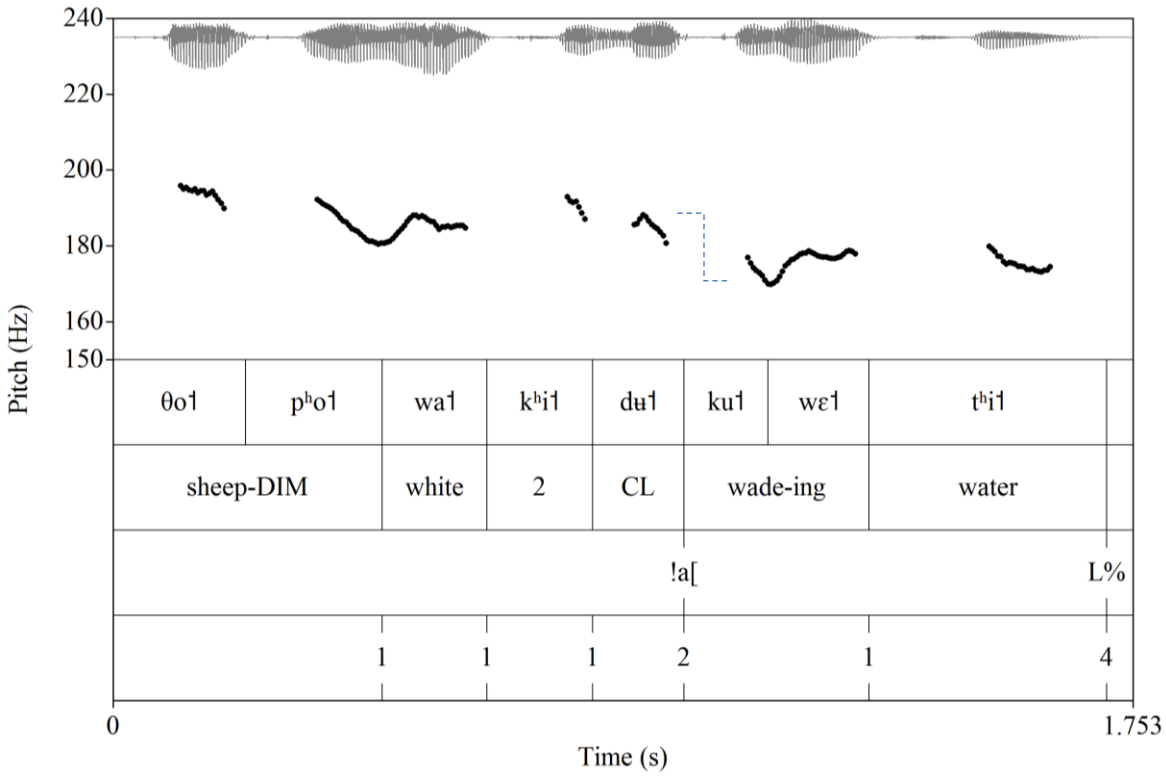


Figure 8: SVO sentence with two APs

The example above (Figure 8) shows a SVO sentence where the subject ‘Two white lambs’ and the predicate ‘(are) drinking water’ each is produced as one AP. A short-dashed line (horizontal-vertical-horizontal) is drawn before the VP, marking downstep at the beginning of the second AP. The main claims are incorporated in the example in (8) below and described in the following subsections.

(8)

	θo-pʰo		θɤ-dɯ		ku-wɛ		tʰi	
Lexical tone:	ɬ	ɬ	ɬ	ɬ	ɬ	ɬ	ɬ	
Syllable:	σ	σ	σ	σ	σ	σ	σ	
Intonation:			(!a)		!a[		!a[	

sheep-DIM 3-CL wade-ing water
“Three white lambs are wading.”

As seen above, the subject noun (‘sheep’) and the diminutive suffix together form one AP. Post-nominal modifiers like quantifiers (i.e., θɤ ‘3’) and classifiers (i.e., dɯ ‘CL’) may or may not be grouped into one AP. Monosyllabic objects (i.e., tʰi ‘water’) may form one AP with the preceding V (ku-wɛ ‘wading’), and the pitch range is lowered at the beginning of each AP except for the sentence-initial AP (§4.4.3). This f0 lowering, which I call ‘f0 downstep’, does not happen within an AP.

Size and description

The AP in Sgaw Karen usually contains 2 to 5 syllables and often corresponds to a single syntactic DP in the case of nouns, or VP if the object is 1 or 2 syllables. As mentioned earlier, the boundary between APs is marked with pitch downstep. Downstep is realized as a 7-10Hz f0 drop at the AP-initial syllable compared to the syllable immediately preceding it, and keep the same lowered pitch range until the end of the AP (see Figure 8).

Heavy phonological weight (in terms of the number of syllables and words) can affect AP formation. In the example above, the subject noun forms one AP including 4 words. Such a heavy prosodic unit can be broken up into multiple APs. The example below shows the same sentence as Figure 8 above, produced by the same speaker, but broken into two APs, with downstep dividing the noun from the following word, thus adjective, quantifier and classifier forming a second AP.

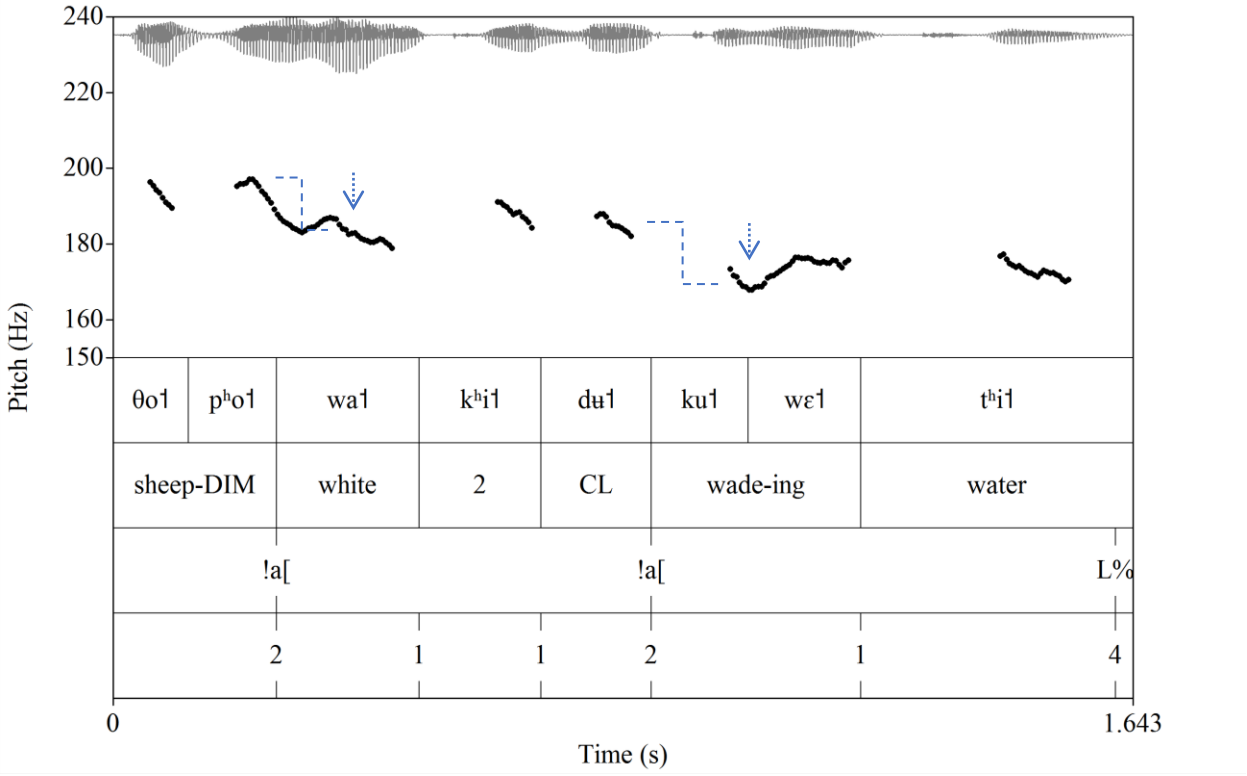


Figure 9: Declarative sentence with 3 APs

Light phonological weight can also affect AP boundaries. Monosyllabic subjects can form a single AP when the predicate is light. It is also possible for monosyllabic subjects to form their own AP. Figure 10 exemplifies an AP including only a monosyllabic subject (left) and an AP including both a subject and a verb (right). Even though the lexical tone of the sentence-final syllable is Tone 1, the same as other syllables, the surface tone is falling (left) or rising (right),

each marking an IP boundary tone. These boundary tones are introduced in Section 4.4.3 and their interaction with lexical tone is discussed in Section 4.4.4.

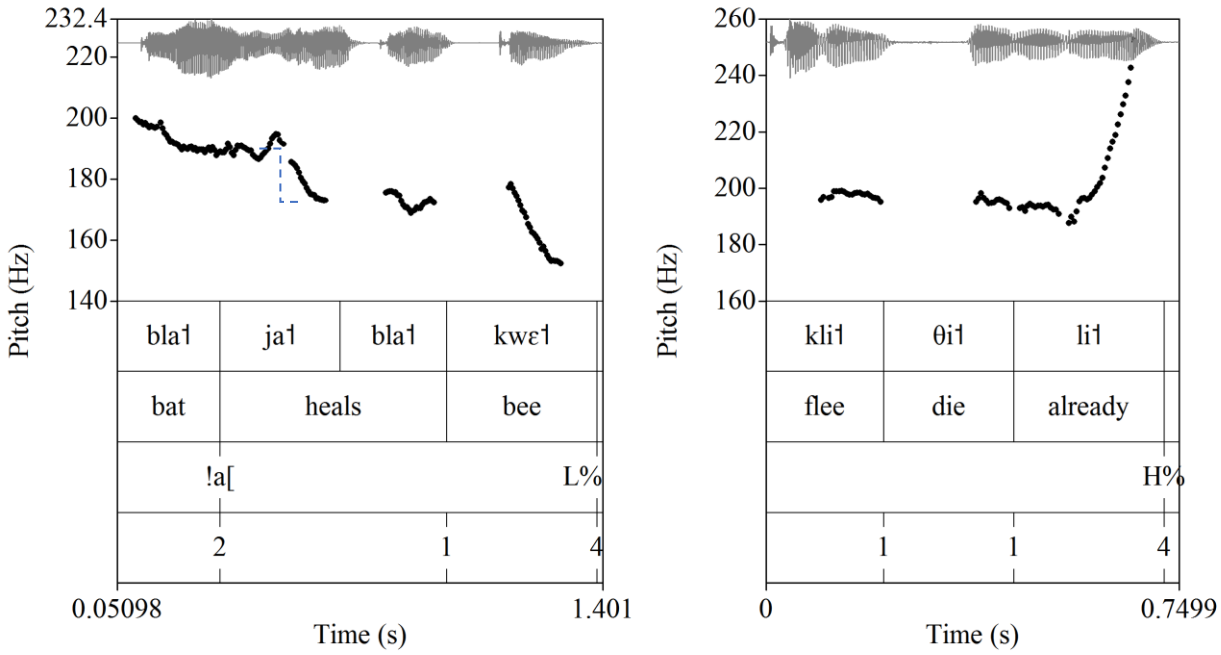


Figure 10: Short SVO sentences of 2 APs (left) or 1 AP (right)

AP boundaries can also be found before a relative clause, between the relativizer /lɤ˥/ 'that' and the relative clause. This occurs at fast speech rate. Otherwise IP boundaries are more common before a relative clause. Figure 11 is a pitch track of a sentence "(The) panther that is wading heals (the) cockroach", produced in two IPs (the IP boundary is shown after the heavy subject noun phrase, i.e., subject noun plus a relative clause, and is marked by H% and a pause). In the first IP, the f0 peak is lowered, i.e., downstepped, after the relativizer [lɤ˥], creating an AP break. Similarly, an AP break is shown after the verb [ja˥ bla˥] 'heals' of the matrix clause in the second IP.

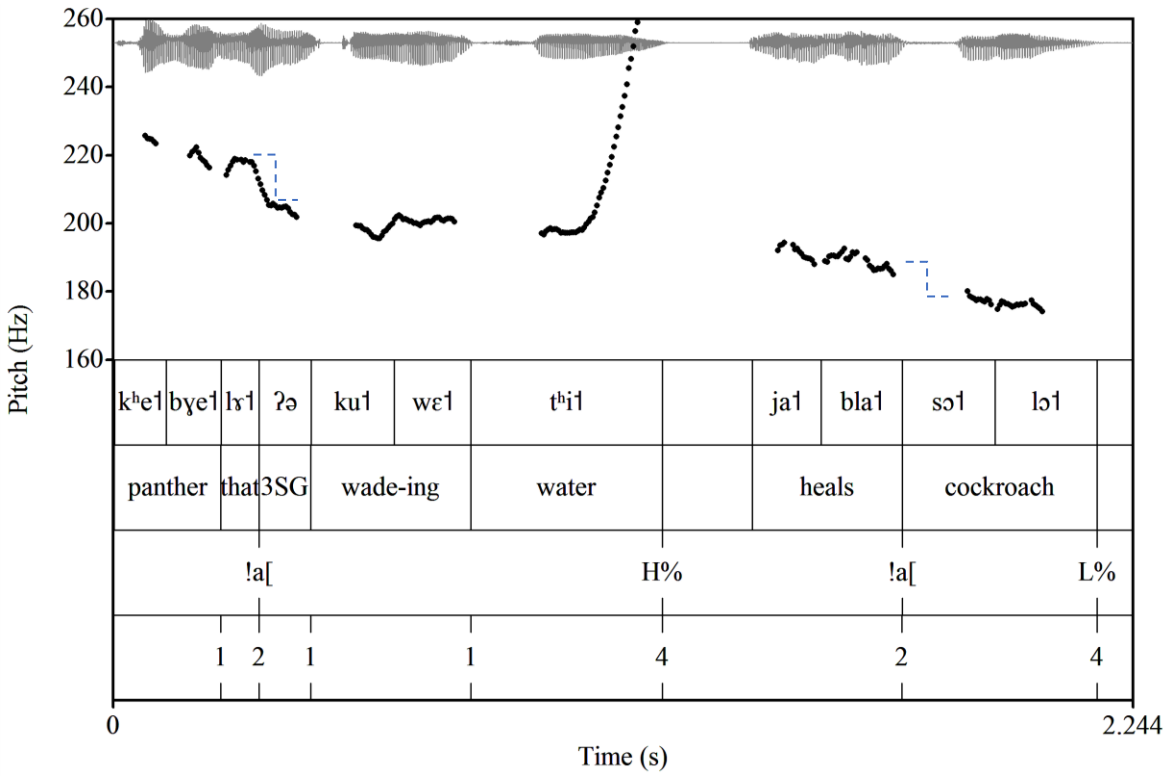


Figure 11: Sentence with relative clause and two IPs

As seen above, the head of a modifying phrase (here the complementizer [lɤ1]) groups prosodically with the phrase it modifies (here [kʰe1 bʸe1] 'panther'). This tendency is found for the C of CPs, Conj of ConjP, and P of PPs in Sgaw Karen. The above figure also shows that downstep across APs continues until the end of the utterance, though it is not uncommon for an IP to reset pitch (§4.4.2).

In short, sequences of tone 1 syllables show systematic f0 deviations from regular declination slope in the form of downstep. The location of the AP break is predictable through the combination of syntactic phrasing, phonological weight and speech rate. These locations tend to correspond to an entire DP or VP up to ~5 syllables and may be as small as a 1 syllable in the right conditions. The following section reports measurement of downstep in a short sentence across 12 speakers to show how consistent downstep is across speakers.

F0 change: AP-initial downstep

To confirm the consistency of the AP-initial f0 drop, f0 at the midpoint of a syllable was examined for two syllables preceding and following the AP break dividing subject and verb. Data from one 49-year-old (F49) was included here to ensure the pattern holds across generations and widen the data-set (5 male, 7 female; age 18-49). Figure 12 and Figure 13 below show normalized f0 values from two syllables before and two syllables after the AP boundary (between subject-verb) for all speakers (n=102). Data from five speakers are from the word stress set (- - - -) and the rest from the IP set (……).

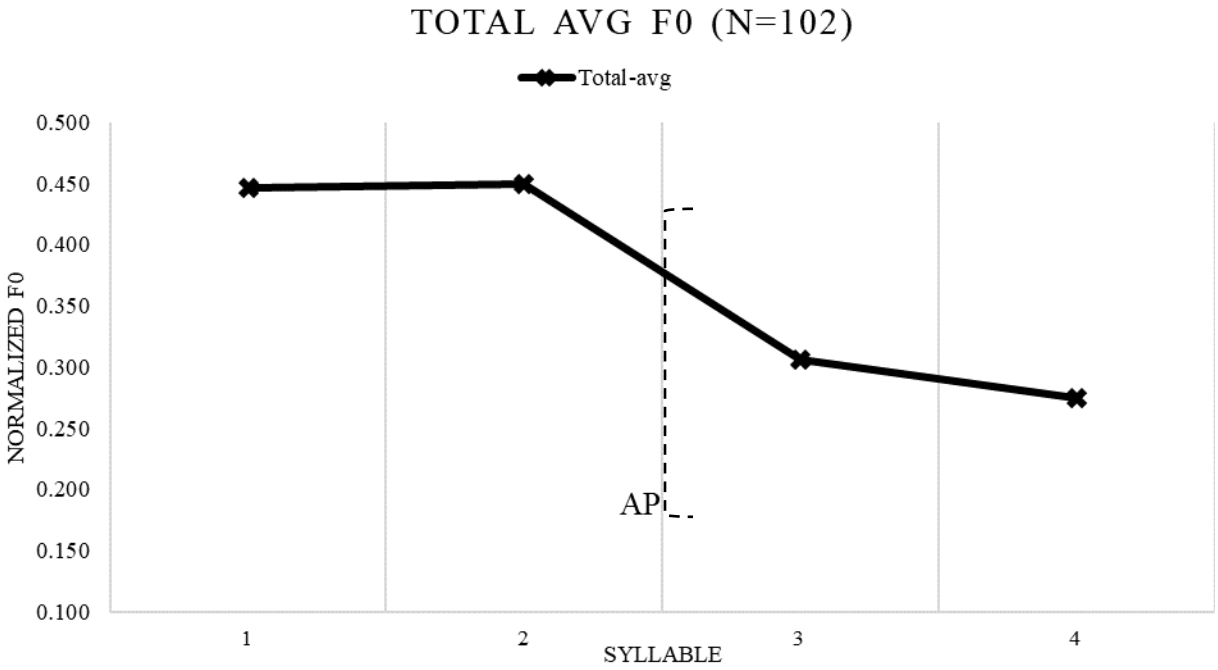


Figure 12: F0 midpoint for two tone-1 syllables (_1) flanking the subject-verb AP boundary (3 sentence frames x 3 repetitions x 12 speakers = 102 tokens).

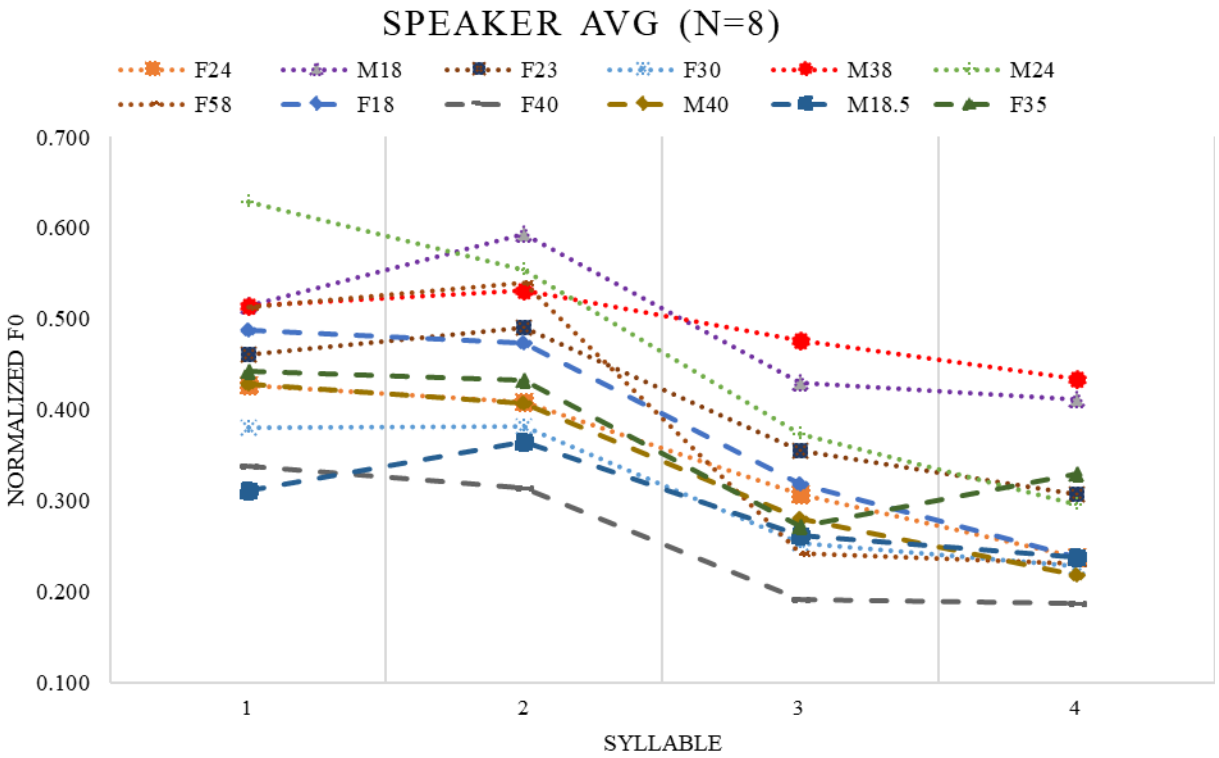


Figure 13: F0 midpoint for 4 tone-1 syllables (_1) flanking the subject-verb AP boundary (12 speakers x 3 tokens = 36).

Treating syllable pair as the main effect with 3 levels (syl. 1 compared to 2, 2 vs. 3, and 3 vs 4) and subject (1-12) as a random effect, an ANOVA found significant differences between the variances based on syllable pair ($F=61.75$; $p=3.74^{-14}$***). To compare the f0 differences between each adjacent syllable pair a second ANOVA was run using syllable pair-difference as the main effect with 2 levels (syl.1-syl.2 compared to syl.2-syl.3, and syl.2-syl.3 to syl.3-syl.4) and subject (1-12) as a random effect, again finding significant differences between variances based on syllable pair-difference ($F=39.19$; $p=1.46^{-15}$***).

To determine which f0 changes between syllables are significant for each subject, t-tests were used to compare f0 of syllable 1 vs. 2, 2 vs. 3, and 3 vs. 4 (rows 1 to 3 in Table 18). A one-tailed t-test was used for syllable 2 vs. 3 because f0 was consistently falling, but all other t-tests are two-tailed, assuming no directionality. The last 4 rows of the chart below show significance of comparisons between raw f0 differences between syllable pairs (i.e. whether the average f0

change between s2 and s3 is greater than s1 and s2 or s3-s4) and absolute f0 difference (i.e. whether the average absolute value of f0 change between s2-s3 is greater than that between s1 and s2, or that between s3 and s4). T-test results per speaker are summarized in Table 19 below. The cut-off for significant p-value is lower (* = 0.0166) for the first 3 hypotheses, since 3 t-tests were run on a single subject. In the other two sections, 2 t-tests were run on each participant, so the cut-off p-value is 0.025.

	Set 1							Set 2				
Hypothesis:	M38	F24	M18	F23	F30	M24	F49	F35	M19	M40	F40	F18
s1 > s2												
s2 > s3 (1-tailed)		***		***	*	**	***	***	**	***	***	***
s3 > s4		**						**		***		*
s2-s3 > s1-s2				**	*		***	**	*	*	**	**
s2-s3 > s3-s4							***	***	*	*	*	*
|s2-s3| > |s1-s2|				**			***	**		*	*	*
|s2-s3| > |s3-s4|							***	*	*	*		*

Table 19: T-test results per speaker, testing the likelihood that hypotheses are due to chance. Grey squares indicate no significant difference. P-value cut-offs: (<0.016 / 0.025, **<0.005, ***<0.0005).*

In sum: (1) midpoint f0 does not significantly differ between syl 1 and syl 2 (all speakers), (2) midpoint f0 does significantly differ ($p<0.0166$) between syl 2 and syl 3 (10/12 speakers). (3) The f0 drop between syl 2 and syl 3 is significantly greater ($p<0.0166$) than for syl 1 and syl 2 (8/12 speakers). (4) For half of the speakers, the syl 2v3 and syl 3v4 difference is similar, suggesting AP phrasing differences across Object and Verb.

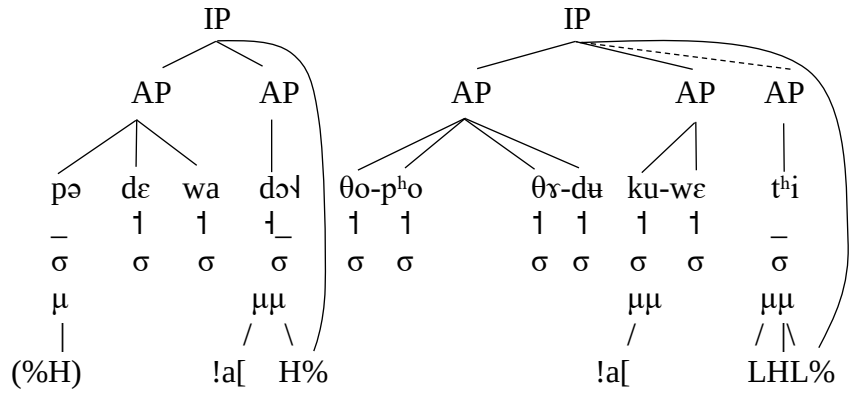
Two types of statistical comparisons point to the syllable 2 and 3 boundary as the significant f0 turning point: (1) comparison of the 4 midpoint f0 averages, and (2) comparison of f0 differences between syllables. Firstly, syllable 3 was consistently lower than syllable 2 for 10 speakers (one-tailed paired t-test; $p<0.0166$) and syllable 4 lower than 3 in a few cases. In short, while the direction of f0 marking the end of the AP (syllable 2) may rise or fall slightly, f0 drops sharply by syllable 3, signalling that a new AP has begun. Pitch of syllable 4 may continue to fall

or resist declination, the latter suggesting the speaker is phrasing the verb as one AP with the object. Variability in the prosodic grouping of the direct object /tʰiˀ/ 'water' may explain this difference. Crucially, the significantly greater f0 fall from syllable 2 to 3 was consistent for 10 of 12 speakers. Lack of a significant difference for the deviant speaker M38 ($p=0.3004$; $n=5$) can be attributed to greater difficulty with the task—re-inspection of the data found more IP phrase breaks and occasional focus-like pitch compression not found with other speakers. The other borderline case, M18 (1-tailed: $p=0.029$, 2-tailed: $p=0.058$; $n=8$) also showed difficulty with the task but performed more consistently, yielding 8 usable tokens. In the future, the task difficulty causing different behavior here could be helped by increasing the number of practice tokens so that participants become more familiar with the task. Though more tokens are still needed from more speakers to be conclusive, the post-AP f0 fall seems to be a consistent prosodic cue defining an AP boundary.

4.4.2 Intonational Phrase

The Intonational Phrase (IP) in Sgaw Karen roughly corresponds to a sentence though an embedded clause is often grouped as a separate IP. A Boundary tone (BT) marking the end of an IP can be complex at sentence edges (e.g., LHL%) but can be simple (e.g, L%, H%) at sentence-medial or final positions. In both cases, lengthening is seen on the IP-final syllable. This section motivates a model where a complex BT overrides lexical tone completely (e.g., LHL% on a single syllable) and a simple BT is realized on the second half of an IP-final syllable, preserving the syllable's lexical tone on the first half of the syllable (e.g., H% on the later part of the IP-final syllable). This is schematized in (9) below, and motivated in the following subsections.

(9)



rabbit white and sheep-DIM 3-CL wade-ing water
"White rabbit[s] and three white lambs are wading."

As seen above, H% tone is found at syntactic breaks like conjunction (/dɚɬ/ 'and'), and the lexical tone of the syllable (/dɚɬ/) may be overridden partially or fully (signified with '_') depending on the syllable's weight and the complexity of the BT (§4.4.3). Finally, if a sentence-final syllable forms a separate AP, AP-initial downstep is not always detectable because of the boundary tone.

The size of an IP can vary from one syllable to a whole sentence, but it often corresponds to a major syntactic constituent. A short sentence can also be broken up into multiple IPs. An example pitch track where a sentence is divided into multiple IPs with H% BT, indicating continuation, is shown below in Figure 14.

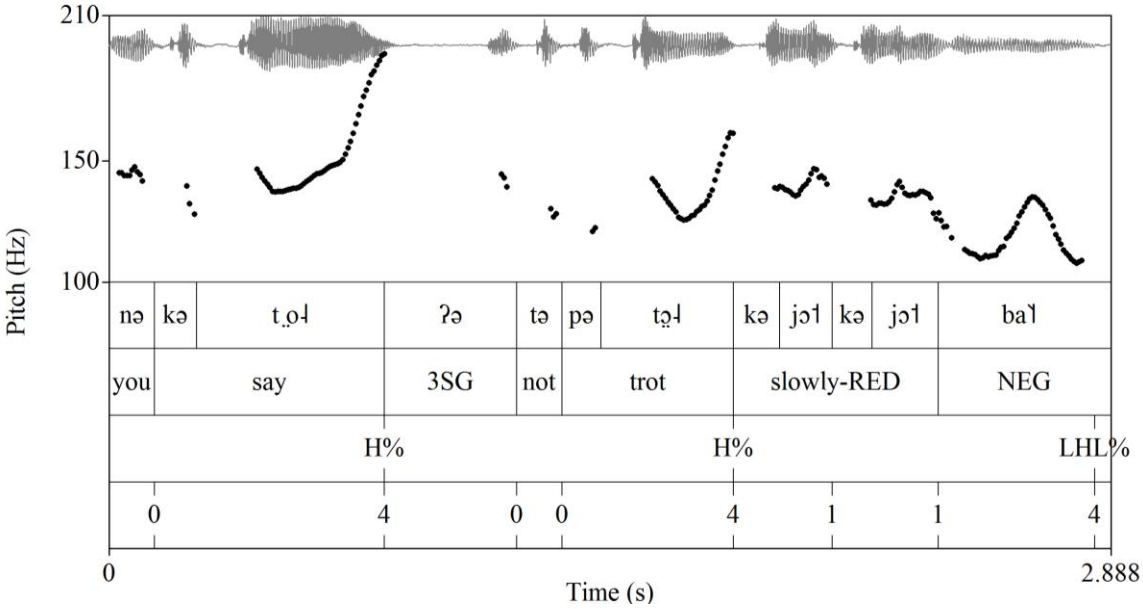


Figure 14: Sentence with quotative and embedded CP

Here, the sentence means "You say that he does not trot quickly", and the sentence is broken into three IPs. The first IP break is shown after the verb 'say', marked by H%, and the second IP break is shown after the embedded verb 'trot', marked by H%, and the end of the sentence is marked by an LHL%. The IP break matches a syntactic unit in some cases, like the first H%, but not in others, like the second H%.

4.4.3 BT inventory

As a tonal language, it is unsurprising that IP boundary tones (BTs) communicating pragmatic, emotive information in Sgaw Karen work hand in hand with an arsenal of sentence final particles (SFPs). Many of their meanings have been described well in previous research (Jones 1961:23), and the same usages are found here. This section presents the BT inventory and then gives an example for each. As seen in the BT inventory in Table 19 below, a LHL pattern is commonly seen on the last syllable of declarative sentences, especially when the declarative particle /lɔ̰ɬ/ is present. The same pattern can indicate a question when the interrogative particle /ɦaˀ/ is present however. For this reason, the inventory described here is best understood as a

collection of BT+particle pairs, the meaning of which not always reducible to the individual parts.

Table 20: Sgaw Karen Boundary tones and final particles

Boundary Tone	Particle	Function
L%	∅	Neutral sentence/description (not necessarily to another person)
	/ɦɛ˩/	Realization/Confirmation "*Oh, I see.*"
H%	∅	Continuation
	/ne˩/	Emphasis, Focus on last element
	/ɦa˩/, /ɦɔ˩/	Soft question/request
	/lɛ˩/	Wh-question
	/(ne˩) mɔ˩/, /nɔ˩/	Confirmation "*Right?*"
HL%	/ɦɤ˩/	Vocative, calling
LHL%	∅	Affirmation
	/lə̰˧/	Declarative in conversation
	/ɦa˩/, /lɛ˩/	Yes/No question, Wh-question

Since many final particles occur only with BTs, it is hard to determine their underlying tone. A few words usually carrying a boundary tone occur elsewhere, however. An f0 rise occurs after most instances of the conjunction /də̰˧/ 'and' as well as the complementizer /lɤ˩/ 'that'. In non-IP-final positions, their lexical tone is realized as expected, suggesting the sharp rise they usually bear is indeed postlexical. Another example is the demonstrative /ne˩/ 'that/there'. Though it often bears H% boundary, the example sentence '*(The) window is there'* in Figure 17 shows that the surface pitch of /ne˩/ (tone 5, high falling) 'there' matches the lexical tone marked in the orthography IP-medially.

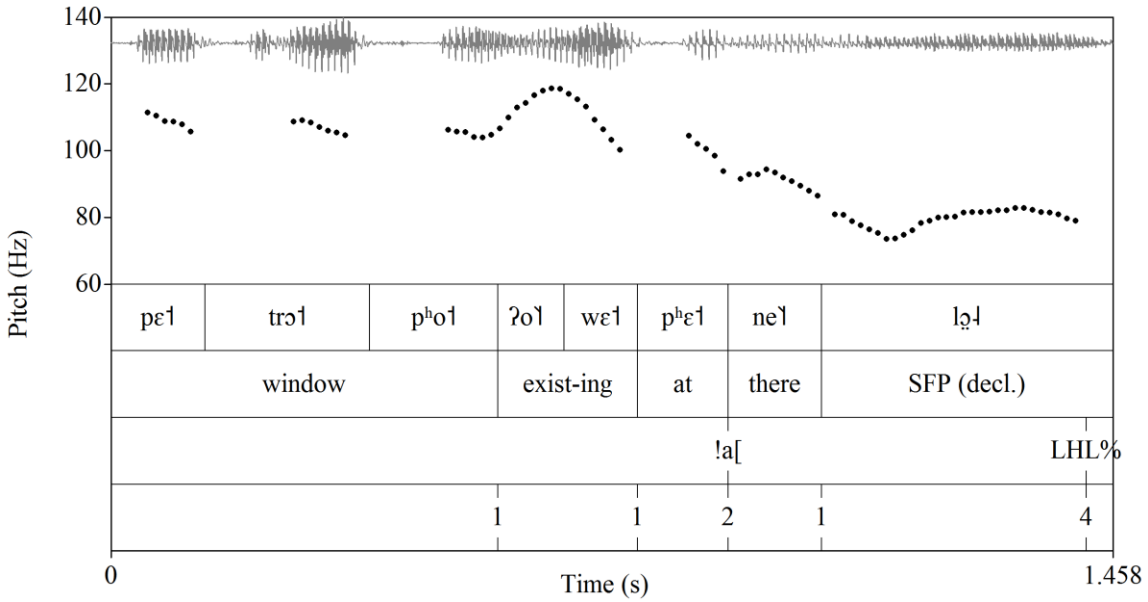


Figure 15: Sentence showing /ne˨/ in IP-medial position

The sentence in Figure 15 also exemplifies an AP boundary occurring between a head (preposition [pʰɛ˧] 'at') and its complement ([ne˨] 'that place/there'). The f0 peak of /ne˨/ is lowered, suggesting an AP-initial downstep. If other final particles pattern like [ne˨] in non-IP-final position above, then the tone of other frequent IP-final syllables can also be determined by the orthographic representation. Any f0 deviations from this underlying tone can be considered postlexical. Regardless of whether this holds for all final particles or not, f0 of other major syllables confirms that lexical and postlexical tones interact IP-finally.

L% and H%

Most examples elicited in this study are of the L% boundary tone, as target sentences were mostly declarative and were elicited as descriptions of pictures or scenes, sometimes with accompanying written stimuli. The H% was the second most common, as it is the main sentence-medial BT and is sometimes also used in Wh-questions or, as in the example below, to signal continuation (e.g., in a narrative). Pitch tracks of two short sentences are shown below, '*(The)*

bat heals the bee' L% and '*(The) flee died already*' H%. In both cases the final syllable is tone 1, modal mid flat or rising, but is realized with falling (L%) and extra high (H%), respectively.

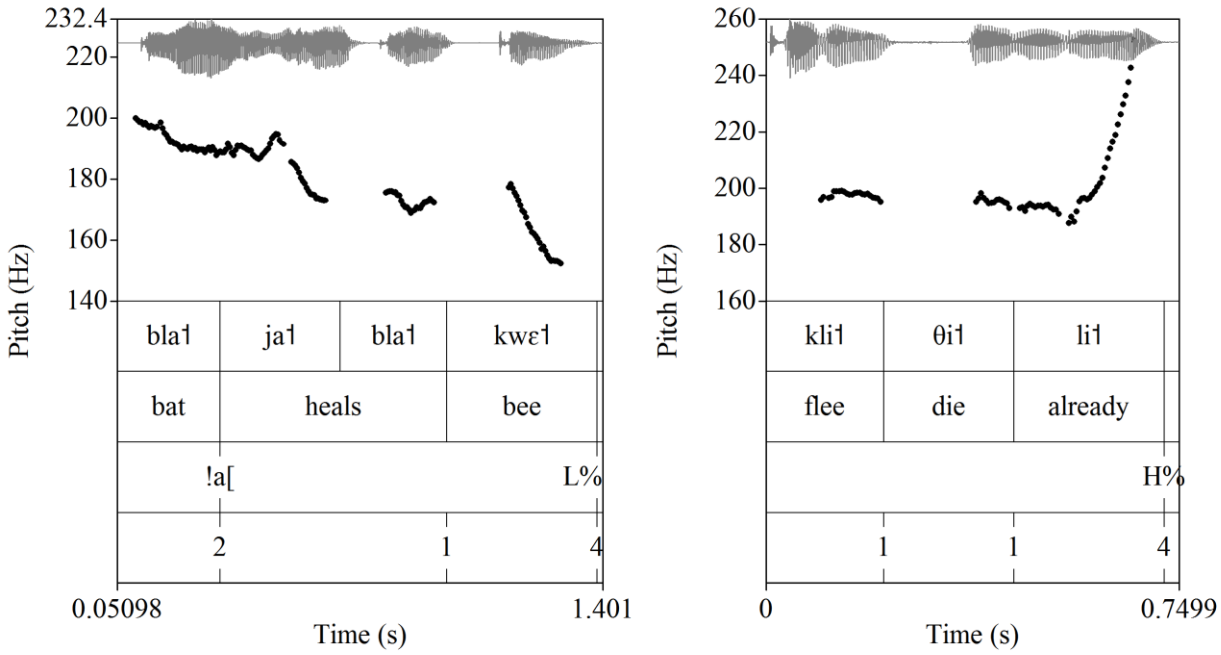


Figure 16: Short sentences with different BTs, L% (left) and H% (right)

H% can also mark an interrogative sentence in the case of softened requests. Figure 17 shows the sentence '*Nawla, can you help me?*', produced as a softened request.

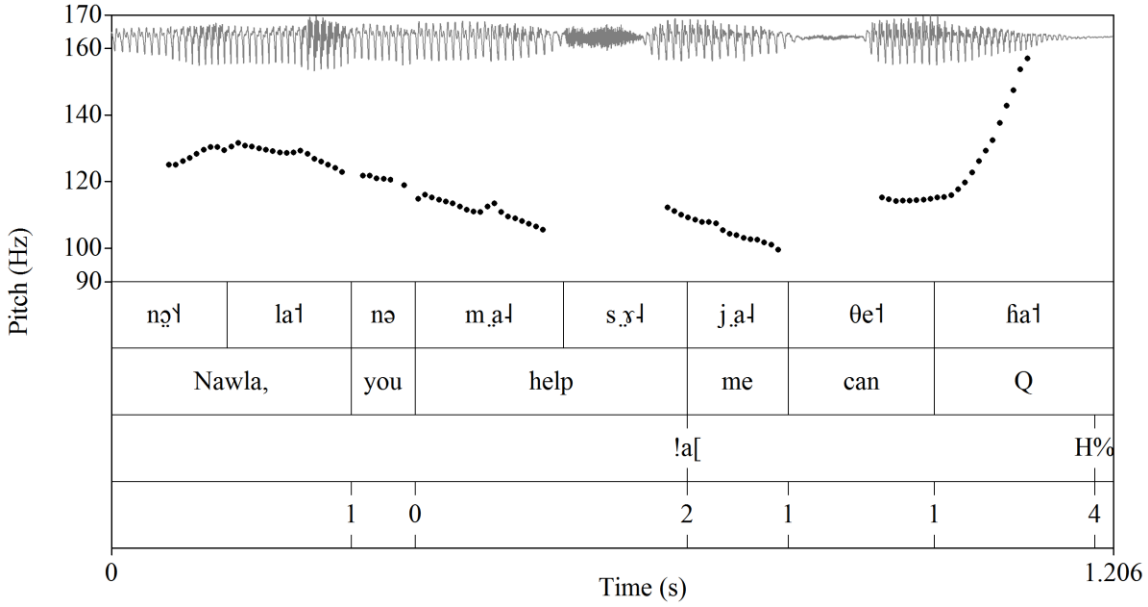


Figure 17: Sentence with H% BT indicating a softened request

HL%

The HL% tone is used for calling someone else's name. It usually occurs on the vocative final particle /ɦɤ˨/, as in the example below. Unlike LHL%, no initial f0 dip is seen. The example below shows HL% on an IP-final tone 1 syllable.

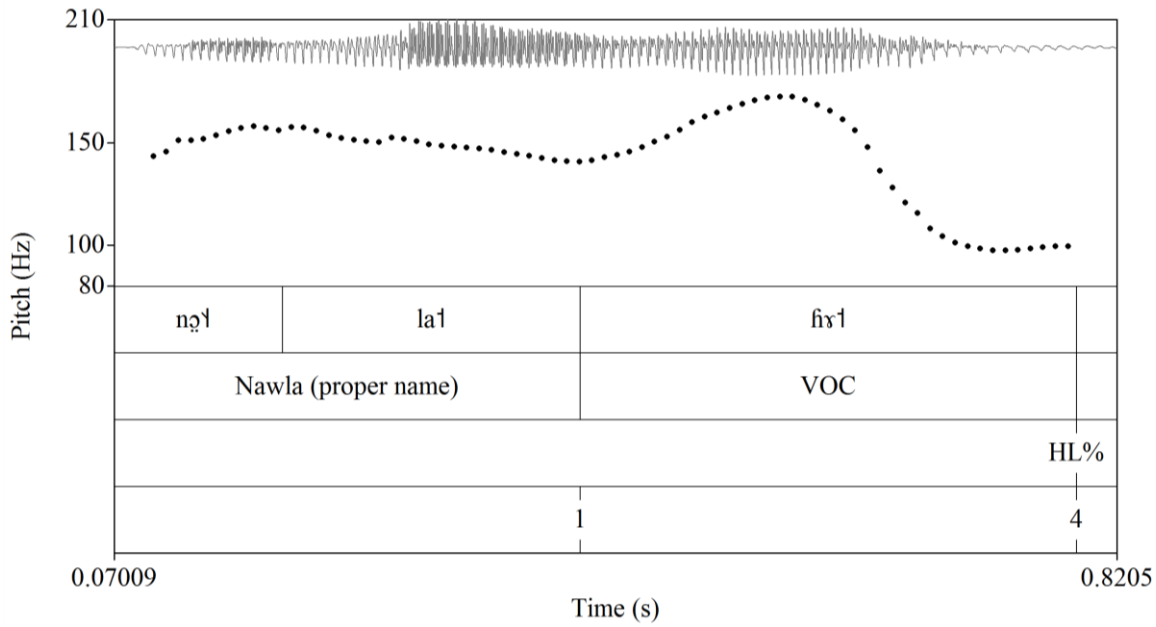


Figure 18: Vocative sentence showing calling contour for the proper name "Nawla"

HL% is also used for imperatives. For ease of reference, the examples in Figure 18 and Figure 19 are produced by the same male speaker. The examples in Figure 19 show HL% realized on a short (one syllable) and longer (three syllable) predicate for the commands '*go!*' (left) and '*come here!*' (right).

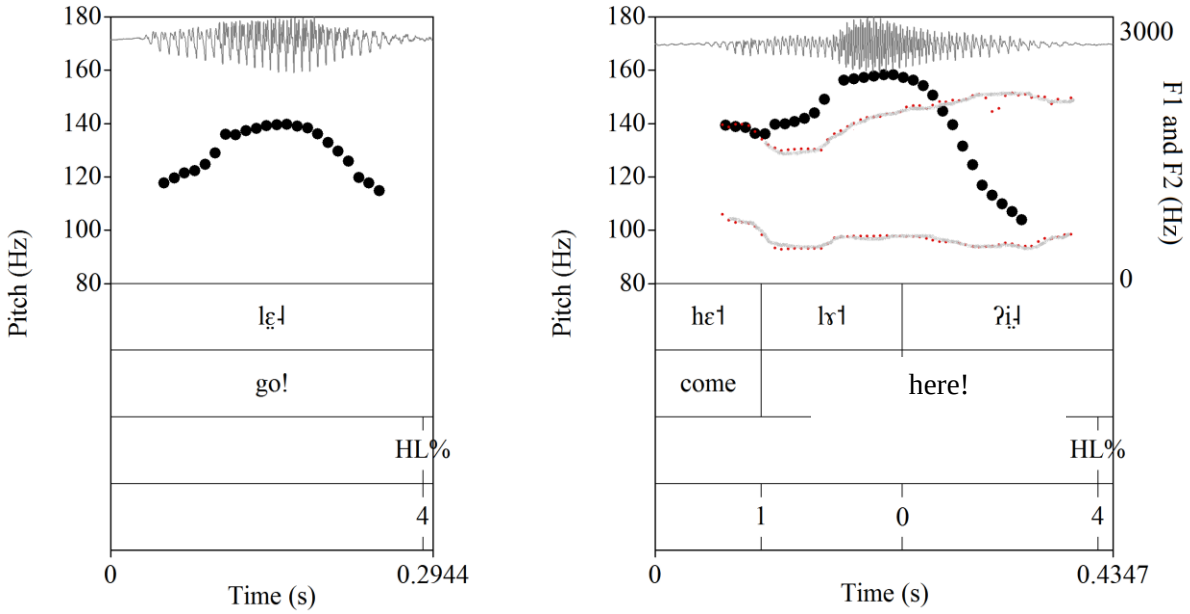


Figure 19: Imperative sentences with HL% realized on the monosyllabic word (left) and on the final two syllables (right)

In the monosyllabic case (the left panel of Figure 19), f0 quickly reaches a sustained high point before falling halfway through the vowel. In the right panel of Figure 19, the phrase involving a two-syllable predicate, the first 2 formants are given to show the boundary between the penultimate and final syllable in '*come here!*'. Here, the HL% seems to be implemented across the last two syllables. The first syllable of [lɤ˧ ʔi̤˩] 'here' begins with a higher onset than the main verb [hɛ˧] 'come', even though both are Tone 1, and the f0 peak is barely reached before vowel formants begin transitioning to the following high front vowel [ʔi̤˩]. Though final syllable [ʔi̤˩] is tone 6 (breathy low) just like the monosyllabic predicate, surface alignment of HL% differs, suggesting that the BT aligns earlier in elided cases like these—a 0 break index separates the last two syllables because of the absence of onset [ʔ] or any glottal constriction. It is possible that the weakened status of the final syllable causes the BT to be realized earlier. In summary, the domain of HL% is the IP-final syllable when appearing on the monosyllabic vocative final particle /ɦɤ˧/, but may spread to the penultimate syllable in an imperative. Because the two imperative examples end in a low lexical tone, however, more data is needed for confirmation.

LHL%

One last tone that is very common is the LHL%. Though it is the exclusive BT for yes/no questions, it has several non-question uses, such as narrative speech. Figure 20 is of a speaker describing a character in a visual scene using the sentence '*He is named Bee*'. The initial f0 dip at the beginning of the sentence-final syllable is characteristic of LHL%.

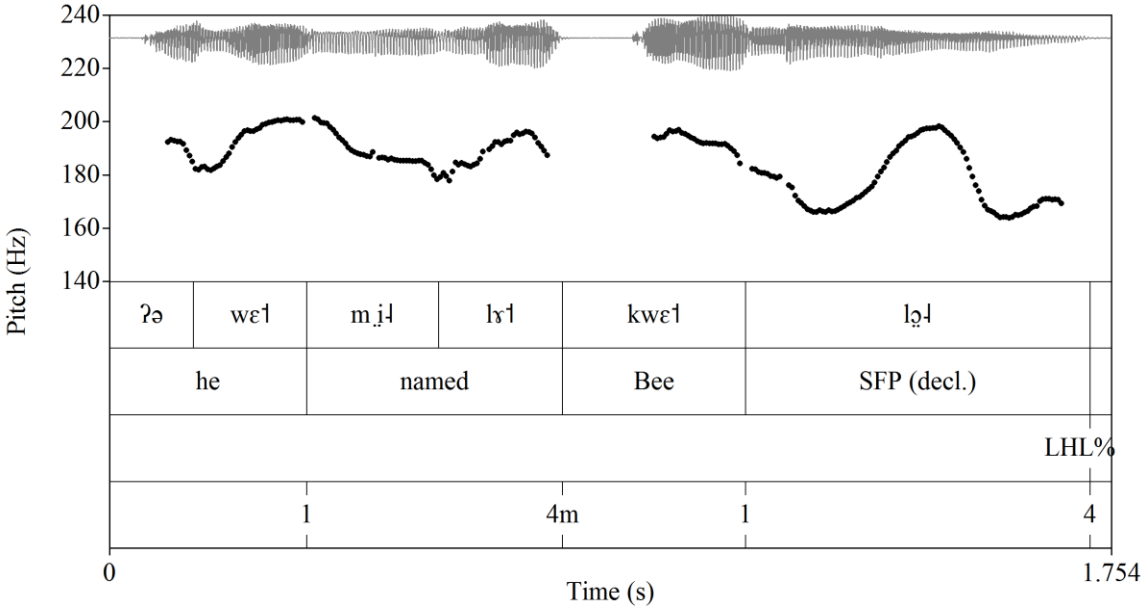


Figure 20: Sentence with LHL% BT in declarative narrative speech

One might interpret the first L tone on the final syllable as realization of the underlying low breathy tone (˩̤), but the example in Figure 21 will cast doubt on this interpretation. Figure 21 is an f0 track of the sentence, '*Did you buy the yellow python*?', where the sentence-final syllable is tone 1 (mid/mid-rising) but shows a LHL%.

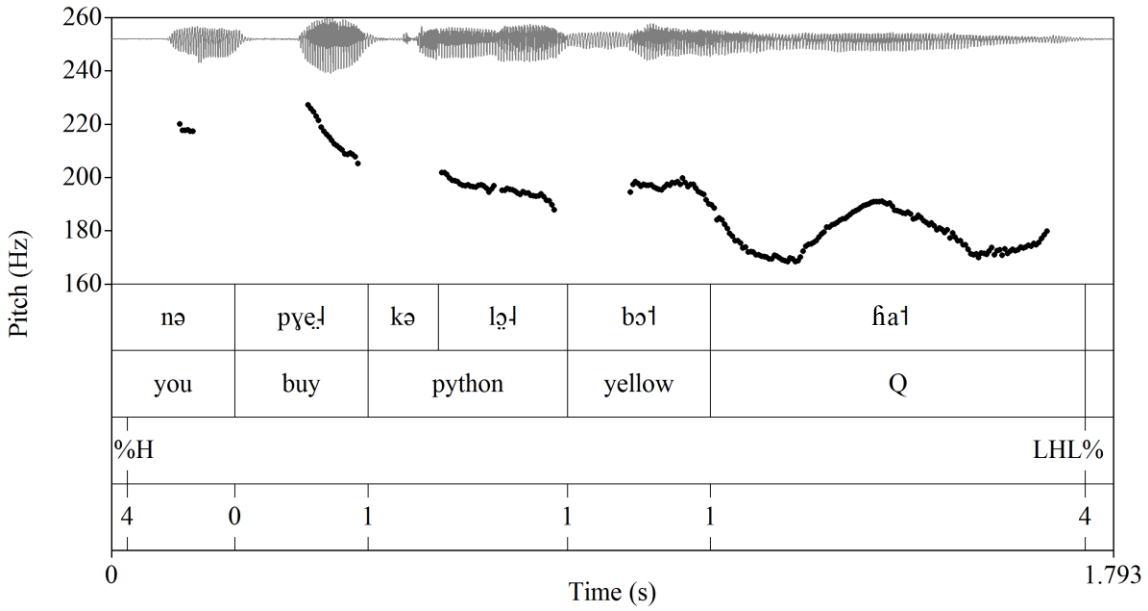


Figure 21: Yes/No question with sentence-final particle /ɦaɬ/ after a mid-high tone

The f0 drop between [bɔɬ] and [ɦaɬ] is too great to be explained by downstep and because the adjacent tones are both mid-high, the f0 dip is most likely due to LHL%.

Comparing this to the same final particle following a low lexical tone as in Figure 22, it appears that the BT (LHL%) is the only source contributing f0 to the final syllable. In both cases (Figures 21 and 22), /ɦaɬ/ is marked as tone 1, high modal, but in the case of Figure 22, its onset is lower than preceding low tone. If the high underlying lexical tone of /ɦaɬ/ were realized, one would expect a rise after the preceding low tone syllable earlier than that shown in Figure 22. Note that the end of f0 contour in Figure 22 is not clearly showing the L target of the LHL% IP boundary tone due to lack of voicing.

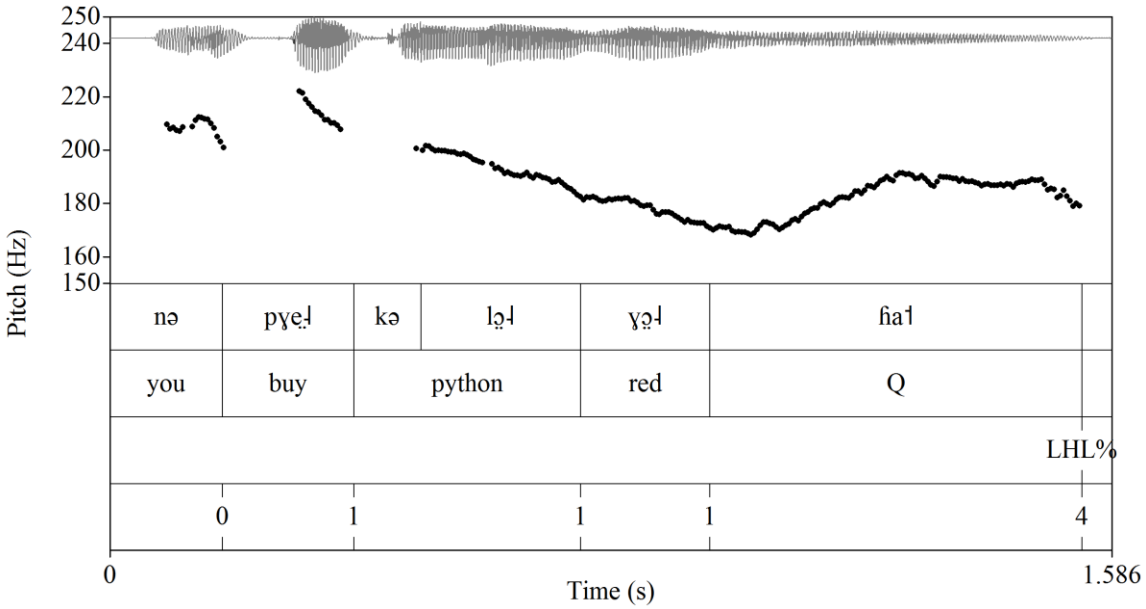


Figure 22: Yes/No question with LHL% after a low tone

IP-initial patterns

The only non-lexical IP-initial pitch pattern found in the data concerns initial minor syllables. There are two possible tonal patterns of IP-initial minor syllables in Sgaw Karen. The most common one is a low f0 on minor syllables until the first major syllable, as seen below. This is similar to the pattern found in Burmese (§2.6).

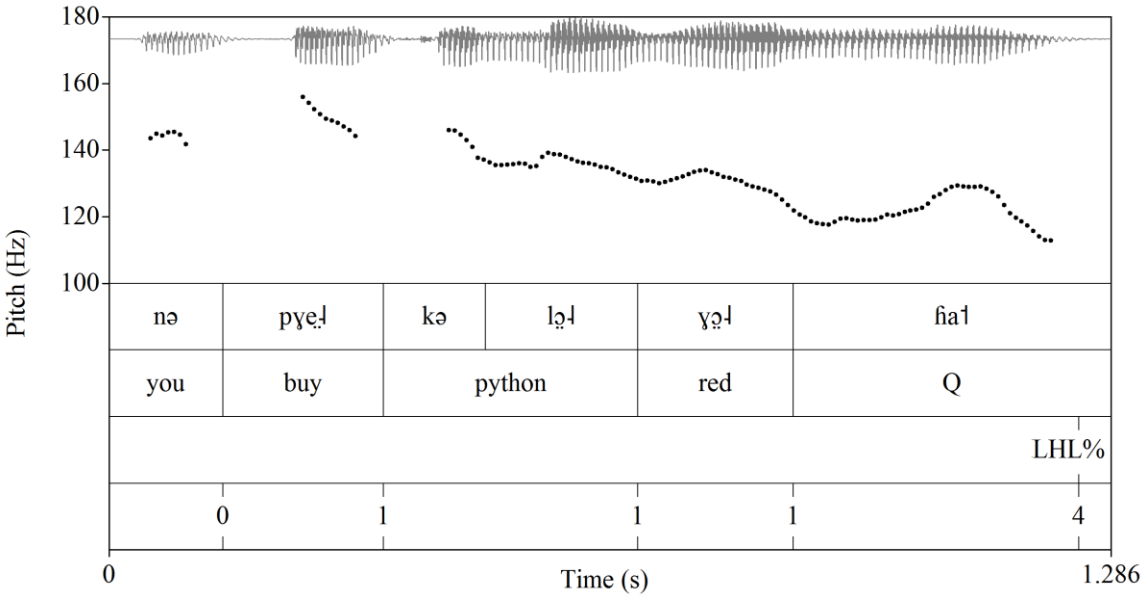


Figure 23: Low (default) pitch on initial minor syllable in sentence "Did you buy (the) red python?"

While low f0 in these cases can be considered the result of a minor syllable L target surfacing in the absence of a BT, the second tonal pattern for IP-initial minor syllables cannot be explained by lexical tone alone. This is because IP-initial minor syllables may also surface with higher f0 than the following major syllables as shown in Figure 24. As seen in the waveform on the left, minor syllable onsets can be voiced intervocalically, especially when the syllables were produced with a small juncture, as marked with 0-level break indices in the figure.

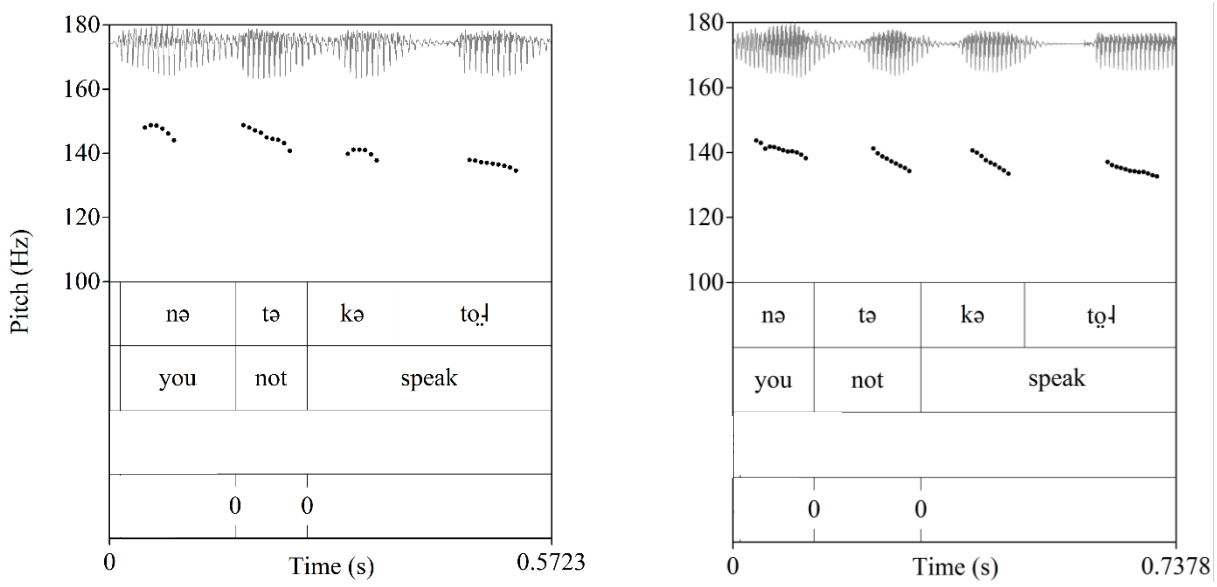


Figure 24: High pitch on initial minor syllable in phrase "you don't speak..."

The meaning difference signaled by this initial high pitch is not yet clear, and some speakers varied in whether they produced the high pattern at all. The examples in Figure 24 are produced by the same speaker as the one in Figure 23. In short, though minor syllables usually surface with lower f0 than adjacent major syllables, they sometimes surface as high f0 at IP-initial position. Though the initial high pitch seen above may appear like an initial high postlexical tone, evidence is too sparse to consider %H as a discrete BT at present.

4.4.4 Interaction with lexical tone

This section gives examples showing that IP-final syllables' pitch is based on both the underlying lexical tone and the complexity of the boundary tone. While AP-final lexical tone has been shown to maintain underlying shape, IP-final syllables show an interaction between lexical and post-lexical tones. First, the underlying lexical tone can be realized on the first half of the syllable. The same sentence provided earlier in §4 ('the rooster is drinking water') is given below (Figure 25) showing a medial IP boundary affecting a falling breathy tone. Pitch of the first half of the syllable [kn̰˩] shows the effect of lexical tone (high onset), and the second half shows the effect of the BT (even higher offset).

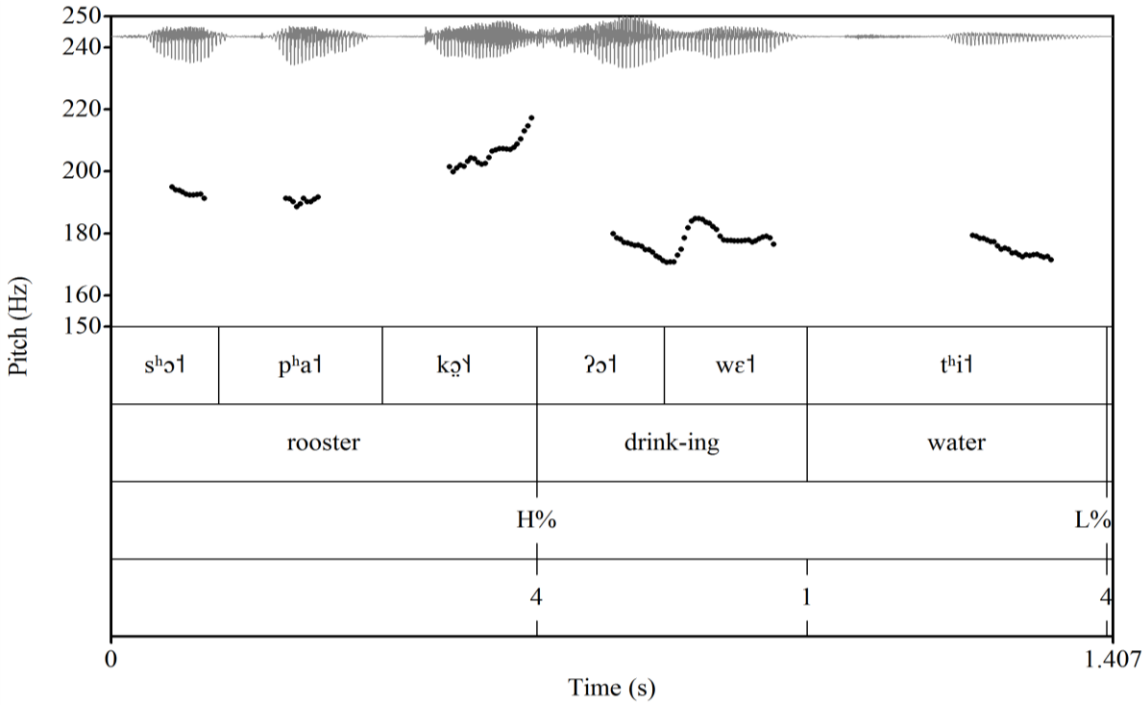


Figure 25: Sentence-medial H% on falling breathy tone

The high f0 onset of tone 2 on the final syllable [kn̰˩] of the subject is understandable since tone 1 of the preceding syllable [pʰa˧] is phonetically mid. The direction of tone 2 [kn̰˩] is unexpected, however, suggesting that the second half of the syllable's f0 is due to the H% boundary tone.

For some syllables bearing BTs, it is difficult to identify traces of the lexical tone because they do not occur non-finally, like sentence final particles /lə̩˩/, /mɔ˥˩/, /lɛ˥˩/ and /ɦa˧˩/. In other cases where the underlying tone is known, the interaction between the lexical tone and the boundary tonal targets are clear. In the case of the high falling modal tone (tone 5), a high IP boundary tone (H%) is implemented after the lexical tone is articulated. Otherwise we would not expect the dynamic surface contour tone shown in the word /kətə̩˩/ 'speak' and the word /pətə̩˩/ 'trot' in Figure 26 below.

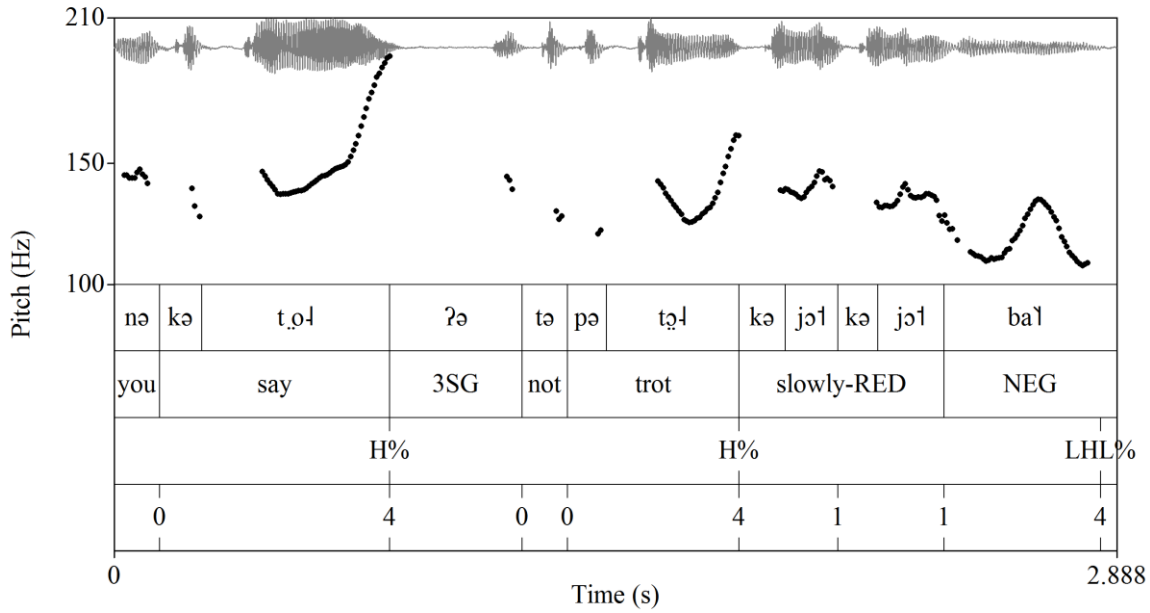


Figure 26: Sentence with quotative and embedded CP

Second, the complexity of the postlexical tone affects a syllable's surface pitch. As mentioned before, the BT onset during the final vowel is contingent on the complexity of BTs. Thus, in cases of complex BTs like LHL% the original lexical tone is not clearly preserved, as in Figure 27 (repeated from Figure 21) below.

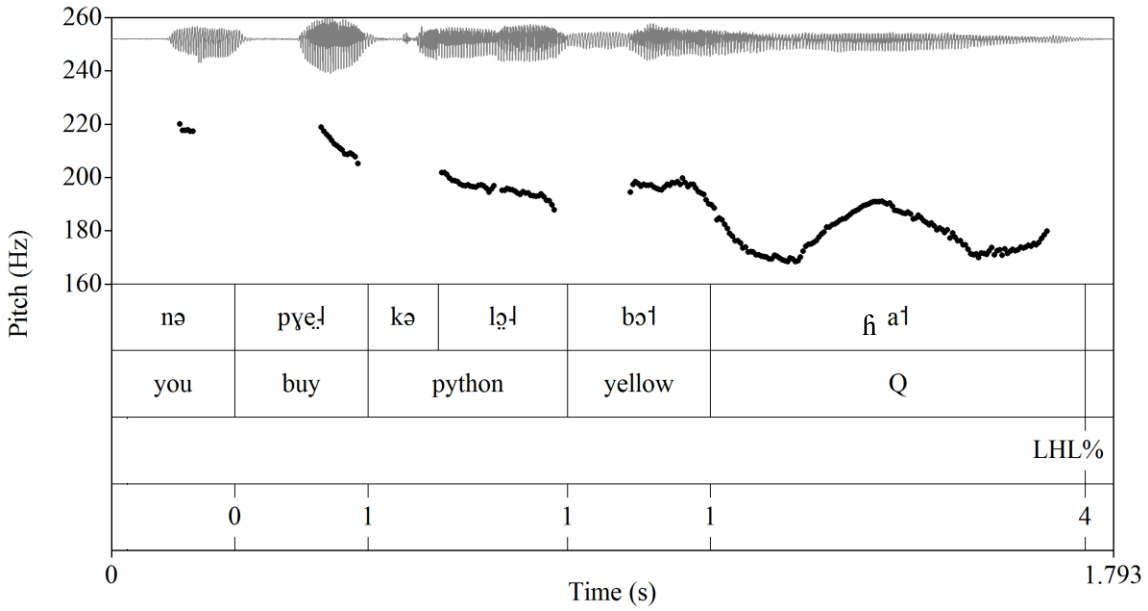


Figure 27: Yes/No question with LHL% after a mid-high tone (same as Figure 21)

The same overriding of lexical tone is found for IP-final syllables other than final particles. The 2nd syllable of the verb /mạ˩ tạ˨/ 'work', is a mid to low falling tone, but in the example in Figure 28 the final syllable's f0 begins at the lowest point of the phrase before rising and falling slightly, suggesting that the lexical tone is overridden by the complex BT, i.e., LHL%.

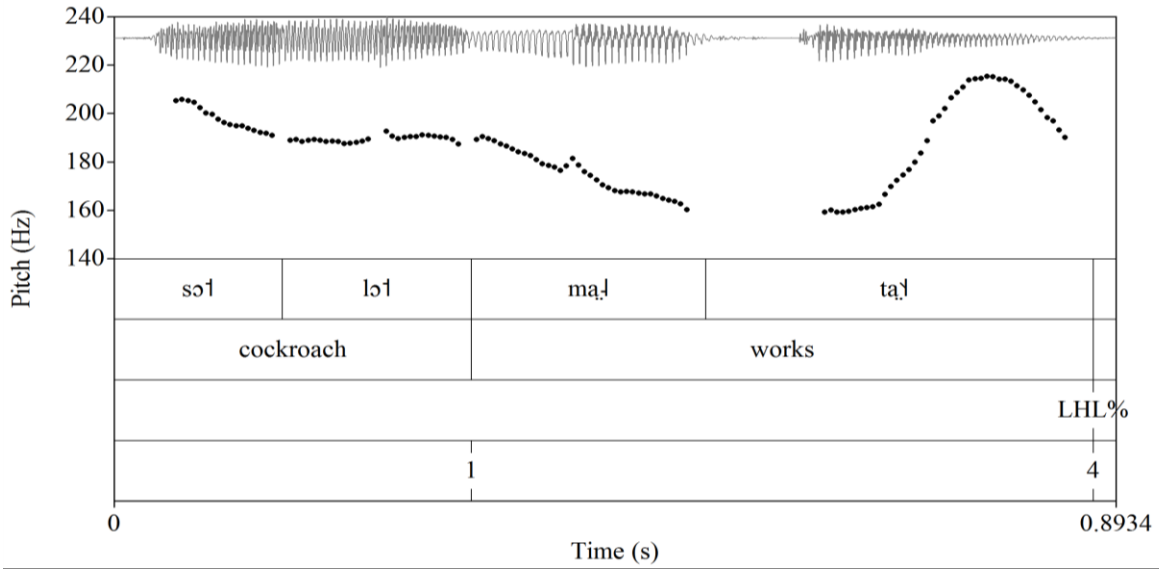


Figure 28: Short sentence with LHL% on a falling tone. That is, multiple BTs in Sgaw Karen override a lexical tone on any IP-final syllable, but a single BT is realized on the second mora of

a major syllable. When a two or three-tone BT falls on a major syllable, the lexical tone no longer has room to realize its tonal target. In summary, when post-lexical tones and lexical tones co-occur in Sgaw Karen, the realization of lexical tone depends on (1) the underlying lexical tone and (2) the complexity of the boundary tone.

4.4.5 Other intonationally defined prosodic units

This section addresses whether there is another prosodic unit in Sgaw Karen, like the intermediate phrase proposed for Mandarin and Pwo Karen (H- and L-). In the case of Pwo Karen, H- intermediate phrase boundary tone is used to mark constructions like listing, seen in Figure 29 below (figure taken from Hsieh 2012:14).

jə	ɣe^{53}	chu^{1}	nai^{1},	mi^{5}dwai^{1},	de^{3}	mi̱^{1}
1SG	come	bring	type-of-basket	matches	with	cooked-rice

"I am bringing a *nai* basket, matches, and cooked rice."

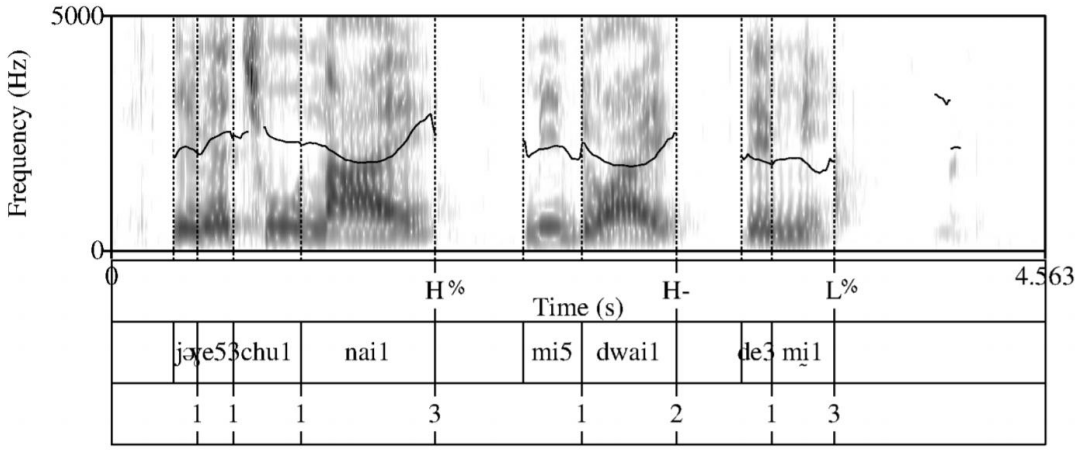


Figure 29: Pwo Karen sentence with both H- and H%

However, it is not clear if H% and H- proposed in Pwo Karen is categorically distinct. The example above shows that the syllable where H% is realized seems to be slightly longer than the syllable where H- is realized, and both syllables are followed by a pause. To propose a prosodic unit, the realization and/or the function of the unit should be categorical.

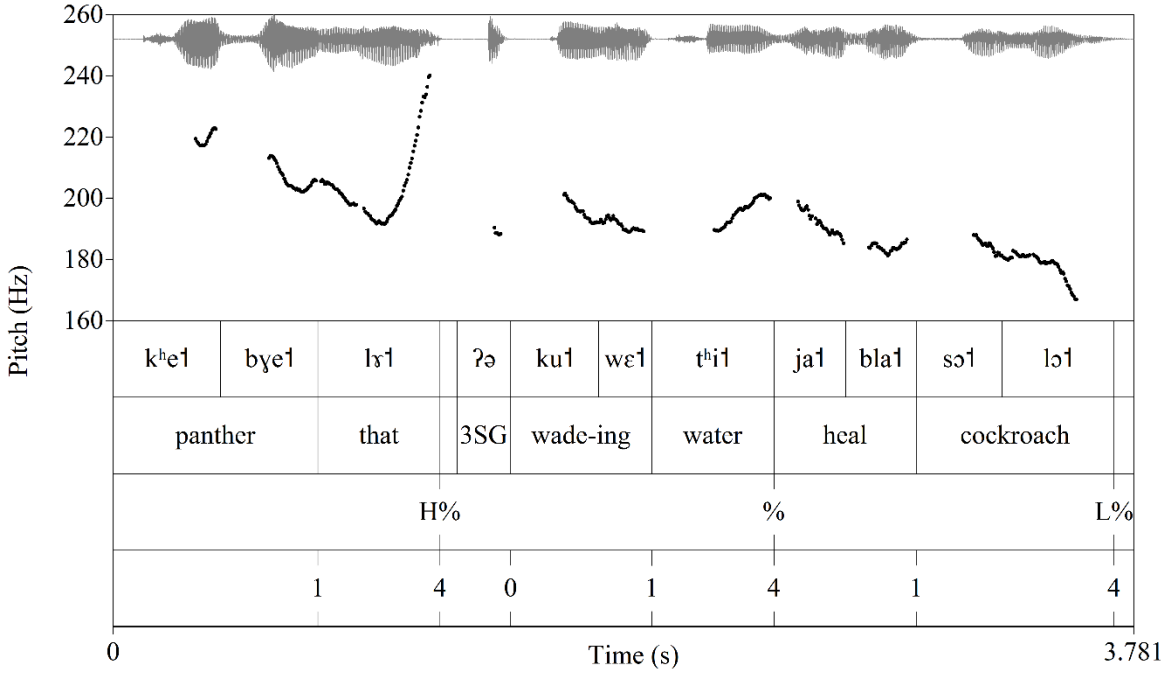


Figure 30: Sentence with two sentence-medial pitch rises

One could perhaps argue Sgaw Karen also has an Intermediate phrase in the example sentence like Figure 30, where two pitch rises occur in a single sentence (on /lɤ1/ 'that' and /tʰi1/ 'water'). That is, the first f0 rise on /lɤ1/ 'that' can be an IP boundary marked by H% and the second f0 rise on /tʰi1/ 'water' can be an ip boundary marked by H-. Here, unlike the examples in Pwo Karen, the phonetic realizations of the two rises are different. The degree of f0 rise and the lengthening of the syllable seems to differ and the first rise is followed by a pause while the second is not. However, it is not clear if the second rise is also distinct from the AP boundary.

Figure 31 shows another example of sentence-medial multiple f0 rises of different strength. As seen below, f0 rise on /dɔ̰1/ 'and' is weaker than that on /bɔ1/ 'yellow' in that the first f0 rise is not as high as the second f0 rise and is followed by a shorter pause than the second one. So, one might interpret the first rise as an ip boundary H- and the second rise as an IP boundary H%. However, in light of the speakers analyzed in this study, these differences are not categorical, but gradient, and do not justify proposing two different prosodic units.

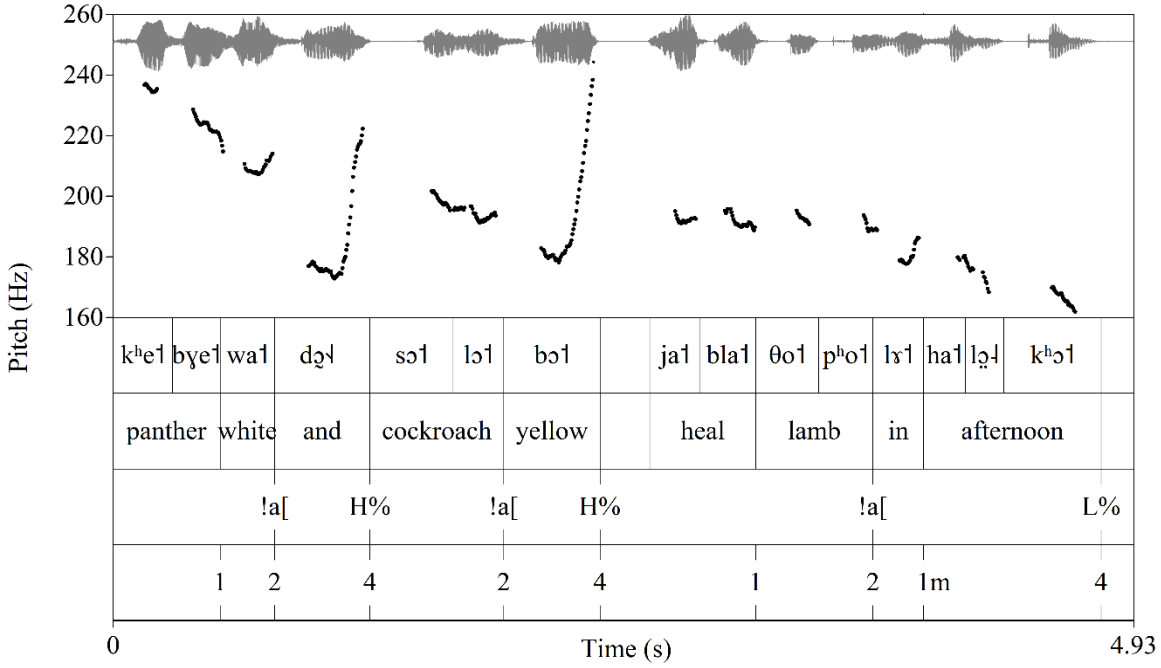


Figure 31: Sentence with coordination and prepositional adjunct

However, the example in Figure 31 shows a third f0 rise, i.e., a slight rise on /lɤ1/ 'in' that do not resemble IP breaks but have f0 patterns deviant from a normal AP. In the above example, f0 stays flat for the duration of the V+Obj 'heals lamb' but drops at the beginning of the PP on /lɤ1/ 'in' and rises again before the next syllable. Because this rise seems to occur consistently after phrase heads (PP: /lɤ1/ 'in/at', ConjP: /dɔ̰ɻ/ 'and', CP: /lɤ1/ 'that') it may be that these form a class which (1) obligatorily form an independent AP, explaining the low onset f0 and slight rise in /lɤ1/ in the above example, and (2) may mark the end of an ip with a smaller rise than that after /dɔ̰ɻ/ or /bɔ1/ in the example. A further study is needed to clarify whether there is a prosodic unit intermediate between AP and IP in Sgaw Karen.

5 Conclusion

This study has examined word prosody, especially the moraic difference between major and minor syllables, and proposed an intonational model for Sgaw Karen, an understudied Tibeto-Burman language. In terms of word stress, no consistent prominence difference was

found for major syllables. Major and minor syllables are found to be prosodically distinct, however. The lexically reduced status of minor syllables is seen in word-shape distribution (§3.3), reduction in compounds (§3.4), and loanword patterns (§3.5).

In terms of intonation, patterns of IP-final post-lexical tone interacting with lexical tone have been shown to be explicable with a bimoraic analysis of major syllables (§4.4). In a moraic view, a simple boundary tone (e.g., L%) overrides lexical tone during the second mora of the bimoraic major syllable, while a complex boundary tone (e.g., LHL%) overrides the entire lexical tone of the syllable. The intonational hierarchy proposed in this study is that the highest prosodic unit is an IP (Intonational Phrase), which can contain at least one AP (Accentual Phrase). Rather than being marked with a post-lexical boundary tone as in other AP languages, Sgaw APs are delineated by f0 downstep, an unsurprising strategy for a tonal language as it avoids obscuring the shape of lexical tones.

Putting Sgaw Karen into the broader picture of Eastern Tibeto-Burman, this study finds similarities and differences with related languages. Sgaw Karen's major-minor syllable distinction aligns closely with systems proposed for related languages like Burmese, Zaiwa and Pwo Karen. Sgaw Karen also patterns with the related Karenic languages in lacking word stress between major syllables. Concerning intonation, Sgaw Karen resembles the related Karenic languages such as Pwo in the limited use of post-lexical tone. Unlike Pwo Karen, however, Sgaw Karen has an Accentual Phrase similar in size to that of Burmese. In sum, though Sgaw's post-lexical tone behaves like Karenic languages, Sgaw's prosodic structure is closer to that of Burmese.

The present study has two main limitations which future intonation research can supplement. First, because only tone 1 (mid-rising modal) was used in the AP stimuli, data with

all other lexical tones is required to confirm whether f0 downstep delineates APs in all cases. Second, because only four of the six lexical tones (tones 1, 2, 3, 4) were investigated at IP boundaries, a full dataset with IP-final tone 5 (high falling modal) and tone 6 (low breathy) are needed to confirm these patterns. Additionally, data is needed with all lexical tones at IP boundaries with BTs of all three types of complexity (L%, HL%, LHL%) to confirm the proposal on the interaction between post-lexical and lexical tone made in this study.

6 Appendix

6.1 Word-prominence phrases (target=subject noun)

Examined syllables: σ^1 σ^2] aP [σ^3 σ^4			
Set 1	SsSS	doɬ kə ʔoɬ-pʰoɬ ʔɔɬ -wɛɬ tʰiɬ owl -DIM drink-ing water	‘(the) owlet is drinking water’
	SsS	doɬ kə ʔoɬ ʔɔɬ -wɛɬ tʰiɬ owl drink-ing water	‘(the) owl is drinking water’
		sʰɣɒɬ kəsʰɣɒ kuɬ -wɛɬ tʰiɬ walrus wade-ing water	‘(the) walrus is wading’
		sʰɒɬ kəsʰɒ kuɬ -wɛɬ tʰiɬ turkey wade-ing water	‘(the) turkey is wading’
	SSS	kʰeɬ bʸeɬ -pʰoɬ kuɬ -wɛɬ tʰiɬ panther -DIM drink-ing water	‘(the) panther cub is wading’
	SS	laɬ waɬ ʔɔɬ -wɛɬ tʰiɬ Lawa drink-ing water	‘Lawa is drinking water’
		sɔɬ lɔɬ ʔɔɬ -wɛɬ tʰiɬ cockroach drink-ing water	‘(the) cockroach is drinking water’
		tɛoɬ-pʰoɬ ʔɔɬ -wɛɬ tʰiɬ school-DIM drink-ing water	‘(the) student is drinking water’
	sS	kəɲɒɬ ʔɔɬ -wɛɬ tʰiɬ person drink-ing water	‘(the) person is drinking water’
Set 2 (nonce-word names)	SsSS	laɬ-lə-laɬ-laɬ ʔɔɬ -wɛɬ tʰiɬ Lal’lala drink-ing water	‘Laləlala is drinking water’
	SSS	laɬ-laɬ-laɬ ʔɔɬ -wɛɬ tʰiɬ Lalala drink-ing water	‘Lalala is drinking water’
	SsS	laɬ-lə-laɬ ʔɔɬ -wɛɬ tʰiɬ Laləla drink-ing water	‘Laləla is drinking water’
	SS	laɬ-laɬ ʔɔɬ -wɛɬ tʰiɬ Lala drink-ing water	‘Lala is drinking water’

6.2 Target phrases used for both AP and IP boundaries

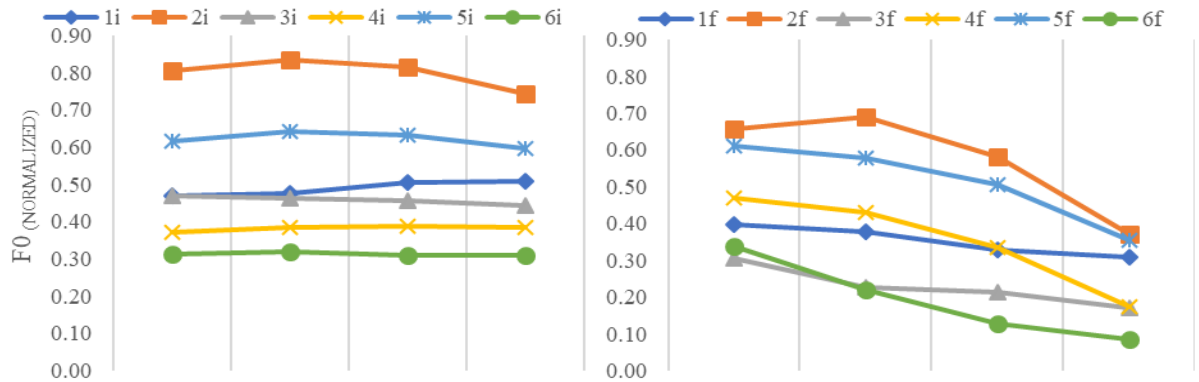
Examined syllables: σ^1 σ^2] AP [σ^3 σ^4 …]] IP	
Set 1	(expected to form a single IP) (subject expected to form AP)
	doɬ kə ʔoɬ-pʰoɬ ʔɔɬ -wɛɬ tʰiɬ owl -DIM drink-ing water ‘(the) owl is drinking water’
	sɔɬ lɔɬ ʔɔɬ -wɛɬ tʰiɬ cockroach drink-ing water ‘(the) cockroach is drinking water’
	laɬ waɬ ʔɔɬ -wɛɬ tʰiɬ Lawa drink-ing water ‘Lawa is drinking water’
Set 2	(expected to form a single IP, or possibly two IPs when sentence length is increased) (long subject expected to have more AP breaks, shorter subject forms one AP)
	kʰeɬ bʸeɬ -pʰoɬ waɬ kʰiɬ dɯɬ ʔɔɬ -wɛɬ tʰiɬ panther -DIM white 2 -CL drink-ing water ‘two white panther cubs are drinking water’
	θoɬ -pʰoɬ waɬ kʰiɬ dɯɬ kuɬ -wɛɬ tʰiɬ sheep -DIM white 2 -CL wade-ing water ‘two white lambs are wading (in) water’
	sɔɬ lɔɬ ʔɔɬ -wɛɬ tʰiɬ cockroach drink-ing water ‘(the) cockroach is drinking water’

6.3 Target phrases specifically for IP boundaries

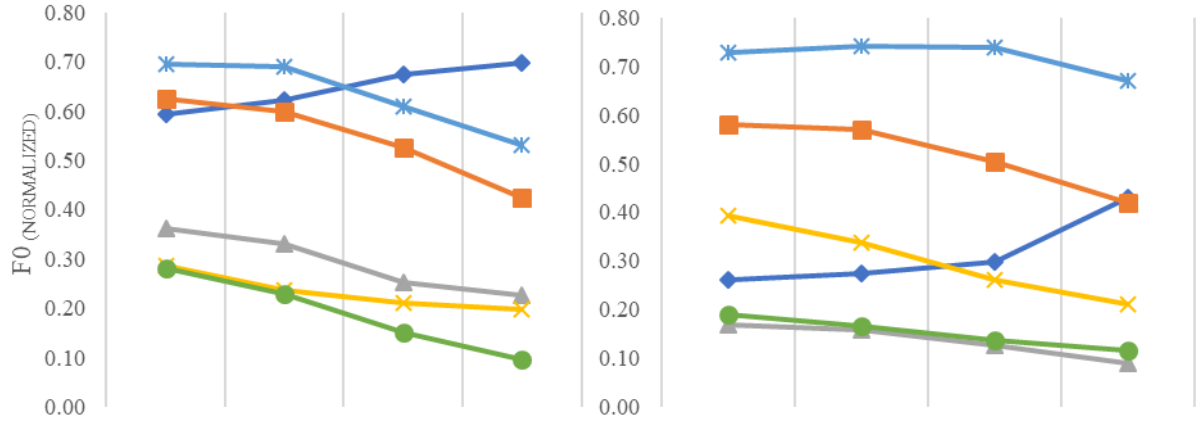
Expected IP break after conjunction words or at end of relative clause	
Set 1	(conjunction)
	kʰeɬ bʸeɬ -waɬ dɔɻ sɔɬ lɔɬ -bɔɬ jaɬ blaɬ θoɬ-pʰoɬ lɤɬ haɬ lɔɻ kʰɔɬ panther -white and cockroach-yellow heal sheep-DIM in afternoon “The white panther and the yellow cockroach heal the lamb in the afternoon.”
	blaɬ dɔɻ kʰeɬ bʸeɬ dɔɻ sɔɬ lɔɬ -waɬ meɻ kə-θiɬ-θə-raɬ bat and panther and cockroach-white be doctor “The bat and the panther and the white cockroach are doctors.”
Set 2	(relative clauses)
	kʰeɬ bʸeɬ lɤɬ ʔə kuɬ-wɛɬ tʰiɬ jaɬ blaɬ sɔɬ lɔɬ panther that 3SG wade-ing water heals cockroach “The panther that is wading in the water heals the cockroach.”
	sʰaɬ-pʰoɬ-kɔɻ-pʰoɬ lɤɬ ʔə tə-sʰuɬ-tə-kʰleɬ ʔaɬ lɔɻ animals that 3SG not-well-not-healthy many SFP “Animals that are sick are many.”

6.4 Lexical tones by speaker (intonation group; normalized f0)

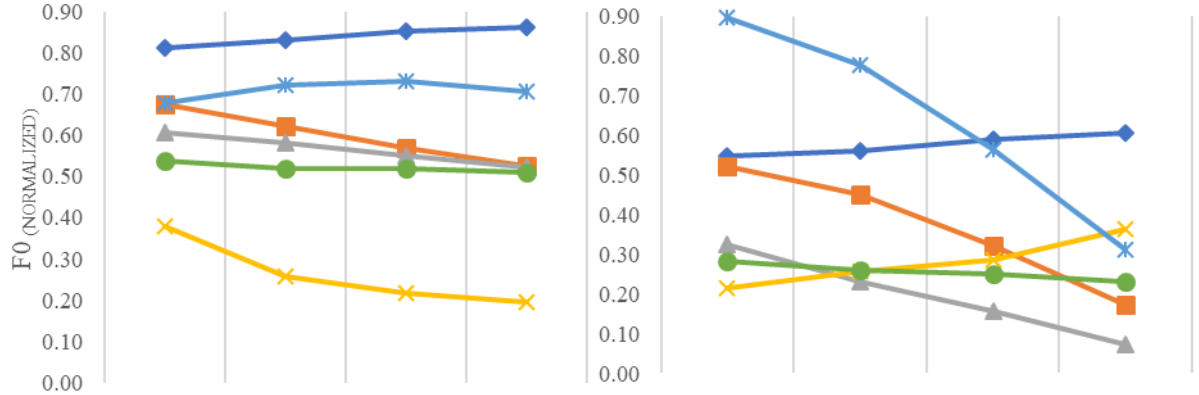
F18 NU



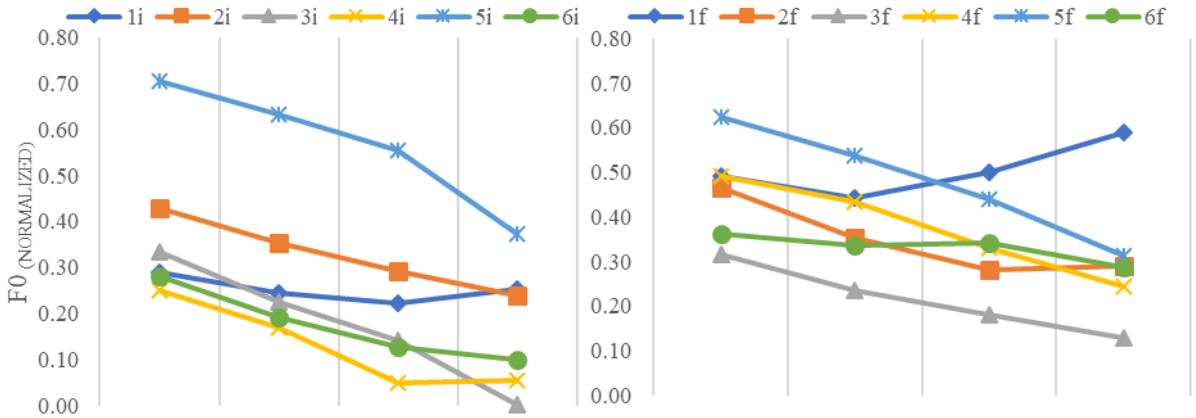
F35_UX



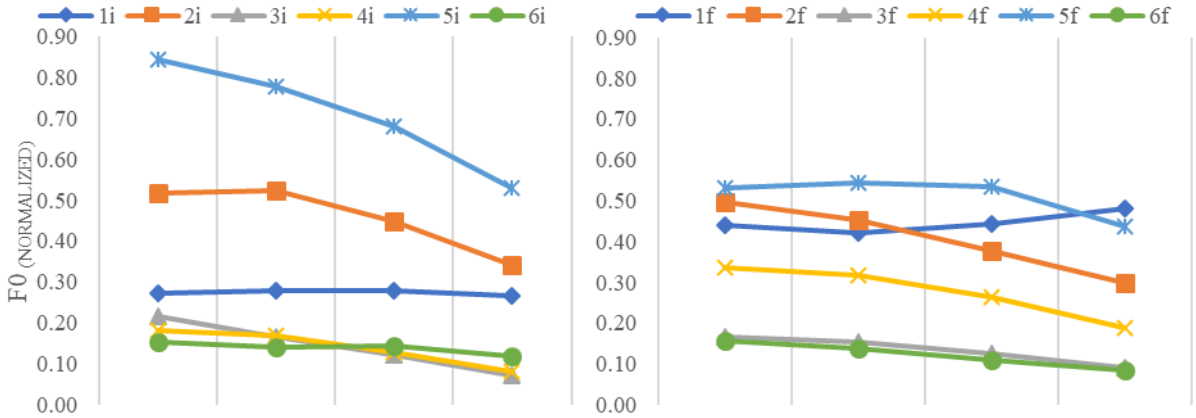
F40_XE



M19_ME Initial Final



M40_NT Initial Final



6.5 Literature genre subsets

Genre	Description	Samples	Unique words
Health	Anatomy, nutrition, disease prevention, childcare and child-rearing	Facts for Life, Child Development, How the Body Works, Food Your Body Needs, 'Teaching Sureh'	1337 Samples: 5
Science	Biology, zoology, agriculture, math and logic games (English translations and Latin taxonomy terms excluded)	Amazing Facts of Planet Earth, Animal Facts, Story about Animals, Brain Sharpening Skills 1 and 2, 'Everyone can make Compost', Low Cost Farming	911 Samples: 7
Culture	Karen-specific cultural traditions: art, food, festivals, beliefs	'The Bronze Drum and the Karen', Karen Clothing, Karen Faith & Beliefs, Karen traditional knowledge, Karen Household, Traditional Karen Snacks	1323 Samples: 6
Newsletter	Online articles about world news, culture; crafts and games aimed at a younger audience	58 articles from 2009-2014	1009 Samples: 58
Fiction	Translations of fictional stories, primarily novels, pertaining to non-Karen cultures	Animal Farm, Gulliver's Travels, Ywa Thwit Gyi Mysteries, The Happy Prince and Oscar Wilde, The Good Earth	1563 Samples: 5
Kid's books	Children's books, short stories and novels aimed at a young audience	Grimm's Fairy Tales, Aesop's Fairy Tales 1 and 2, Creative Writing: 'Imagine', Shan Folk tales, Karenni Folklore, Karen Folklore, 'Stories for Little Children'	1512 Samples: 8

6.6 Word-shape (entire lexicon)

N=6338		% of total			% of total			% of total			% of total
Shape	#	95.24%	Shape	#	3.36%	Shape	#	0.80%	Shape	#	0.43%
SS	1421	22.42%	SssSS	14	0.22%	SSSSSsSS	3	0.05%	ssSsSsS	1	0.02%
SSS	1158	18.27%	SSSsSS	14	0.22%	SsSSSSsS	3	0.05%	SsSSsssSSS	1	0.02%
SSSS	635	10.02%	SsSSSSS	12	0.19%	ssSSS	3	0.05%	SSsSSSsS	1	0.02%
SsS	450	7.10%	SsSSsSS	12	0.19%	SsSsSsSS	2	0.03%	SSSsssSSS	1	0.02%
S	408	6.44%	SSSsSsS	10	0.16%	SSsSSSSSS	2	0.03%	SSsSsSS	1	0.02%
SSSSS	237	3.74%	SssSsS	10	0.16%	ssSSsS	2	0.03%	SSsSsSsS	1	0.02%
sS	232	3.66%	SSSSSsS	10	0.16%	SsSSsSsS	2	0.03%	SSSssS	1	0.02%
SSsS	229	3.61%	SSsSSSS	9	0.14%	SssSSSS	2	0.03%	SSSssSS	1	0.02%
sSS	207	3.27%	SSsSSsS	9	0.14%	SSSSsSSS	2	0.03%	SSssSS	1	0.02%
SsSS	179	2.82%	SssSSS	9	0.14%	sSSSSSS	2	0.03%	SSssSsS	1	0.02%
SsSsS	110	1.74%	SsSsSsS	8	0.13%	ssSsS	2	0.03%	SSssSssS	1	0.02%
sSSS	102	1.61%	sSSsSS	8	0.13%	SsSsSSSS	2	0.03%	SSSsSsSS	1	0.02%
SSSsS	97	1.53%	sSSSsS	7	0.11%	SsSSsSSS	2	0.03%	SSSsSSsS	1	0.02%
sSsS	88	1.39%	SsSSSsS	7	0.11%	SsSsSSSSS	2	0.03%	SssSSSSS	1	0.02%
SsSSS	71	1.12%	SsSsSSS	6	0.09%	SSSSSSSSS	2	0.03%	SsSSsSSsS	1	0.02%
SSSSSS	60	0.95%	ssSS	6	0.09%	SsSsSSsS	2	0.03%	SsSSssS	1	0.02%
SsSSSS	46	0.73%	sSSSSS	6	0.09%	SSSsSSSS	2	0.03%	SsSsSSsSS	1	0.02%
SSSSsS	46	0.73%	SSSSsSsS	5	0.08%	SSsSssS	2	0.03%	SsSsSssSS	1	0.02%
SSsSS	45	0.71%	sSsSsS	5	0.08%	SSSSsSSsS	2	0.03%	SsSssSsS	1	0.02%
sSSSS	27	0.43%	sSsSSS	5	0.08%	sSsSsSS	1	0.02%	SsSssS	1	0.02%
SSsSsS	27	0.43%	s	5	0.08%	SSSSSSsSsS	1	0.02%	SssSSSSsS	1	0.02%
SSsSSS	27	0.43%	SSSSSSsS	5	0.08%	sSSSSsSS	1	0.02%	SssSSsSS	1	0.02%
SsSsSS	26	0.41%	sSSsSsS	5	0.08%	SSSSSsSsS	1	0.02%	SssSsSS	1	0.02%
SssS	21	0.33%	SSsSSSSS	5	0.08%	sSsSSsS	1	0.02%	SssSsSsSsS	1	0.02%
SSSSSSS	20	0.32%	SSssS	5	0.08%	sSSsSsSS	1	0.02%	SsssSsS	1	0.02%
SsSSsS	19	0.30%	SSSsSSS	4	0.06%	SSSSSsSSsS	1	0.02%	SsssS	1	0.02%
sSSsS	17	0.27%	SSSSSSSS	4	0.06%	sSSssSSS	1	0.02%	SsSSSsSS	1	0.02%
ssS	16	0.25%	SSSSsSS	4	0.06%	ssSSSS	1	0.02%			
sSsSS	15	0.24%	SsSSSSSS	4	0.06%	sSSssS	1	0.02%			

7 References

Abramson, Arthur (1992). *Laryngeal timing in Karen plosives*. 25th International Conference of Sino-Tibetan Languages and Linguistics, Berkeley.

Alderete, J., Beckman, J., Benua, L., Gnanadesikan, A., McCarthy, J., Urbanczyk, S. (1999). Reduplication with fixed segmentism. *Linguistic inquiry*, *30*(3), 327-364.

Armstrong, L. E., Tin, P. M. (1925). *A Burmese Phonetic Reader*. London:University of London Press.

Beckman, M., Ayers, G. (1994). *Guidelines for ToBI Labelling*. Unpublished manuscript, Ohio State University.

Beckman, M. E., Hirschberg, J., Shattuck-Hufnagel, S. (2005). The original ToBI system and the evolution of the ToBI framework. *Prosodic Typology–The Phonology of Intonation and Phrasing*, ed. by Sun-Ah Jun, 9–54.

Beckman, M. E., Pierrehumbert, J. B. (1986, July). Japanese prosodic phrasing and intonation synthesis. In *Proceedings of the 24th annual meeting on Association for Computational Linguistics* (pp. 173-180). Association for Computational Linguistics.

Brunelle, M., Finkeldey, J. (2011). Tone perception in Sgaw Karen. In *Proceedings of the 17th International Congress of Phonetic Sciences (ICPhS 17)* (pp. 372-375).

Chao, Y. R. (1968). *A grammar of spoken Chinese*. Berkeley, CA : University of California Press

Chávez-Peón, M. E. (2008). Phonetic cues to stress in a tonal language: Prosodic prominence in San Lucas Quiaviní Zapotec. In *Proceedings of the 2008 Annual Conference of the Canadian Linguistic Association. Available (January 2014) at http://homes. chass. utoronto. ca/~ cla-acl/actes2008/CLA2008_Chavez-Peon. pdf.*

Drum Publications. Transliteration Guide. In Learn Karen. Drum Publications, Online website: www.drumpublications.org.

Everett, K. M. (1998). The acoustic correlates of stress in Pirahã. *The Journal of Amazonian Languages, 1* (2), 104-162.

Féry, C. (2010). Indian Languages as Intonational 'Phrase Languages'. In Hasnian, Imtiaz and Shreesh Chaudhury (eds.), *Problematizing Language Studies; Cultural, Theoretical And Applied Perspectives—Essays In Honor Of Rama Kant Agnihotri*, 288-312. Delhi: Aakar Books.

Finkeldey, J. (2011). Tone and phonation types in Sgaw Karen. *Sgaw Karen papers: Presented to Andrew Nimrod*, 25-35.

Fischer, L. L. (2013). *Sgaw Karen as spoken by a member of the local North Carolina Karen community: a phonetic analysis and phonemic description* (Doctoral dissertation, The University of North Carolina at Chapel Hill).

Green, A. D. (1995). The prosodic structure of Burmese: A constraint-based approach. *Working Papers of the Cornell Phonetics Laboratory*, *10*, 67-96.

Griffin, J. (2014) A brief investigation of Sgaw Karen tones and intonation. In *S'gaw Karen: A Compilation Grammar*. UNC Chapel Hill.

Griffith, T. (1991). *Cambodian as an Iambic Language*. Ms., UC Irvine. Presented to the LSA Summer Institute, 1991.

Hayes, B. (1995). *Metrical Stress Theory: Principles and Case Studies*. Chicago: University of Chicago Press.

Hsieh, J. (2012). *The alignment of gesture and intonation in Pwo Karen*. Senior essay: Yale University.

Hyslop, G. (2010). *Stress in a tone language: a case study with Kurtöp*. Presentation.

Jones, R. B. (1961). *Karen linguistic studies: description, comparison, and texts* (Vol. 25). University of California Press.

Jun, S. A. (2005). Korean intonational phonology and prosodic transcription. *Prosodic typology: The phonology of intonation and phrasing*, *1*, 201.

Jun, S. A. (2014). Prosodic typology: By prominence type, word prosody, and macro-rhythm. *Prosodic typology II: The phonology of intonation and phrasing*, 520-540.

Jun, S. A., Fletcher, J. (2014). Methodology of studying intonation: From data collection to data analysis. *Prosodic typology II: The phonology of intonation and phrasing*, 493-519.

Kansakar, T. R. (1977). Rhythm and intonation in colloquial Newari. *Contributions to Nepalese studies*, *1*, 1-14.

Kato, A. (1995). The phonological systems of three Pwo Karen dialects. *Linguistics of the Tibeto-Burman area*, 18(1), 63-103.

Ladd, D. R. (1996/2008). *Intonational phonology*. Cambridge: Cambridge University Press.

Lewis, P., Lewis, E. (1984). *Peoples of the Golden Triangle*. London: Thames and Hudson Ltd.

Lim, J. K. (2014) *Intonational Phonology of Lhasa Tibetan*. Poster. Department of Linguistics University of Ottawa Département de linguistique Université d'Ottawa. *TIE6*.

Manson, K. (2010) *A Bibliography of Karen linguistics*. Payap University & La Trobe University.

Michael, L. D. (2011). The interaction of tone and stress in the prosodic system of Iquito (Zaparoan, Peru). *Amerindia*, 35.

Minkova, D. (2002). Ablaut reduplication in English: the criss-crossing of prosody and verbal art. *English Language and Linguistics*, *6*(01), 133-169.

Ozerov, P. (manuscript). Tone, intonation and phrasing in Burmese.

(https://www.academia.edu/16774194/Tone_intonation_and_phrasing_in_Burmese).

Peng, S. H., Chan, M. K., Tseng, C. Y., Huang, T., Lee, O. J., Beckman, M. E. (2005). Towards a Pan-Mandarin system for prosodic transcription. *Prosodic typology: The phonology of intonation and phrasing*, 230-270.

Phillips, A. (2000). West-Central Thailand Pwo Karen phonology. *33rd ICSTLL Papers*, 99-110.

Pierrehumbert, J. B. (1980). *The phonology and phonetics of English intonation* (Doctoral dissertation, Massachusetts Institute of Technology).

Pierrehumbert, J., Beckman, M. (1988). Japanese tone structure. *Linguistic inquiry monographs*, (15), 1-282.

Rattanaporn, P. (2012). Phonetics of Sgaw Karen in Thailand: An acoustic description.

Remijsen, B. Bert Remijsen's Praat scripts. http://www.ling.ed.ac.uk/~bert/praatscripts.html

Shue, Y. L. (2010). *The voice source in speech production: Data, analysis and models* (Doctoral dissertation, University of California Los Angeles).

Simpson, A., Watkins, J. (2006). Constituent focus in Burmese: A phonetic and perceptual study. *Studies in Burmese Linguistics*, 27-66.

Sun, J. T. S., Thurgood, G., LaPolla, R. J. (2003). *The Sino-Tibetan Languages*.

Sun, X. (2016). Interaction between breathy tones and aspirated consonants in S'gaw Karen. *Tonal Aspects of Languages 2016*, 121-124.

Wannemacher, M. W. (1998). *Aspects of Zaiwa Prosody*. Summer Institute of Linguistics.

Watkins, J. (2000, June). Phonation type phenomena in Burmese Tone. In *Tone Symposium, Universitetet i Tromsø*.

Weidert, A. (1987). *Tibeto-Burman Tonology*. Amsterdam: John Benjamins.

West, L. A. (2015). Pitch Specification of Minor Syllables in Sgaw Karen. Master's thesis University of Toronto, Toronto, Ontario.

Zhao, Y. (2014). Phonetic studies of Sgaw Karen tones. *S'gaw Karen: A Compilation Grammar. UNC Chapel Hill*.