Right-Edge Phonological Phenomena in Kaqchikel

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Abstract

This paper examines a slew of phonological phenomena that occur at the right edge of the prosodic word in Kaqchikel (cak), a Mayan language of Guatemala spoken by about 400,000 people (Heaton & Xoyón, 2016). Based on previous phonological work by Brown, Maxwell, & Little (2006) and Bennett (2018), I first introduce the phonemic inventory (22 consonants, 10 vowels) and prosodic structure of Kaqchikel, with the latter being composed of primarily stress-final, recursive prosodic words, and intonational prominence on the right-edge of the phrase. This is followed by a review of Bennett's (2016b) discussion of the Kaqchikel tense-lax distinction in vowels, which only surfaces in stressed (word-final) syllables. Thus, an underlying lax vowel { ɪ ɛ ə ɔ ʊ } surfaces as its corresponding tense vowel { i e a o u } in any unstressed syllable. I next discuss final aspiration of stops, and then spirantization of final sonorants, unifying them as a process of epenthesis of a [spread glottis] feature at the right edge of the word. Each phenomenon individually shows that the right-edge is a position of particular prominence in Kaqchikel; all together they demonstrate it is one ripe for future (and current) exploration into their acoustic correlates and their higher-level prosodic and morpho-syntactic implications.

Key words: phonology, right-edge, allophony, tense/lax, aspiration, spirantization, spread glottis

Languages: Kaqchikel (cak), English (eng), Spanish (spa)

Territorial Acknowledgement

This research was carried out upon traditional territories of several indigenous groups, upon which I was/am simply a guest. This includes Kaqchikel territory in southern Iximulew (Guatemala) between Armita (Guatemala City) and Lake Atitlán, most research of which took place in the Pan Choy/Pan Q'än valley where Antigua Guatemala now sits within the department of Sacatepéquez. Furthermore, due to the armed conflict (1960s-1990s) there are now thousands of displaced K'ichee' and Ixil Maya within those lands, which often bear Nahuatl-derived names. Additional analysis took place in Treaty 7 region in Southern Alberta, which includes the Blackfoot Confederacy (comprising the Siksika, Piikani, and Kainai First Nations), the Tsuut'ina First Nation, and the Stoney Nakoda (including the Chiniki, Bearspaw, and Wesley First Nations). Mohkinstsis (The City of Calgary) is also home to Métis Nation of Alberta, Region III. [1]

1 Introduction*

In describing the prosody of Kaqchikel, Brown, Maxwell, & Little (2006) noted that "word stress in Kaqchikel is generally on the final syllable of a word," and "in phrases, the primary stress falls on the last word" (p. 138). Additional prominences at the right edge are also discussed in work by Bennett (2016a; 2016b) with allophony in both vowels: "Lax vowels are restricted to the stressed syllable… which is almost always the ultimate syllable of the word" (Bennett, 2016b, p. 3), and consonants: "Plain stops are typically aspirated in word-final position" (Bennett, 2016a, p. 486) with a "parallel pattern of word-final sonorants devoicing" (p. 487).

Kaqchikel, a K'ichee'an language within the Mayan language family, is spoken by ~400,000 people in southern Guatemala, between Lake Atitlán and Guatemala City (Heaton & Xoyón, 2016). This area is shown in Figure 1. Most of these speakers are bilingual, also speaking Spanish (spa), the national language of Guatemala. Many are also able to speak other Mayan languages or English (eng), and the data analyzed in this paper were produced from wordlists and narrations by native speakers of Kaqchikel who were fluent in Spanish and had experience with English.

[1] Super special thanks to the native speakers of Kaqchikel who participated in this study, Aq'ab'al, B'alam, Ixnal, Kawoq, and Yab'un. Significant portions of this paper were developed after discussions with Dr. Darin Flynn, my supervisor, and Dr. Judith M. Maxwell, my former MA adviser. I thank them immensely. I also wish to thank the teachers, students, alumni, and associates of the Oxlajuj Aj Kaqchikel language and culture course. None of this would be possible without the initial and countless following steps I took into this language community with them there. I also appreciate the input from the attendees at NoWPhon 2019.

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Figure 1: Map of Guatemala with Kaqchikel area outlined. CC BY-SA 3.0 (https://commons.wikimedia.org/wiki/File:Idiomasmap_Guatemala.svg)

The body of this paper proceeds as follows: first, in section 2, I present the phonological inventory of Kaqchikel. This is followed by a discussion of the prosody of the language in section 3 with exemplifying spectrograms. Section 4 contains a discussion of the segmental processes that occur at the right edge of the word, and possibly elsewhere, in the language, again with accompanying spectrograms. This leads into a discussion of a previous analysis of Kaqchikel allophony by Nasukawa, et al. (2018), which was done under the framework of Element Theory. The ultimate section concludes by summarizing the findings of this paper.

2 Phonemic Inventory

Standard Kaqchikel has a phonological inventory of 32 phonemes, though, as discussed in this section, many speakers make fewer than this maximal number of distinctions. The consonantal inventory of the language is one typical of the Mayan language family and is presented as Table 1 (after Brown, Maxwell, & Little, 2006; Bennett, 2016a).

Table 1: Kaqchikel Consonantal Inventory

Place / Manner	Bilabial	Alveolar	Palatal	Velar	Uvular	Glottal
Plain Stop	p	t		k	q	ʔ
Glottalized Stop	ɓ̥	t’		k’	ʠ̥	
Plain Affricate		ts	tʃ			
Glottalized Affricate		ts’	tʃ’			
Fricative		s	ʃ	x		
Nasal	m	n				
Lateral Approximant		l				
Approximant		ɾ				
Glide	w		j			

As shown, there are 22 consonantal phonemes spread across six places of articulation. The primary consonantal contrast among consonants is one of glottalization and is exhibited among the stops and affricates of the language. Thus, there are two series of four stop consonants each, and two series of two affricates each. Note that at the peripheral places of articulation (bilabial and uvular) the glottalized stops are realized as voiceless implosives, while all other glottalized consonants are ejectives. The glottal stop does not have any counterpart at its place of articulation. In addition to these 13 stop-like consonants, Kaqchikel has three (3) fricatives /s, ʃ, x/, two (2) nasal consonants /m, n/, and four (4) non-nasal sonorants /l, ɾ, w, j/. These three groupings become phonologically apparent after discussion of phonological processes in section 4.

To complete the segmental inventory, the ten (10) vowels of Kaqchikel are shown in Table 2. These ten vowels are distributed across five (5) general Places of Articulation, based on features of Height and Backness. Each of these Places has two (2) distinctive vowels: one Tense and one Lax. An interesting note about the Lax vowels is that they are reflexes of Proto-K'ichee'an Long vowels and are cognate with modern K'ichee' Long vowels (Campbell, 1977; Bennett, 2016a). Vowel length is therefore not distinctive in modern Kaqchikel, differing from most other Mayan languages.

Table 2: Kaqchikel Vocalic Inventory

	High, Front	**Mid, Front**	**Low, Front**	**Mid, Back**	**High, Back**
Tense	i	e	a	o	u
Lax	ɪ	ɛ	ɜ~ə~ɨ	ɔ	ʊ

Not all speakers exhibit the Lax distinction at every Place, with most speakers having between seven (7) and nine (9) phonemic vowels. The distinction is almost always made at the Low, Front Place of Articulation, and, as such, there is substantial inter- and intra-speaker variation in the phonetic realizations of the Lax counterpart at that Place, ranging from open [ɜ] through the most common realization of schwa [ə] to close [ɨ].

3 Prosody

With this knowledge of the segmental make-up of Kaqchikel, we can now move on to the prosodic suprasegmentals, namely word stress and phrasal intonation. One, and possibly more, of the segmental phenomena discussed in the subsequent section depends entirely upon the prosodic elements discussed here.

3.1 Word stress

As mentioned in the introduction, Brown, Maxwell, & Little (2006) described Kaqchikel as having word stress and that that word stress "is generally on the final syllable of a word" (p. 138). Bennett (2016a), reporting on Mayan languages more broadly, states that "final stress is the norm in K'iche[e']an languages" (p. 495). To verify these claims, this subsection examines words of various syllable lengths (one to four syllables), generally agreeing with the claims, although with a few exceptions.

Figure 2 shows the waveform and spectrogram for a production of monosyllabic *tuj* /tux/ 'sauna'. The single syllable in this noun trivially bears stress, and its vowel shows a rise and fall in intensity over its length.

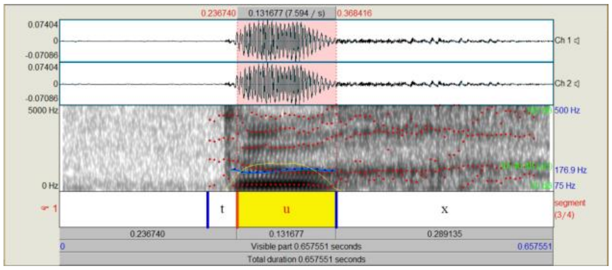

Figure 2: <tuj> /tux/ *produced by Aq'ab'al.*

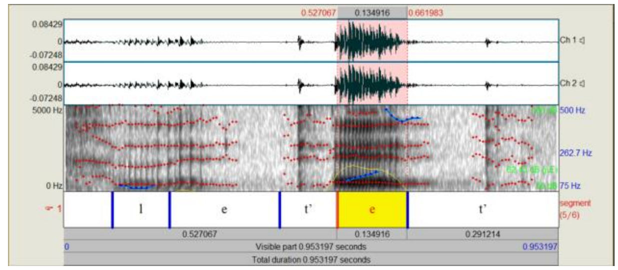

Figure 3: <let'et'> /let'et'/ *produced by Aq'ab'al.*

Moving up to a disyllabic example we have *let'et'* /let'et'/ 'bicycle' in Figure 3. Here we can see the first evidence in support of this final syllable analysis. This disyllabic word displays iambic stress, with stress on the second (i.e. final) syllable. Similar to the previous example, there is a marked rise and fall of intensity throughout the vowel of the final syllable, especially when contrasted with the first syllable's vowel.

Next we have the trisyllabic example in Figure 4, *chikopi'* /tʃikɔpiʔ/ 'animals'. This is an interesting case because the root of this word is *chiköp* 'animal', with //-iʔ// an inflectional (plural) suffix. Nevertheless, the stress appears on the rightmost syllable, that of the suffix. The acoustic realization of this stress is less clear than the previous examples, however. We do have the stressed syllable's vowel bearing a higher intensity, however the prior syllable also shows this. Both syllables are much more intense than the first syllable, which does appear to be more similar acoustically to the first, unstressed syllable observed in Figure 3. What that second syllable does not show, though, is a rise in pitch, which the final, stressed syllable does bear.

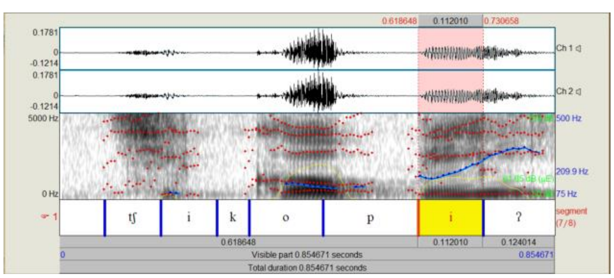

Figure 4: <chikopi'> /tʃikɔpiʔ/ *produced by Aq'ab'al.*

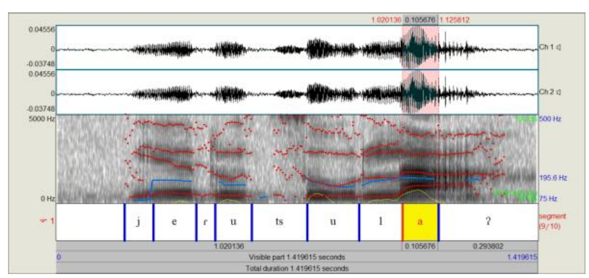

Figure 5: <yerutzula'> /jeɾutsulaʔ/ *by Speaker 1.*

Again, adding another syllable, we move on to the tetrasyllable *yerutzula'* /jerutsulaʔ/ 'he repeatedly looks at them' of Figure 5. This example shows another part of Kaqchikel phonology, with the verb root //tsuʔ// being inflected with the frequentative suffix and also with agreement prefixes. Again, however, the stress falls on the final syllable of the whole word, though the relative intensity measure of its vowel is a greater indicator in this example than the previous one. The pitch in this example, on the other hand, does not seem to be an indicator of stress here, as it remains flat during the nucleus [a] after a slight rise during the Onset [l].

The preceding examples show that Kaqchikel does in fact place main word stress on the final syllable of the word. However, there are a few exceptions to this that must be mentioned. Word-final stress is by far the most common pattern for native vocabulary, yet there are examples of native vocabulary that do not match this pattern. Furthermore, non-native vocabulary is more variable, depending on the source language for its stress placement.

Figure 6 shows an example of native vocabulary, *janila* /xanila/ 'very', and how it does not have word-final stress. Instead, the higher relative intensity as well as the pitch rise are realized on the second (penultimate) syllable. This shows that stress in Kaqchikel is lexical, though the ultimate syllable is preferred. Note also that the standard orthography does not indicate stress in any way.

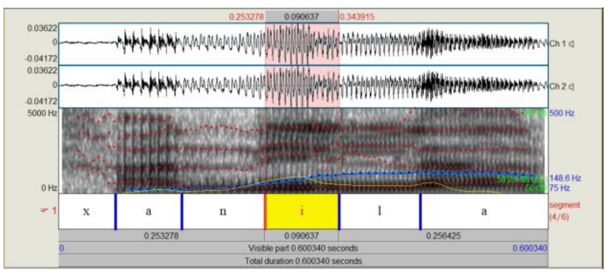

Figure 6: <janila> /xanila/ *produced by Kawoq.*

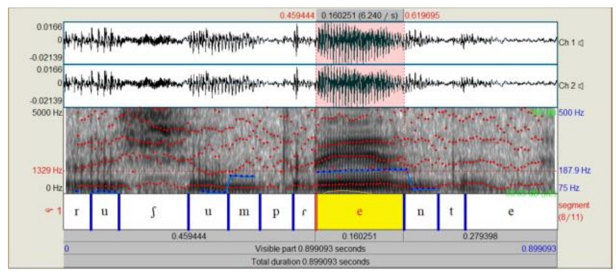

Figure 7: <ruxumprente>/ɾuʃumpɾente/; *Speaker 1.*

The final example in the subsection (Figure 7) shows a loanword (from Spanish), *ruxumprente* /ɾuʃumpɾente/ 'his (little) hat'. The Spanish source is *sombrerete* and bears typical Spanish penultimate stress. However, when adapted to Kaqchikel the antepenultimate and penultimate syllables contract into a single syllable, and that syllable bears stress, with its vowel being relatively more intense and longer.[2]

These examples show that, while Kaqchikel overwhelmingly prefers word-final stress, there is no absolute restriction against other patterns. Instead of stress being inherited from the prosodic hierarchy, it is lexically bound, so that lexical items determine the word-level prosody of the language.

3.2 Intonation

Moving up the prosodic hierarchy from the word to the phrase, this subsection discusses the phrase-level intonation claim of Brown, Maxwell, & Little (2006), that phrase-level prominence is realized on the last word of the phrase. The two examples shown here are drawn from a video-narration task (of the Pear Film (Chafe, 1980)) produced by the same

[2] This syllable also happens to be exceptionally complex for a Kaqchikel word-medial syllable, showing a complex onset and a coda, both of which are rare in Mayan languages which typically have /CVC/ roots with /CV-/ prefixes and /-VC/ suffixes (see Bennett, 2016a).

speaker. These data are very preliminary, and are the initial step in a process of an in-depth documentation and analysis of the intonation of Kaqchikel for the first time (Bennett, 2016a).

The first phrasal example is shown as Figure 8: *y k'a ri xuxïm chi ruqul.* 'and then he tied it to its neck.', a simple declarative with a discourse particle preceding it. At the right edge of this phrase there is a larger fall in pitch across the duration of the final syllable of the final word *ruqul* 'its neck'. Loudness modulates with each word, as expected with word stress, but at no other point other than the over the final syllable of the final word does the pitch change so drastically.

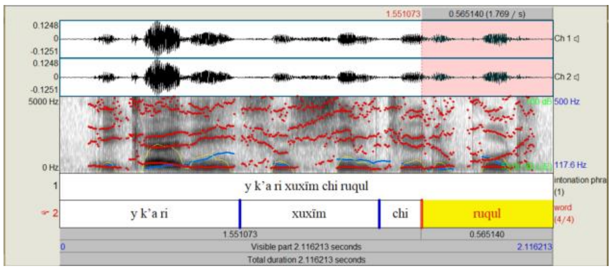

Figure 8: Phrase by Aq'ab'al: '... he tied it to its neck.'

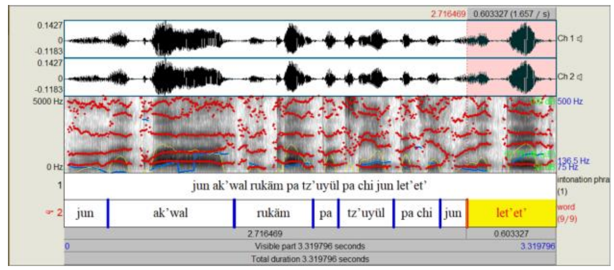

Figure 9: Iambic pentameter spoken by Aq'ab'al.

The next example comes from a more complex sentence featuring an intransitive verb modified by two locative/prepositional phrases: *jun ak'wal rukäm pa tz'uyül pa chi jun let'et'* 'a child is coming seated on a bike'. This is shown in Figure 9. Again the stress-indicating loudness is apparent in each word, but note again that at the right-most word of the utterance *let'et'* (and possibly of the initial intonational phrase *ak'wal*) features a sharp rise in pitch in the Onset of the final syllable followed by a slight fall in its nucleus. These two prominences create a salient boundary tone, which led Brown, Maxwell, & Little (2006) to describe declarative assertions as being marked with a falling tone on their respective final syllable. Brown, Maxwell, & Little (2006) further note that content (wh-) questions also bear a falling boundary tone, while polar (yes/no) questions carry a rising boundary tone. Due to the nature of the tasks, however, no questions appear in the current data set that confirm these claims.

4 Segmental processes at the right edge

Members of both segmental sets of vowels and consonants participate in particular phonological processes at the right edge of the word in Kaqchikel. This section discusses both of those sets. First, we consider the primary vocalic distinction of tense/lax and where it surfaces in stressed syllables. This is followed by a discussion of the consonants, particularly plain stops and sonorants.

4.1 Vowels

As introduced in section 2, the primary phonemic distinction among Kaqchikel vowels is one between a tense series and a lax series. However, this distinction does not surface in all positions of a word. In fact, lax vowels are restricted to stressed (word-final) syllables

(Bennett, 2016b). When affixation displaces an underlying lax vowel from the stressed syllable, it will always surface as its tense counterpart. Thus, the presence of a lax vowel serves as an indirect method to identify word stress, though the presence of a tense vowel does not serve as an indicator of non-stressed syllables, as they too may surface in stressed syllables.

Perhaps because of their limited surface distribution, there exists copious variation in the realization of the lax vowels cross-dialectically as well as within a single speaker. Indeed, not all dialects produce the tense-lax distinction for every vowel pair, with very few speakers having ten phonemic vowels (Patal Majzul, García Matzar, & Espantzay Serech, 2000). Furthermore, speakers of southern dialects of Kaqchikel, which provide the sample data for the current study, tend to have fewer distinctions than speakers of other dialects. Nevertheless, the next three examples strive to show some of those distinctions being produced by a speaker of one of those southern dialects.

In Figure 10 we have *tinamït* 'town; village', which has a high front vowel in both its first and last syllable. However, while the first syllable contains a tense vowel /i/, the final syllable's vowel is lax /ɪ/. As this syllable is stressed, the lax vowel is able to surface. This can be seen through the vowels' formant values. The unstressed tense vowel has midpoint F1 of 358hz and F2 of 2308hz, while those same values for the stressed lax vowel are 490hz and 1868hz, giving -132hz difference between their F1 and 440hz between their F2. Note also the increased length of the stressed lax vowel.

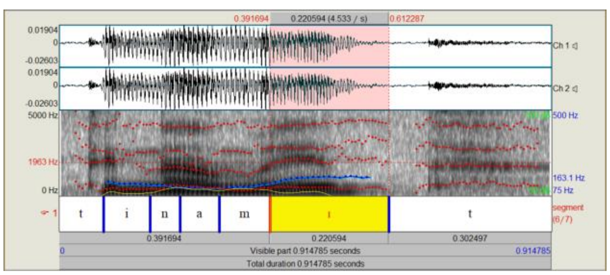

Figure 10: <tinamït> /tinamɪt/ *by Speaker 3.*

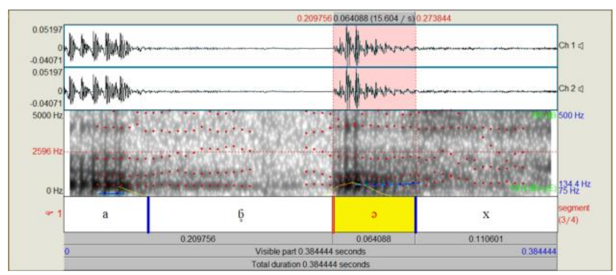

Figure 11: <ab'äj> /aɓ̥əx/ *produced by Speaker 3.*

The next pair of examples come from *ab'äj* 'stone' in Figure 11, which has both members of the low vowel pair /a-ə/. The lengths of these vowels are much more even, as are their formant values. The unstressed tense vowel's F1 is 650hz and its F2 is 1216hz, while the stressed lax vowel's F1 is 640hz and its F2 is 1079hz, for a difference between the vowels' F1 and F2 of 10hz and 137hz respectively, giving a slight distinction on F2.

The last pair of vowels examined in this paper are the mid back vowels /o/ and /ɔ/ in *jotöl* 'in a raised position' of Figure 12. The unstressed tense vowel is actually longer here, but the stressed lax vowel is more intense and has a higher pitch. The F1 values for these two vowels are 488hz and 503hz (-15hz difference), while the F2 values are 1115hz and 1299hz (-184hz difference). Thus, the lax vowels that surface only in stressed positions exhibit a more centralized realization, and that is particularly shown on F2.

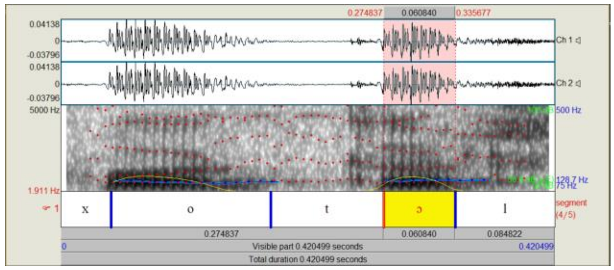

Figure 12: <jotöl> /xotɔl/ produced by Speaker 3.

4.2 Plain stops

The set of plain stops exhibit allophony of a different nature at the right edge. These four stops may each appear in both onset and word-final coda positions. This section shows examples of these consonants in those positions, first in Onset and then in word-final Coda. Note that all of these examples are CVC monosyllabic words, except for one. All syllables with the target stops contain the vowel [i].

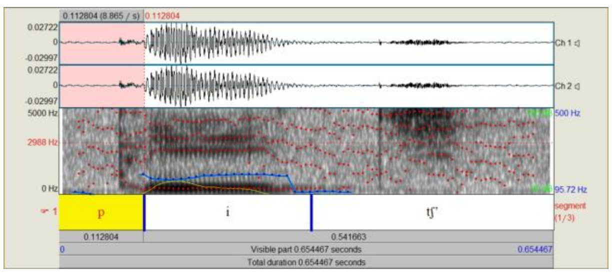

Figure 13: <pich'> /pitʃ'/ produced by Yab'un.

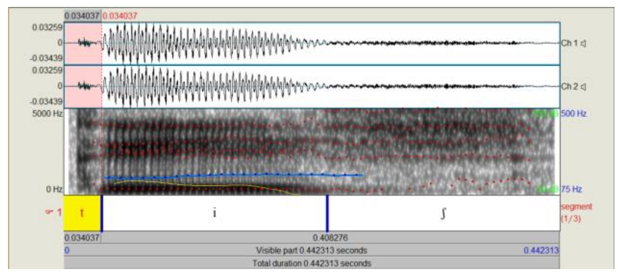

Figure 14: <tix> /tiʃ/ produced by Yab'un.

In Figure 13, *pich'* 'tender corn', we have the Onset example for the bilabial /p/. Following its initial burst, there is brief 32ms VOT, and only light frication during that time. A similar pattern is seen in the alveolar example in Figure 14 *tix* 'tapir', with a VOT of 23ms and similar levels of frication.

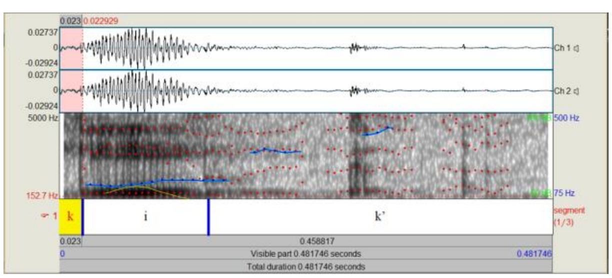

Figure 15: <kik'> /kik'/ produced by Yab'un.

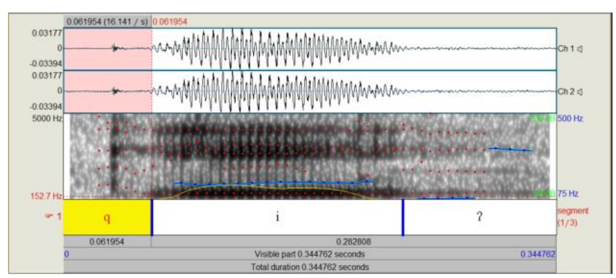

Figure 16: <qi'> */qiʔ/* produced by Yab'un.

The next two Onset examples are shown in Figure 15 *kik'* 'blood' and Figure 16 *qi'* 'ourselves', with the velar and uvular stops respectively. The velar stop has 20ms of VOT and minimal frication, while the uvular stop is produced with 29ms of VOT and little frication after the initial burst. These examples lead to the characterization of these stops in Onset as having short lag voicing and little to no frication during that lag. They are plain, unaspirated voiceless stops.

The next four examples illustrate these same phonemes in word-final coda position. First, in Figure 17, we have the bilabial example *sip* ‘tick’, which is produced here with an extended release allowing for some frication across it. Though much less apparent than the following examples, it is transcribed as being an aspirate here due to its extended release.

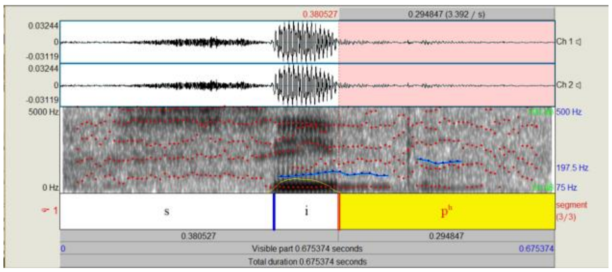

*Figure 17: <sip> /*sip*/ produced by Yab’un.*

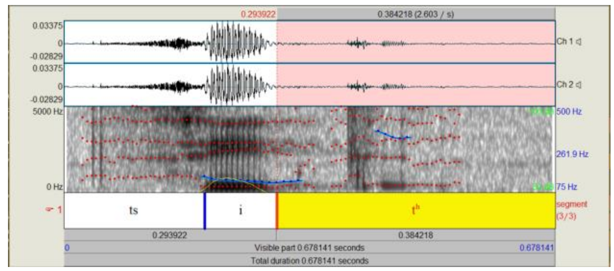

Figure 18: <tzit> /tsit/ produced by Yab’un.

The examples in Figure 18 *tzit* ‘a little bit’ and Figure 19 *jik* ‘straight’ display much more apparent aspiration/frication. The former, alveolar example has both an apparent period of silence prior to release of the stop, and 84ms of frication after the initial burst. The latter, velar example also has the offset after the vowel and 98ms of frication.

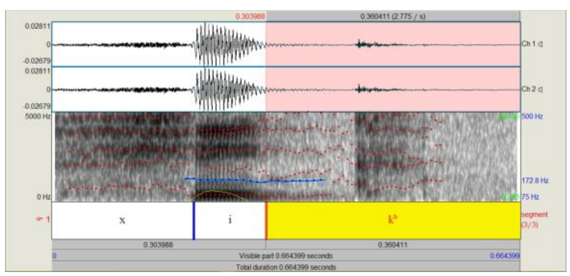

Figure 19: <jik> /xik/ produced by Yab’un.

The final stop example is shown in Figure 20 *nib’iq* ‘it is degrained’. Although disyllabic, the target consonant remains as the Coda of the stressed syllable of the word. Again, we have a period of relative silence, followed by the initial burst and a period (111ms) of frication.

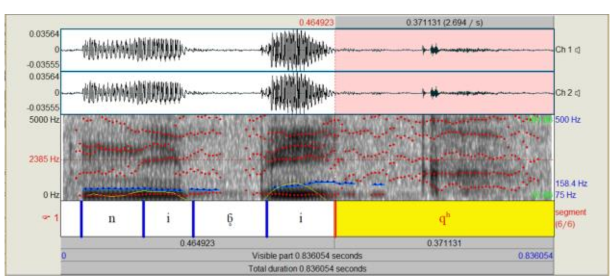

*Figure 20: <nib’iq> /*nɓ̥iq*/ produced by Yab’un.*

These examples show that Kaqchikel plain stops /p t k q/ surface as aspirated stops /pʰ tʰ kʰ qʰ/ in word-final coda position, and that aspiration is characterized by a noisy release burst. Several possibilities exist for phonological processes that cause this allophony. Under the set of classical features of Featural Phonology, however, only the insertion of [continuant] and [spread glottis] are logical possibilities. At this point both are viable here. However further probing of Kaqchikel consonantal allophony changes that.

4.3 Non-nasal sonorants

The final set of Kaqchikel sounds analyzed in this paper are the non-nasal sonorants, of which there are four: two liquids /l ɾ/ and two glides /w j/. As with the previous section, in this section these four phonemes are exemplified in both Onset and Coda, in order to illustrate their positional allophony. We begin with these four in Onset.

The example shown in Figure 21 is *yesolon* ‘they untie’, with the segment of interest being the Onset of the final syllable, [l]. This liquid is produced with modal periodic voicing, with only slightly less intensity than the adjacent vowels. Thus, it is transcribed here as [l], a voiced sonorant.

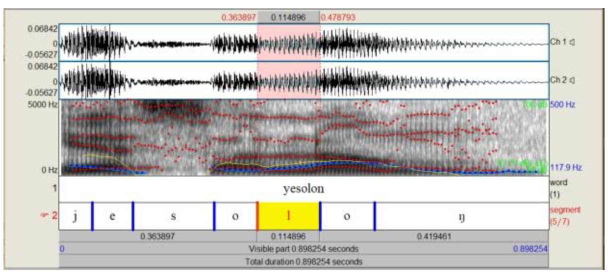

Figure 21: <yesolon> /jesɔlon/ *produced by Kawoq.*

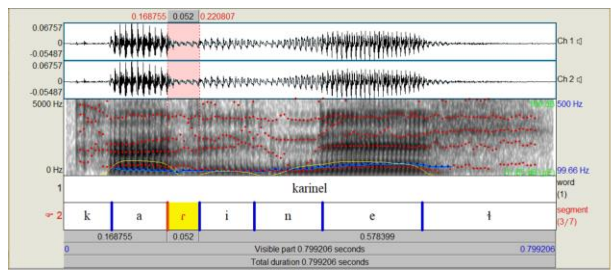

Figure 22: <karinel> /kəɾinel/ *produced by Kawoq.*

Moving on to Figure 22, we have the example for /ɾ/: *karinel* ‘fisher’. Although this particular example removes the target segment from stressed position, we can see that it remains voiced and again, slightly less intense than the adjacent vowels, with no aperiodic frication. All of this leads to the transcription as [ɾ], the voiced sonorant.

Next we have the labiovelar glide /w/, shown by *82etwar* ‘it gets cold’ in Figure 23. Though the formants are distinct from the adjacent vowels, the segment retains semivocalic properties of those formants, modal voicing, and absence of aperiodic noise. In onset position, /w/ goes unchanged and surfaces as [w].

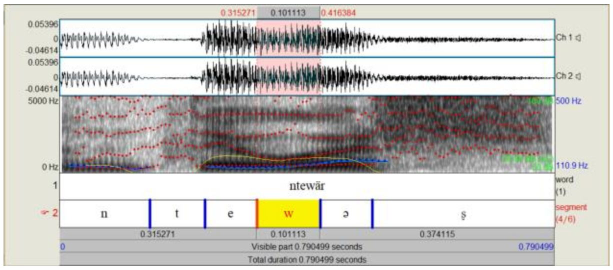

Figure 23: <ntewar> /ntewəɾ/ *produced by Kawoq.*

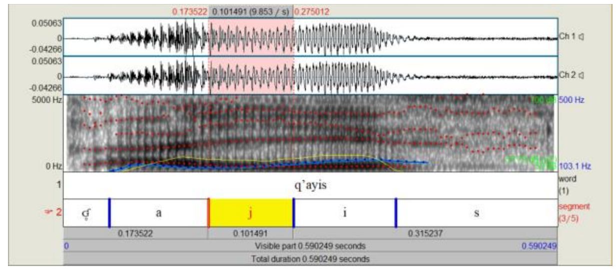

Figure 24: <q'ayis> /ʠəjis/ *produced by Kawoq.*

The final Onset analyzed in this paper is an example of the palatal glide /j/, shown by *q'ayis* 'weeds; trash' in Figure 24. As with the previous example, the semivocalic properties of this sound are apparent, especially its formants and lack of aperiodic noise. The voicing has a somewhat lower frequency than the following [i], and this, combined with the fact that adjacent vowels are disallowed in Kaqchikel leads us to the conclusion that this too surfaces unchanged as a voiced glide [j].

The preceding four examples show that the underlying forms of these sonorants do not change when they surface as Onsets. They display modal voicing and little aperiodic frication. The next four examples, all of which are based on the same roots as the previous four, show that this lack of allophony is again only found in onset position. Word-final coda position causes a particular allophonic pattern; one that will be explained in the following paragraphs.

The first Coda example of these sonorants shown in Figure 25 is *nkisöl* 'they untie it', the active voice form of *yesolon*. The target segment would be difficult to find were it not at the end of the word because its voicing has completely disappeared and instead has been replaced with aperiodic frication. The underlying /l/ surfaces in this word-final Coda as a lateral voiceless fricative [ɬ].

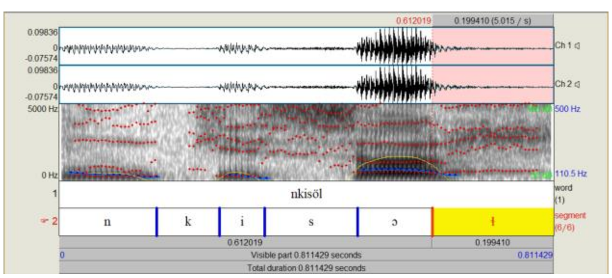

Figure 25: <nkisöl> /nkisɔl/ *produced by Kawoq.*

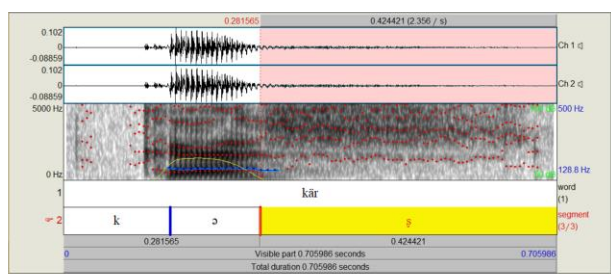

Figure 26: <kär> /kəɾ/ *produced by Kawoq.*

The example in Figure 26 shows the surface form of the underived root of *karinel*, *kär* 'fish', although the /ɾ/ in coda position (along with the preceding Lax vowel) obscure that relation at the surface. The /ɾ/ here is much longer than in *karinel*. It also has lost its voicing and is instead realized with voiceless frication; it surfaces as the retroflex fricative [ʂ].

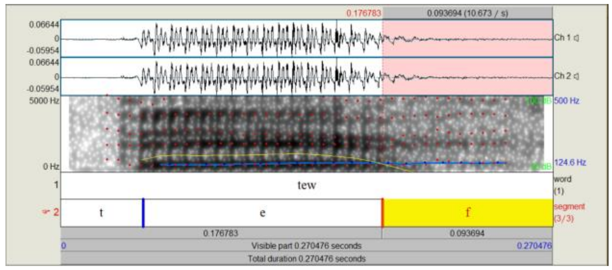

Figure 27: <tew> /tew/ *produced by Kawoq.*

The penultimate example of this paper shows /w/ in word-final Coda: *tew* 'cold' in Figure 27. As with the previous two examples, the segment in question here is not voiced, except perhaps briefly at its onset, is longer than its Onset counterpart, and is full of aperiodic frication. The underlying /w/ surfaces here as a voiceless labial fricative [f] or [ɸ] (the latter observed by Nasukawa et al., 2019).

Finally, we have Figure 28. Here, *nq'äy* 'it rots' reveals the Coda allophone of /j/. Again, there is the complete absence of the low-frequency voicing band, but extreme prevalence of high-frequency, aperiodic noise. This voiceless fricative retains the palatal place of articulation of its underlying sonorant, and surfaces as the palatal fricative [ç].

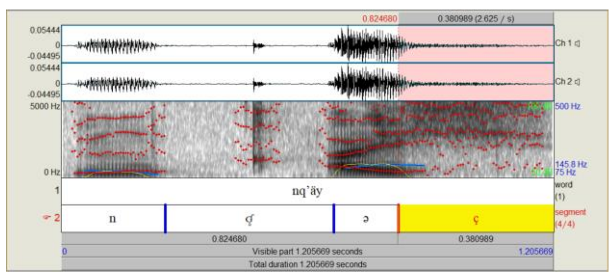

Figure 28: <nq'äy> /nʛ̥əj/ *produced by Kawoq.*

These last eight examples have demonstrated that there is a positionally motivated allophony for sonorants, just as there was for the voiceless stops in their eight examples. While Onsets retain their underlying form of (voiced) sonorants, the Coda allophones are all voiceless fricatives at identical or nearby places of articulation. Brown et al. (2006) describe these allophones as voiceless varieties of those sonorants, however Lombardi (1991) and Clements (1985) and Mester and Ito (1989) before her, argue that these are fundamentally, and featurally, equivalent: they are both underlyingly aspirates.

The positional allophony exhibited by Kaqchikel non-nasal sonorants closely mirrors the stop allophony described in section 4.2, and, following Vaux (1998) there is one phonological feature that unites these two processes of spirantization and aspiration, [spread glottis]. Vaux (1998), in examining data from numerous languages, found that they suggest [+ spread glottis] is present in unmarked voiceless fricatives, in other words there is an inherent connection between voiceless fricatives and [spread glottis], and in systems that do not contrast fricatives laryngeally, these fricatives nonetheless adopt [spread glottis]. Thus adding [spread glottis] to the non-nasal sonorants, in the absence of a [voice] feature, creates the voiceless fricatives observed in Kaqchikel word-final Codas.

Insertion of [spread glottis] also achieves the aspiration exhibited by Kaqchikel plain stops in word-final Coda. Lombardi (1991) among others, have shown that aspirated stops occur due to an [aspiration] feature, however, admits that this, again, is fundamentally equivalent to [spread glottis]. Thus, the same feature that can account for the spirantization of sonorants can account for the aspiration of stops. The right edge of the word, and possibly every syllable, is marked by the insertion of [spread glottis].

5 Nasukawa, et al. (2019): Element Theory

The current paper is not the first examination and unification of these two processes as a single edge-marking process in Kaqchikel. Nasukawa et al. (2019) examine similar data to come to a similar conclusion: there is a single rule of insertion that can account for both sets of allophony. They use this to argue that Kaqchikel has preference for Coda rather than the near-universal preference for Onset.

However, Nasukawa et al (2019) argue for this under the framework of Element Theory. This theory is similar to traditional featural theories of phonology in that every phonological unit can be accounted for with smaller atomic units. However, under Element Theory, there are only six of these atomic Elements: three vocalic in nature and three consonantal in nature (Backley, 2011). The critical element for Nasukawa et al.'s (2019) analysis is the [H] element, which they name 'Edge'.

This Edge element, Nasukawa et al. (2019), claim, is added at the right edge of the prosodic unit of the syllable to mark its prominence. This is realized among the voiceless stops as aspirated stops, and among the four non-nasal sonorants as voiceless fricatives. However, adding [H] to sonorants only produces voiced fricatives, therefore another [H] must be added to achieve the desired outcome of voiceless fricatives. Thus, their unified analysis is not unified: Stops receive one [H] element in Coda, while sonorants receive two.

Furthermore, Nasukawa et al. (2019) do not account for why only these classes of consonants exhibit this kind of positional allophony, only mentioning the other classes of consonants in passing while describing the whole inventory. Indeed, only these two classes of plain stops and non-nasal sonorants. However, under the [spread glottis] view argued for here, their application to the other classes can be argued away in a series of ways. Most simply for the three fricatives /s, ʃ, x/, these are already voiceless fricatives, so inherently have [spread glottis]. Inserting that feature again does not change anything, therefore they do not change. The glottalized consonants of Kaqchikel have [constricted glottis] underlyingly. This feature is antithetical to the newly inserted [spread glottis], so nothing happens.

Nasals, of which there are two phonemes in Kaqchikel, also do not exhibit any analogous allophony.[3] A possible explanation for this may lie in the particular feature geometry (Clements, 1985) underlying these segments that prevents [nasal] and [spread

[3] There is, however, an ongoing process of velarization of nasals in word-final position in some dialects of Kaqchikel not analyzed here:

/m/ > [n] / _#
/n/ > [ŋ] / _#

glottis] from co-existing. Nonetheless, Nasukawa et al. (2019) do not provide any explanation for these consonants' lack of allophony, and it remains unclear how their implementation of Element Theory could account for those cases.

6 Conclusion

This paper has surveyed the various phonetic, phonological, and prosodic phenomena that occur at the right edge of prosodic units in Kaqchikel. First, Kaqchikel stress was shown to be overwhelmingly bound to the right edge of the word, no matter the length of the word. There are, however, few examples of both native and loan words that do not bear this pattern. With these word stresses, phrase level intonational prominences also appear at the right edge of the phrase, with the final syllable bearing a phrasal boundary tone.

Allophonic variation is pervasive at the right edge of the word in Kaqchikel. Vocalically, this is seen in the variation between Tense and Lax vowels. Lax vowels, which are cognate with long vowels elsewhere in the K'ichee'an branch of Mayan, only surface as Lax in stressed, word final position. Outside of these positions, these vowels surface as their Tense counterpart.

Consonantally, there exist two seemingly parallel patterns of allophony among plain stops and non-nasal sonorants when found at the right edge of the word. Plain stops surface as aspirated stops, while the sonorants spirantize to voiceless fricatives. The current proposal argued for here is that this is due to the marking of the right edge of the word via a [spread glottis] feature. All of the examples analyzed here show this to be occurring at the right edge of the word, though it may in fact be the case that this process applies at the right edge of every syllable. Further analysis of data should shed light on the precise locus of this process. Additional statistical analyses of the acoustics and frequency distributions of these processes may also provide critical insight into the phonological possibilities of not only Kaqchikel, but other languages manipulating these and other features.

These findings provide valuable insight to positions of interest in the study of the acquisition of Kaqchikel. Languages differ in the features that underly their segments, but they may also differ in how they manipulate the features they may otherwise share. How these types of differences may impact acquisition is a major question of future research. At the very least, these findings show that the right edge must not be ignored in such studies of acquisition.

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