Acoustic Description of Secwepemctsín Vowels*

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Abstract: Kuipers (1989) argues that in Secwepemctsín (Shuswap) nearly all unstressed vowels will phonetically surface as schwa (/ə/), this includes unstressed /a/, /e/, /i/, /o/, and /u/. Under his analysis, it is posited that the unstressed position automatically reduces the vowel to /ə/. Furthermore, Kuipers makes the claim that reduced vowels and epenthetic /ə/ may be classified as the same sound. This paper provides an acoustic description of the vowels of Secwepemctsín to test theories presented by Kuipers' hypothesis (1989). This acoustic description is based on two Secwepemctsín speakers recorded in 2020–2021. After obtaining voice recordings, vowels were manually transcribed and first (F1) and second (F2) formant frequencies were measured. This study confirms some previous observations relating to the pronunciation of stressed Secwepemctsín vowels, but presents several novel insights, most notably in regard to unstressed vowels and occurrence of /ə/. Based on the analysis presented in this paper, I propose that unstressed /e/ partially reduce to /ə/, while other vowels appear to not be significantly reduced to /ə/ in unstressed position. The findings presented in this paper may potentially lead to classroom applications for learning Secwepemctsín pronunciation.

Keywords: Secwepemctsín, Salish, phonetics, vowels, schwa, pronunciation

1 Introduction

1.1 Secwepemctsín vowels

Secwepemctsín (Shuswap) is from the Northern Interior branch of the Salish family, traditionally spoken in the interior BC region. It is considered critically endangered with less than 50 L1 speakers (FPCC 2018). Several studies have described Secwepemctsín vowels, most notably Kuipers (1974, 1989). Kuipers (1974) characterizes the Secwepemctsín vowel system as consisting of 5 underlying vowels, each with stressed and unstressed variants: /á/, /é/, /í/, /ó/, /ú/, /a/, /e/, /i/, /o/, and /u/. This system forms the basis of the practical orthography presented in Kuipers (1974) where /á/, /é/, /í/, /ó/, and /ú/ are "stressed" and /a/, /e/, /i/, /o/, and /u/ are "unstressed". Kuipers (1989) argues that nearly all unstressed vowels are reduced to schwa (henceforth /ə/). Kuipers claims that the unstressed position automatically reduces the vowel to /ə/. Furthermore, he states that reduced vowels and epenthetic /ə/ are descriptively identical. Under this claim, Kuipers (1989) presents the

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hypothesis that all unstressed vowels (/a/, /e/, /i/, /o/, and /u/), as well as epenthetic /ə/, should each be acoustically similar to one another.

Cross-linguistically, full vowel reduction is considered most likely to occur in unstressed closed syllables in order to reduce the phonological weight of the non-head (Flemming 2009). While Kuipers (1989) argues that Secwepemctsín vowel reduction will surface as /ə/, there are other analyses of vowel reduction in Salish languages which argue that unstressed position will result in partial vowel reduction rather than full vowel reduction (e.g., Blake's 2000 analysis of ʔayʔaǰuθəm/Comox-Sliammon).

1.2 Sonority hierarchy

To discuss environments motivating schwa epenthesis, I will first establish the sonority hierarchy as it relates to syllabic requirements that will determine predictability of schwa epenthesis. First, the term *syllable* refers to a phonological entity in which segments are organized around a single sonority peak (e.g., Sievers 1881:203–206). Sonority is defined as the physical force contained by a syllable, which typically is analyzed as minimized at the margins of syllables and raised to a peak in sonority contained in the nucleus (e.g., Pike 1943; Selkirk 1984). The sonority scale, posited by Clements (1990), describes the sonority distances between types of segments. According to Clements (1990), in order of sonority: vowels are valued highest in sonority (index value of 5), followed by glides (index value of 4), liquids (index value of 3), nasals (index value of 2), and obstruents (index value of 1). While this ordering system is widely accepted, the hierarchical assignment of the following more specific groups of sounds remains controversial due to language-specific sonority effects: (1) /h/ and /ʔ/, (2) voiceless fricatives vs. voiced stops, and (3) affricates (Parker 2002). Clements (1990) generalizes these sounds within the obstruent category, however, different languages will treat these sounds variably relative to sonority requirements. Languages are variable in their tolerance of sonority hierarchy violations. For many languages, schwa epenthesis is a common solution to avoid such violations (Bader 1985).

Salish languages are known to strictly follow the sonority hierarchy. There is a phonological opposition between resonants (including liquids, nasals, glides, /h/ and /ʔ/) and obstruents (stops, affricates, and fricatives), where resonants are closer to the syllabic nucleus than obstruents. Violations of the sonority hierarchy generally lead to schwa epenthesis (Davis 2019).

1.3 Salish /ə/ distribution

Schwa in Salish languages is often described as only appearing in surface representations as a result of some phonetic or phonological process of vowel reduction or insertion. See, in particular, Kinkade (1993, 1998) who proposed that every /ə/ in Salish is absent from underlying representations.

According to Levin (1987), cross-linguistically there are two types of /ə/ that occur due to insertion: excrescent and epenthetic /ə/. Excrescent /ə/ is described as a sound that may optionally be inserted within certain consonant clusters solely for the purpose of easing articulatory or perceptual transitions between sounds and does not carry stress nor affect syllabification (see Bagemihl 1991; Dyck 2004; Leonard 2007; and Rowicka 2002 for work on excrescent schwa in Salish). Crucially, excrescent /ə/ is often highly variable in phonetic quality (Gick & Wilson 2006). In contrast, epenthetic /ə/ is non-optional and is inserted by a phonological rule. Unlike excrescent /ə/, epenthetic /ə/ interacts with the prosodic rules of the language. Thus, it is important to exclude excrescent /ə/ in the current analysis.

To identify epenthetic /ə/, I surveyed previous literature regarding epenthetic /ə/ distribution in Salish languages. Most descriptions analyze epenthetic /ə/ as occurring to prevent illicit consonant clusters and to carry stress when no full vowel is present (Parker 2011). For Salish languages, phonological rules will often insert /ə/ for the purposes of stress assignment or syllabification (see Bianco 1994; Blake 2000; Czaykowska-Higgins & Willett 1997; Matthewson 1994a, 1994b; Shaw 2002). Several other studies on Salish languages also discuss the occurrence of epenthetic /ə/ as a means to prevent illicit consonant clusters, most prominently with onset consonant clusters (Nakamura 2000). Epenthetic /ə/ in Salish languages is described as occurring most often in illicit consonant clusters that are in the first syllable; these consonant clusters often fall in the following sound categories: obstruent-obstruent (OO), resonant-resonant (RR), resonant-obstruent (RO), or obstruent-resonant (OR) clusters (Dyck 2004; Flemming et al. 2008 Leonard 2007; Shaw et al. 1999; Shaw 2002; Shaw 2004; Urbanczyk 2001). For Bella Coola (Nuxalk), Bagemihl (1991) argues for the occurrence of excrescent /ə/ only and no epenthetic /ə/. Epenthetic /ə/ is not needed to break apart consonant clusters because, under Bagemihl's analysis, all unsyllabified consonants in Bella Coola are moraic. For a vowelless word with two obstruents and a fricative (e.g., *t'xt* 'stone'), Bagemihl (1991) argues for two possible analyses which do not require /ə/ insertion: (1) no syllabification, or (2) one syllable per obstruent. Mellesmoen (2021) argues for a third analysis, where the fricative will be nuclear and stops will be parsed as onset and coda. This solution is permitted only when there is not a better option nearby to fill the nucleus. Crucially these analyses provide an analysis alternative to epenthetic /ə/.

Based on this analysis, I present several examples of words with incidence of schwa epenthesis in Secwepemctsín (see Table 1).

Table 1: Schwa epenthesis

Lexical item	IPA transcription	Gloss
qmút	/q**ə**mut/	'hat'
xlécw	/x**ə**læxw/	'tooth'
s7í7llc̦w	/s**ə**ʔiʔɬxʷ/	'some of them'
kwellk̓múse7	/kwełk'**ə**musəʔ/	'cheek'
cméye	/x**ə**mejə/	'house fly'
tmúsmes	/t**ə**musməs/	'four (people)'

1.4 /ə/ variability and acoustic susceptibility

In an investigation on Lekwungen vowel variability it was found that of the vowels, /ə/ was the most persistently affected by its surrounding environment (Nolan 2017). It was determined that uvular and glottal consonants had the most persistent effects on F1, F2, and F3 of all vowels, most notably /ə/ (Nolan 2017). Likewise, an analysis of ʔayʔaǰuθəm (Mellesmoen & Huijsmans 2019) demonstrates that /ə/ had significant overlap with phonemic vowels /a/, /i/, and /u/.

1.5 The current study

There are two goals for the current study: (1) conduct an acoustic analysis of Secwepemctsín vowels, and (2) test Kuipers' (1989) hypothesis regarding vowel reduction of stressed vowels by comparing the acoustic similarity between unstressed vowels and epenthetic /ə/, as well as the acoustic similarity between stressed vowels and unstressed vowels. This project has potential implications for the classroom context. A careful understanding of the relationship between the orthography and sound system may facilitate L2 acquisition of pronunciation (Bassetti 2008).

2 Methods

2.1 Elicitation of word list

I began the study by compiling a list of words for comparison with the following vowels: /a/, /e/, /i/, /o/, /u/, /á/, /é/, /í/, /ó/, /ú/; and /ə/. To properly compare these vowels, words that were elicited were minimal pairs and near-minimal pairs, controlling for phonological environment. An example of a minimal pair featured in this analysis is *pá̱q* (‘get caught’ as in *yiri7 es páq* ‘the one who has been caught’) and *pé̱q* (‘white’); an example of a near minimal pair is *tú̱qweqwiqw* (‘to gallop’) and *stí̱qtem* (adj. ‘cloudy with still clouds’).

True minimal pairs are difficult to find in Secwepemctsín for several reasons. Secwepemctsín is a polysynthetic language, and as such many lexical items are too morphologically complex to find true minimal pairs (Rose & Blackmore 2018:587). Near-minimal pairs as well as reduplicated words where the stressed and unstressed comparisons allow sounds to be compared to one another in the absence of true minimal pairs.

2.2 Speakers

Data consisted of 13 hours of recordings, containing 136 words. Each word has 3 repetitions for a total of n=904 vowel tokens. All speech data were recorded from two speakers; both speakers are female, L1 speakers of the Western dialect of Secwepemctsín, and are bilingual speakers of English. Neither report to have studied any other languages. Here are a few examples of minimal pairs and near-minimal pairs to compare stressed and unstressed vowels. Many words have more than one vowel which we were able to analyze. BD (born in Skeetchestn in 1942) was raised by two monolingual speakers of Secwepemctsín. LJ (born in Skeetchestn in 1960) was raised by bilingual speakers of Secwepemctsín and English. Due to COVID-19 restrictions, all elicitation was remote and conducted via Zoom.

2.3 Annotation and acoustic measurement

Speech data were recorded through Zoom in a .m4a format, then converted to .wav, and then converted from stereo to mono using Audacity (Audacity Team 2021). I then annotated the files at word and grapheme level using Praat (Boersma & Weenink 2021). Epenthetic /ə/ was identified by first predicting the likely environment which would elicit epenthetic /ə/ based on previous work. Previous work identified this environment to be onset consonant clusters and syllables that have no vowel present. After locating these environments, the presence or absence of /ə/ was identified perceptually. Text grid and audio files were then separated into individual files at the word level, cut by word, and then cut at the segmental level using the Extract Vowels tool via Fast Track (Barreda 2021), a Praat plugin. Then, using the Track Folder tool in Fast track, I extracted the following types of acoustic information: mean formant values (F1–F3), pitch, intensity, and duration of each vowel token. Cross-linguistic investigations of vowel inventories often measure vowel categories in terms of first and second formants (F1 and F2, in Hz) (e.g., Becker-Kristal 2010) thus for this preliminary analysis, I used F1 and F2 primarily to measure and compare vowel categories.

2.4 Statistical analysis

Given the small sample size, raw formant values were used, and analysis was separated by speaker. R was used for statistical analysis to take the average measurements for F1 and F2 for each vowel and to measure the differences between vowels. Vowels were measured at the midpoint of first and second formants (F1 and F2, in Hz), then a mean was calculated. A *t*-test was used to measure significance in differences between average F1 and F2 values for vowels.

3 Results

In Figures 1 and 2, vowels are separated by stressed and unstressed forms, divided by speaker. Both figures demonstrate significant overlap in stressed and unstressed forms and /ə/ is well scattered acoustically. Tables 2 and 3 provide F1 and F2 averages for each vowel, divided by speaker.

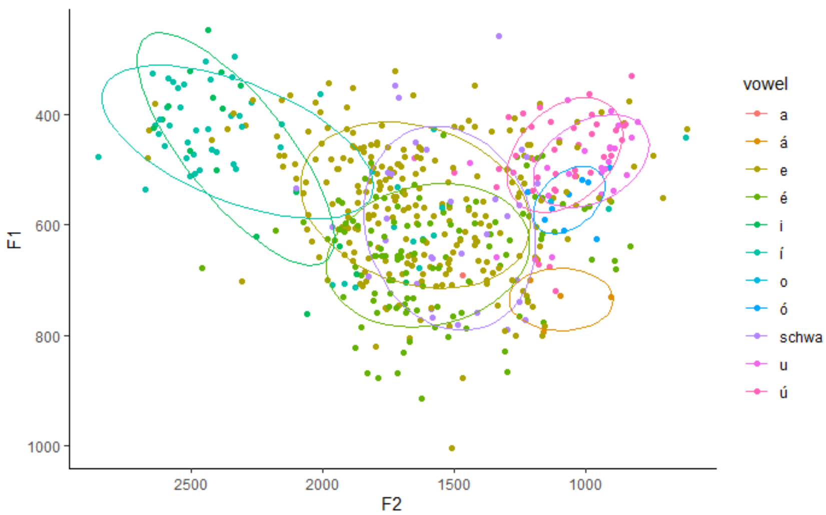

Figure 1: Full vowel system; Speaker = BD

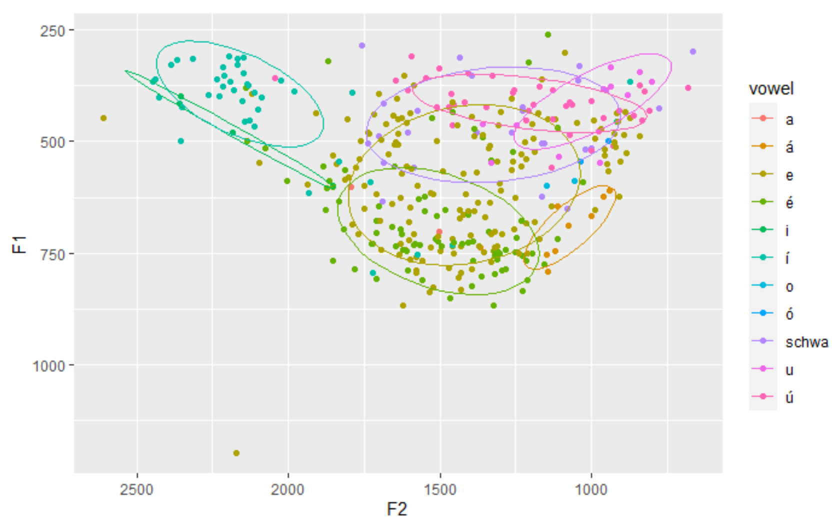

Figure 2: Full vowel system; Speaker = LJ

Table 2: BD; Vowel measurements — mean F1 & F2 (Hz)

Vowel	F1	F2
a	692.0000	1465.000
á	738.2500	1091.000
e	562.6471	1629.000
é	656.2174	1575.365
i	479.0588	2298.588
í	466.4118	2220.020
o	557.0000	1133.000
ó	558.1111	1057.667
u	491.1304	1028.913
ú	482.3684	1090.421
ə	595.1250	1522.125

Table 3: LJ; Vowel measurements — mean F1 & F2 (Hz)

Vowel	F1	F2
a	652.5000	1648.000
á	695.6667	1095.444
e	592.4295	1425.147
é	672.3457	1511.988
i	473.2500	2188.250
í	422.8780	2063.195
o	594.5000	1101.500
ó	522.0000	990.000
u	428.2500	1026.750
ú	415.5000	1209.325
ə	460.7308	1318.308

To obtain a closer look, I have created maps specific to unstressed and stressed counterparts of the vowels along with /ə/. Figures 3 and 4 depict unstressed and stressed variations of /a/. Unfortunately, the count of /a/ tokens in the current analysis is very low and thus, at this time, there is not sufficient data to draw meaningful conclusions for /a/. The sample size is too low to meet requirements to run a *t*-test.

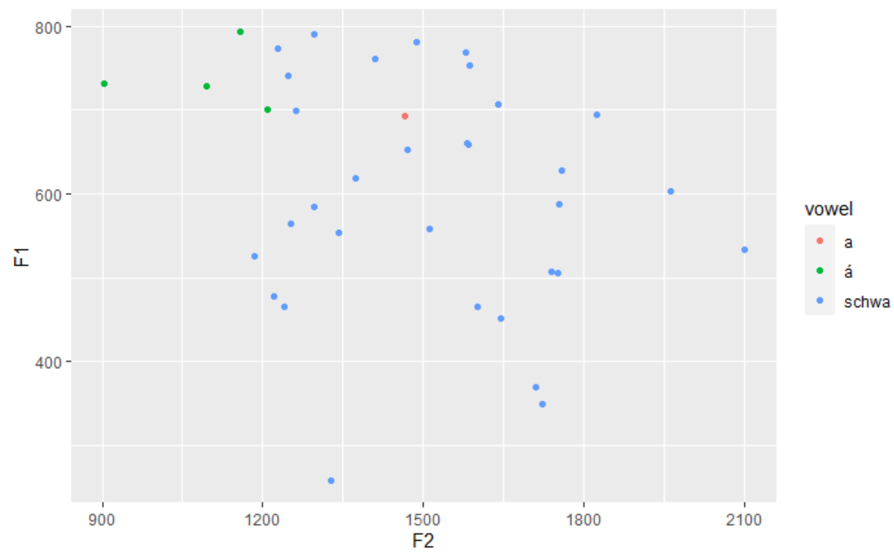

Figure 3: BD; /a/, /á/, /ə/

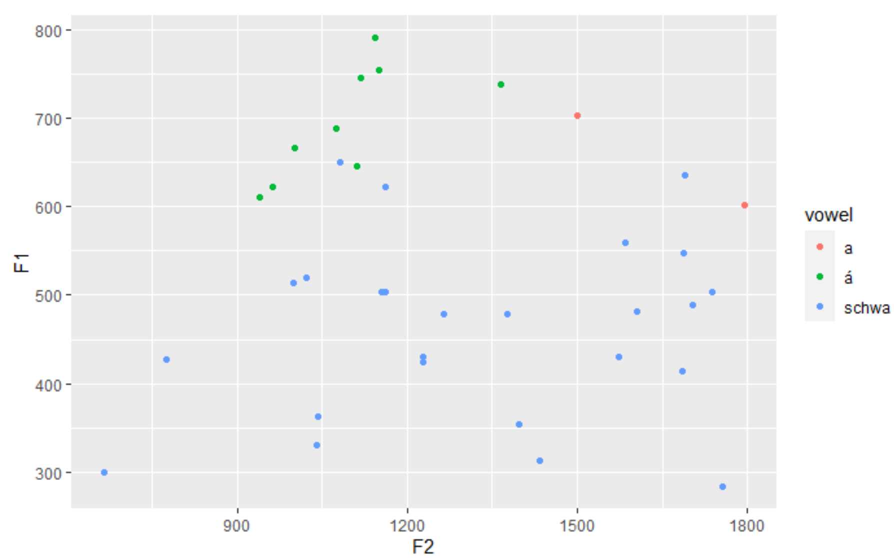

Figure 4: LJ; /a/, /á/, /ə/

Figures 5 and 6 depict unstressed and stressed versions of /e/, along with /ə/. Although there is overlap in all three categories (/ə/, /e/, and /é/), it appears that /é/ has a significantly higher F1 than /e/. Regarding F1, /ə/ does not seem significantly different from /e/, however in terms of F2 /ə/ appears significantly different from /e/, with a rightward bias. A *t*-test was run to confirm whether /e/, /é/, and /ə/ are significantly different. The *t*-test results are shown in Table 4 and 5. For BD, a *t*-test comparing /é/ and /e/, as well as /e/ and /ə/ demonstrates the following outcomes: (1) /é/ and /e/ are significantly different in F1, with /é/ being significantly higher in F1 than /e/; and (2) /e/ and /ə/ are significantly different in F2, with /ə/ being significantly lower in F2 than /e/. For LJ, a *t*-test comparing /é/ and /e/, as well as /e/ and /ə/ demonstrates the following outcome: (1) /é/ and /e/ are significantly different in F1 and F2 values, with /é/ being significantly higher in both F1 and F2 than /e/; (2) /e/ and /ə/ are significantly different in F1, with /ə/ being significantly lower in F1 than /e/. Values that did not reach significance do demonstrate slight differences. Overall, these data do not support the claim that /ə/ and /e/ are acoustically identical, and may instead support the claim that /ə/, /ė/, and /e/ are acoustically distinct.

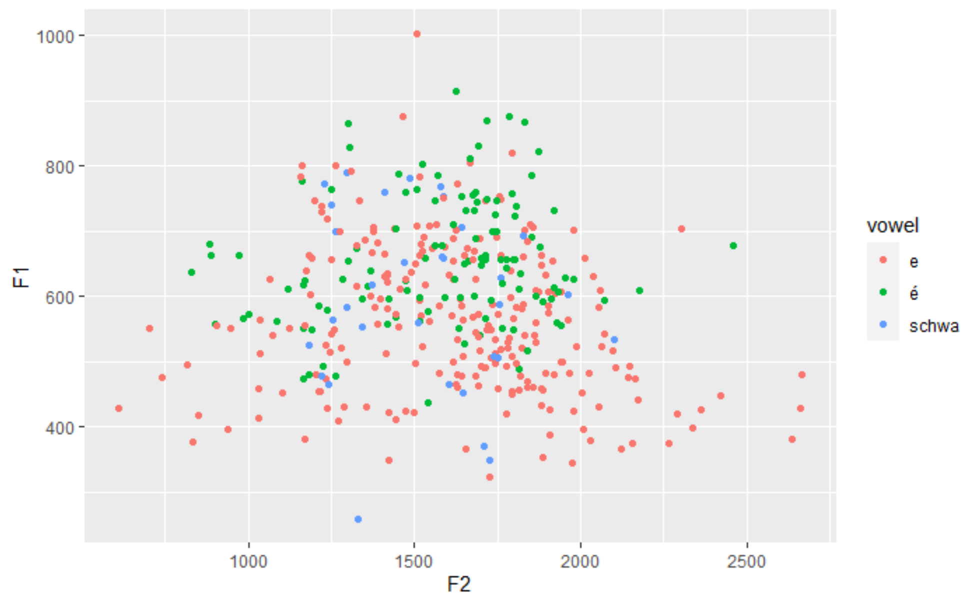

Figure 5: BD; /e/, /ė/, /ə/

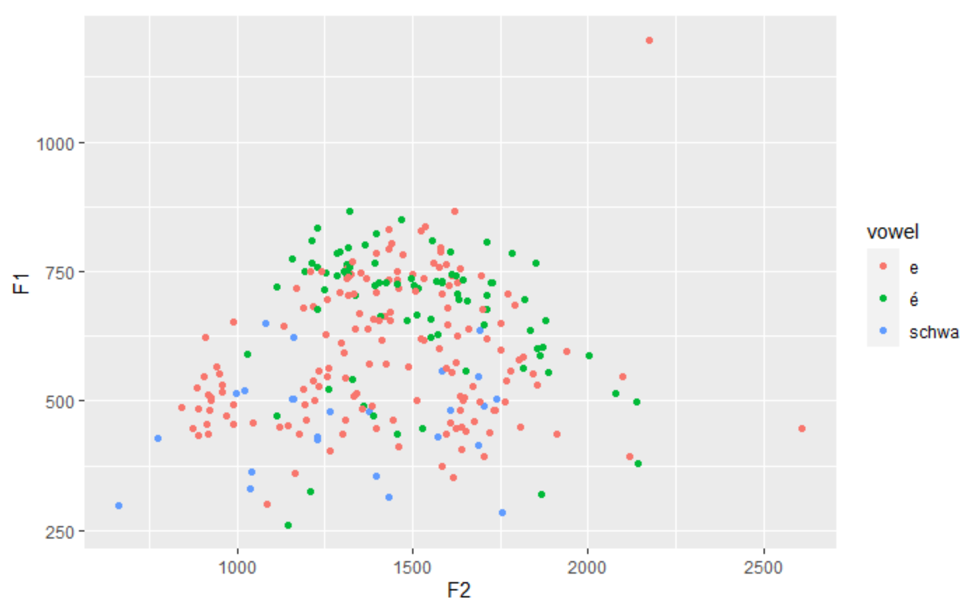

Figure 6: LJ; /e/, /ė/, /ə/

Table 4: Pairwise comparisons of stressed and unstressed counterparts within /e/ and /ə/ for both F1 and F2. Shaded contrast reaches significance at *p*<0.05. Speaker: BD

Contrast	Dim.	df	*t*-ratio	*p*-value	cohensD effect size	Outcome
stressed_e unstressed_e	F1	261.51	7.9763	4.73e-14	0.8558999	/é/ and /e/ are significantly different in F1, with /é/ being significantly higher in F1 than /e/.
	F2	260.11	-1.4958	0.1359		
unstressed_e /ə/	F1	37.153	-1.2898	0.2051		/e/ and /ə/ are significantly different in F2, with /ə/ being significantly lower in F2 than /e/.
	F2	51.017	2.2386	0.02957	0.3160494	

Table 5: Pairwise comparisons of stressed and unstressed counterparts within /e/ and /ə/ for both F1 and F2. Shaded contrast reaches significance at p<0.05. Speaker: LJ

Contrast	Dim.	df	*t*-ratio	*p*-value	cohensD effect size	Outcome
stressed_e unstressed_e	F1	169.65	4.4875	1.325e-05	0.3050838	/é/ and /e/ are significantly different in F1 and F2 values, with /é/ being significantly higher in both F1 and F2 than /e/.
	F2	185.25	2.3386	0.02042	0.3050838	
unstressed_e /ə/	F1	41.892	5.907	5.453e-07	1.011649	/e/ and /ə/ are significantly different in F1, with /ə/ being significantly lower in F1 than /e/.
	F2	33.226	1.6384	0.1108		

Figures 7 and 8 depict unstressed and stressed variations of /i/, along with /ə/. In both speakers' plots, there is no evidence to support the claim that /i/ and /í/ are acoustically distinct. Regarding /i/ and /ə/ for BD, it appears that /ə/ is distinct from /i/. With LJ's plot this is less clear as there are very few /i/ tokens from which we may draw meaningful conclusions. After running a *t*-test, it appears that (i) /i/ and /ə/ are significantly different in F1 and F2 values, with /i/ being significantly lower in F1 and /i/ being significantly higher in F2 than /ə/ and (ii) /i/ and /ə/ are significantly different in F2, with /i/ being significantly higher in F2 than /ə/. See Tables 6 and 7 for specific *t*-

test results. Much like with results from /e/, results from /i/ do not support Kuipers' claim that unstressed /i/ will surface as acoustically identical to /ə/. In fact, in the case of /i/ there is more data to support the claim that unstressed /i/ and stressed /i/ are acoustically the same, while /i/ and /ə/ are distinct.

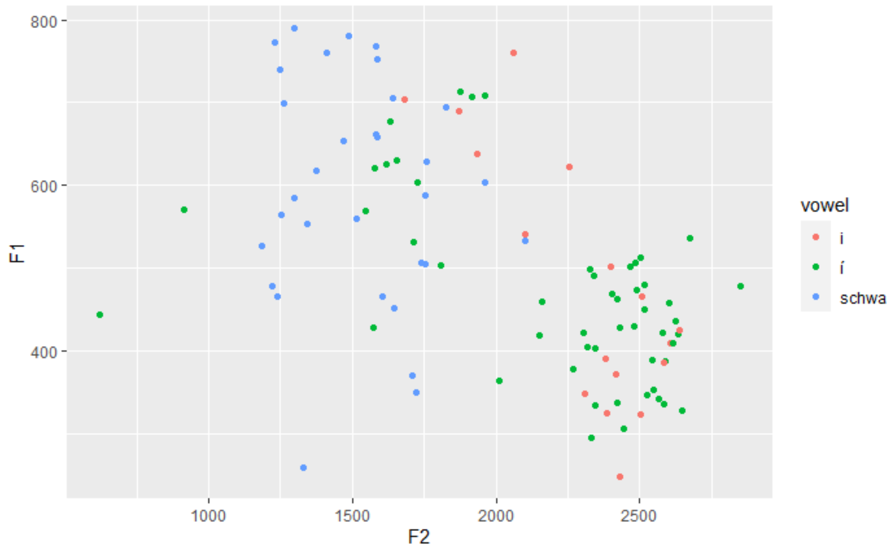

Figure 7: BD; /i/, /í/, /ə/

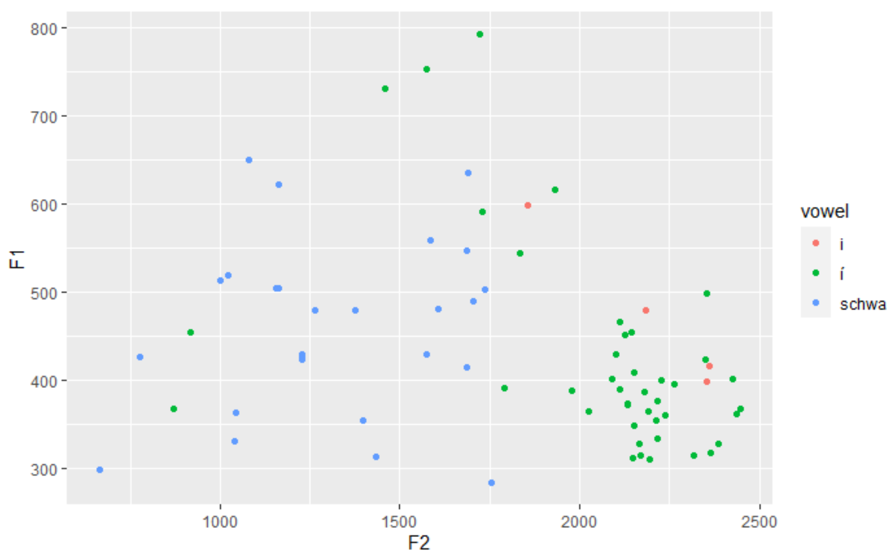

Figure 8: LJ; /i/, /í/, /ə/

Table 6: Pairwise comparisons of stressed and unstressed counterparts within /i/ and /ə/ for both F1 and F2. Shaded contrast reaches significance at *p*<0.05. Speaker: BD

Contrast	Dim.	df	*t*-ratio	*p*-value	cohensD effect size	Outcome
stressed_i unstressed_i	F1	21.475	-0.31399	0.7566		
	F2	46.561	-0.84213	0.404		
unstressed_i /ə/	F1	29.424	-2.6129	0.014	0.8148809	/i/ and /ə/ are significantly different in F1 and F2 values, with /i/ being significantly lower in F1 and /i/ being significantly higher in F2 than /ə/
	F2	28.691	9.7922	1.185e-10	3.08234	

Table 7: Pairwise comparisons of stressed and unstressed counterparts within /i/ and /ə/ for both F1 and F2. Shaded contrast reaches significance at *p*<0.05. Speaker: LJ

Contrast	Dim.	df	*t*-ratio	*p*-value	cohensD effect size	Outcome
stressed_i unstressed_i	F1	4.0738	-1.0259	0.3619		
	F2	4.3773	-0.95784	0.388		
unstressed_i /ə/	F1	4.1917	0.25304	0.8122		/i/ and /ə/ are significantly different in F2, with /i/ being significantly higher in F2 than /ə/
	F2	4.734	6.5261	0.001552	2.875949	

As with /a/, /o/ does not have enough unstressed /o/ tokens to draw meaningful conclusions. Figures 9 and 10 depict the variation between /o/, /ó/ and /ə/ for both speakers, however, no *t*-test was run as the number of unstressed /o/ tokens does not meet the requirements to run a *t*-test.

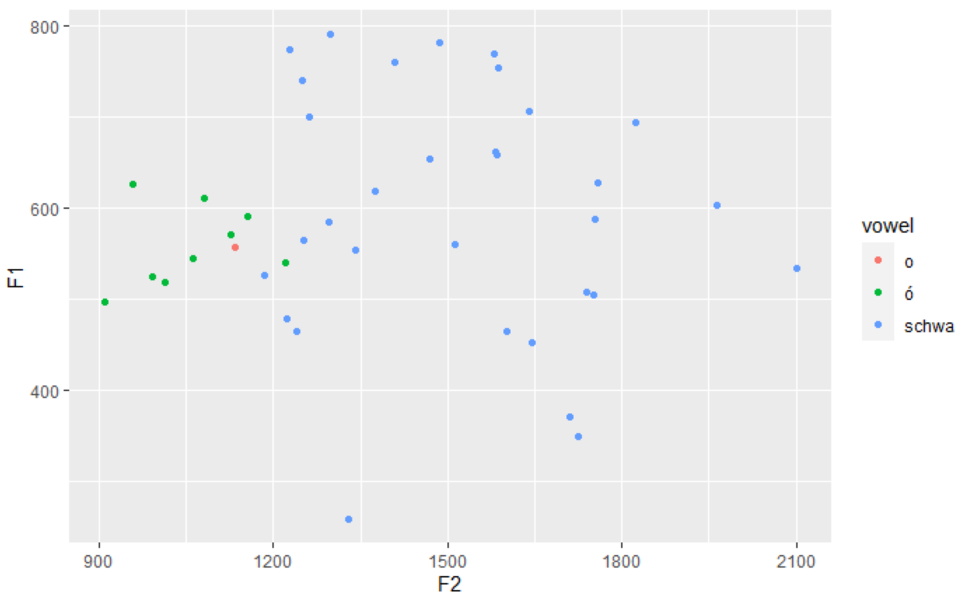

Figure 9: BD; /o/, /ó/, /ə/

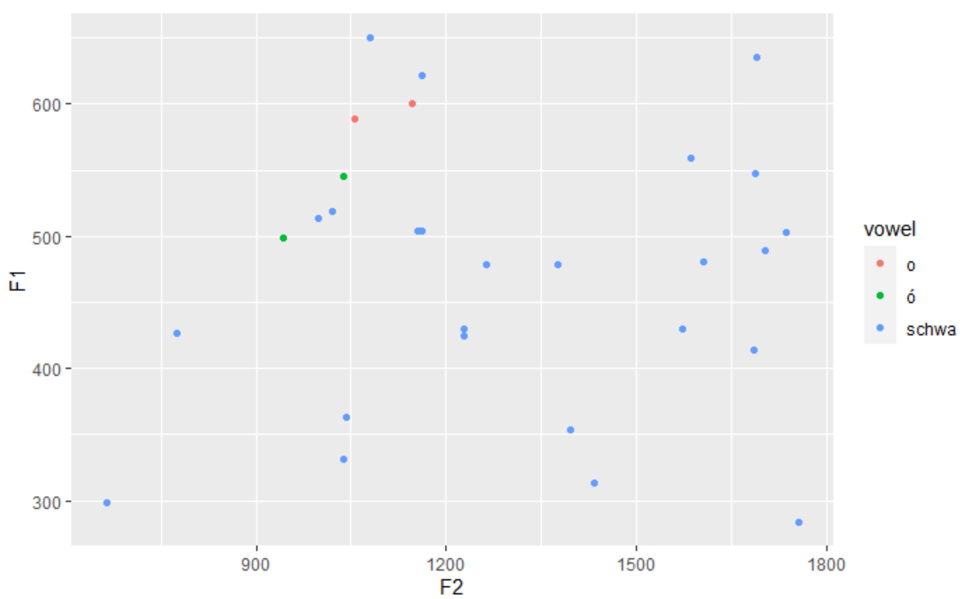

Figure 10: LJ; /o/, /ó/, /ə/

Lastly, for /u/, /ú/, and /ə/, it appears that with BD, /u/ and /ə/ are significantly different, whereas /u/ and /ú/ are not considered significantly different. A *t*-test provides support for the claim that /ú/ and /u/ are not significantly different while /u/ and /ə/ are significantly distinct. This relationship is less clear with LJ, where pairwise comparisons between /ú/ and /u/, and /u/ and /ə/ are both significantly distinct only along the F2 axis but not in terms of F1. Figures of acoustic plots for speakers BD and LJ appear in Figures 11 and 12, respectively. *T*-test results are provided in Tables 7 and 8, respectively.

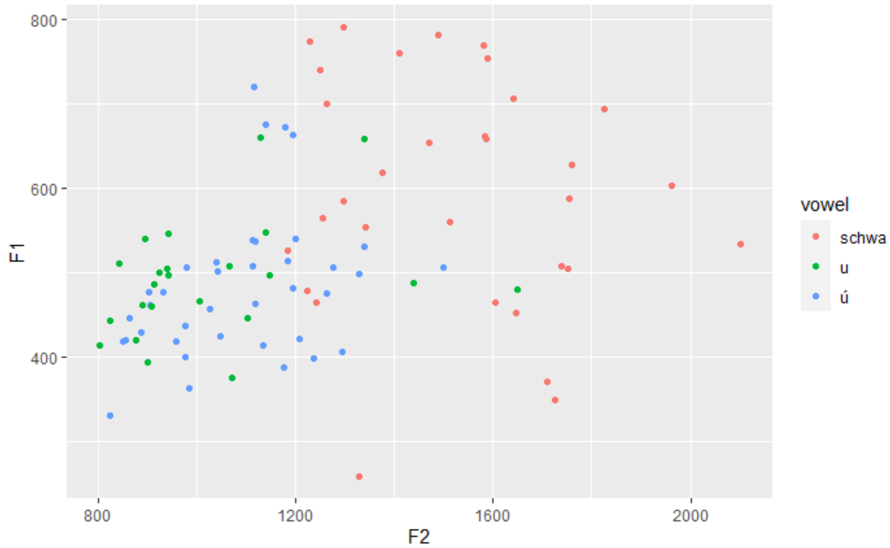

Figure 11: BD; /u/, /ú/, /ə/

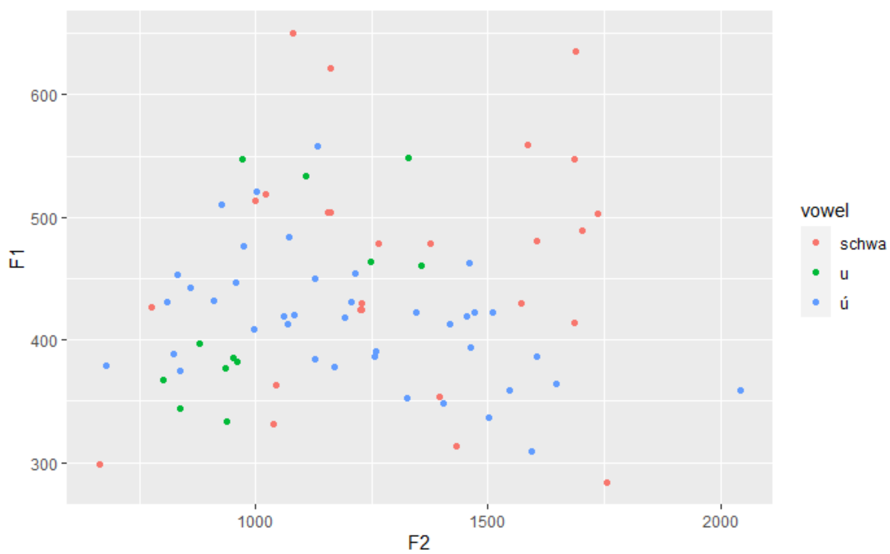

Figure 12: LJ; /u/, /ú/, /ə/

Table 8: Pairwise comparisons of stressed and unstressed counterparts within /u/ and /ə/ for both F1 and F2. Shaded contrast reaches significance at *p*<0.05. Speaker: BD

Contrast	Dim.	df	*t*-ratio	*p*-value	cohensD effect size	Outcome
stressed_u unstressed_u	F1	54.137	-0.435	0.6653		
	F2	37.482	1.2122	0.233		
unstressed_u /ə/	F1	48.571	-3.7024	0.0005455	0.9177484	/u/ and /ə/ are significantly different in F1 and F2 values, with /u/ being significantly lower in F1 and /u/ being significantly lower in F2 than /ə/
	F2	50.761	-8.1409	9.05e-11	2.178726	

Table 9: Pairwise comparisons of stressed and unstressed counterparts within /u/ and /ə/ for both F1 and F2. Shaded contrast reaches significance at *p*<0.05. Speaker: LJ

Contrast	Dim.	df	*t*-ratio	*p*-value	cohensD effect size	Outcome
stressed_u unstressed_u	F1	13.833	-0.52411	0.6085		/ú/ and /u/ are significantly different in regards to F2 where /ú/ is significantly higher than /u/.
	F2	28.254	2.5556	0.01626	0.670271	
unstressed_u /ə/	F1	26.564	-1.078	0.2907		/u/ and /ə/ are significantly different in F2 where /u/ is significantly lower in F2 than /ə/.
	F2	32.892	-3.5729	0.001114	1.048063	

4 Additional findings: A syllabic consonant can take the place of /ə/

The inserted /ə/ is expected to occur when there are no full vowels present to break apart consonant clusters. However, the data reveal this is not always the case and is optional, dependent on the speaker.

Rather than a /ə/, a syllabic consonant is produced in several instances. For example, the word *m7éll* ('to feel better') is predicted to insert a /ə/ due to the onset complex consonant cluster, however, /ə/ was only inserted 50% of the time. The other 50% of the time, the word was pronounced with a syllabic /m/. Syllabic consonant occurred in three onset environments in this dataset: (1) #mʔ, (2) #n_ʔ, and (3) #l_ʔ. This alternative pronunciation occurred only by speaker LJ, and never by BD. Speaker BD inserted a /ə/ in such environments 100% of the time, while LJ produced a syllabic consonant 100% of the time. Table 9 describes four examples of this pattern.

Table 10: A syllabic consonant can take the place of /ə/

Word	/ə/ insertion	BD count of /ə/ insertion	LJ count of /ə/ insertion	Syllabic consonant	BD count of syllabic consonant	LJ count of syllabic consonant
m7éll	**Mə7**éll	3/3 tokens	0/3 tokens	**M̩7**éll	0/3 tokens	3/3 tokens
m7íxw	**Mə7**íxw	3/3 tokens	0/3 tokens	**M̩7**íxw	0/3 tokens	3/3 tokens
n7éq	**Nə7**éq	3/3 tokens	0/3 tokens	**N̩7**éq	0/3 tokens	3/3 tokens
l7éṗ	**Lə7**éṗ	3/3 tokens	0/3 tokens	**L̩7**éṗ	0/3 tokens	3/3 tokens

5 Discussion

Referring back to Kuipers' (1989) claim regarding vowel reduction in unstressed positions, acoustic results provide a more complex picture. For /e/, results demonstrate that /é/ and /e/ are significantly different in F1 and F2 values, with /é/ being significantly higher in both F1 and F2 than /e/. This offers support for the claim for partial vowel reduction. However, these data do not support the claim that stressed vowels fully reduce to /ə/. I base this claim on statistical evidence which demonstrates that /e/ and /ə/ are acoustically distinct, whereby /ə/ is lower in F1 and F2 than /e/. For /i/, results indicate no significant difference between /i/ and /í/. Instead, /ə/ and /i/ are significantly different from one another. It is unclear if there is support for the claim of partial vowel reduction due to variable proximity between /i/ and /ə/. For /u/, productions of /u/ and /ə/ are significantly different in F1 and F2 values, whereas unstressed and stressed counterparts of u are not significantly different from one another. It is also unclear if there is support for the claim of partial vowel reduction due to variable proximity between /u/ and /ə/. Based on this preliminary analysis, I propose that only unstressed /e/ will partially reduce toward /ə/, whereas unstressed /i/ and /u/ do not exhibit signs of vowel reduction toward /ə/. This analysis does not support the claim of full vowel reduction to /ə/ for any vowels.

Further evidence is required to make strong conclusions regarding partial vowel reduction, particularly in vowels /a/ and /o/, but also in /i/ and /u/ because these counts are relatively low in number compared to the sample population of /e/. Future steps to improve this analysis also lies in a more thorough investigation of Secwepemctsín phonology, primarily for the purposes of identifying epenthetic /ə/. Finding some alternation between whether an illicit consonant cluster is resolved either via epenthetic /ə/ or syllabic consonant may suggest that the inserted /ə/ is phonologically optional and perhaps phonetically variable. In reevaluating which consonant clusters are illicit and thus require epenthetic /ə/ in Secwepemctsín, this may lead to more accurate identification of epenthetic /ə/ and thus a more precise acoustic description of /ə/ for which other vowels can be compared.

Furthermore, evidence in ʔayʔaǰuθəm indicate that /ə/ had greatest susceptibility to conditioning effects as a result of its phonological environment (Mellesmoen & Huijsmans 2019). Narrowing the analysis to include only specific phonological environments will provide further insight as to understand the acoustic variability of /ə/ in Secwepemctsín. Focusing on phonological environment rather than on minimal pairs is reiterated in Mellesmoen and Cardoso (2021).

Investigating the role that vowel stress may have on vowel reduction links directly to better understanding the pronunciation of vowels in Secwepemctsín (i.e., whether stressed vowels compared to unstressed vowels are only different prosodically or whether full or partial vowel reduction occurs and therefore acoustically distinguishes stressed and unstressed vowels).

6 Conclusion

This paper set out to present an acoustic description of the vowel system of Secwepemctsín. Mean formant values separated per speaker are summarized in this paper. This paper also was interested in testing Kuipers' (1989) claim of vowel reduction in unstressed position. This analysis suggests that only stressed /e/ will reduce partially when unstressed, whereas for other vowels, including /i/ and /u/, stressed and unstressed forms appear statistically indistinguishable. This acoustic analysis overall does not find evidence to support the claim that vowel reduction to /ə/ occurs in unstressed position in Secwepemctsín.

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Appendix

Table A1: Full word list

Lexical item	Gloss
7newí7	2SG
ápels	‘apple’
ckelltsínten	‘key’
ck̓em̓ímen	‘jail’
ckemtsenéllcw	‘door’
ck̓lúcw	‘terminally ill’
ck̓úl̓ten	‘culture, heritage’
ck̓úlusem	‘building a road/bridge’
ckúpcen̓	‘socks’
ckupwíl̓epten	‘sled’
ckwtústen	‘eye’
cmegmgétkwe	‘warm water’
cmegmín	‘kettle’
cméye	‘housefly’
cpespesíselt	‘kittens’
ct̓eqw7mín̓tn	‘sewing machine’
ctsemts̓m̓éqs	‘sharp’
cú7tsem	‘again, repeat’
cwecuwéll	‘small road’
cwecwéll	‘road’
cwetcwét̓t	‘clean’
estsék̓	‘squirrel’
geyú7	‘carrot’
gwesgwést	‘sunny’
gyepuwíken	‘I am angry’
íxw	‘sweeping movement’
íxwle7p	‘broom’
kélc	‘hand’
kelúcwkelcw	‘to gallop’
képkept	‘painful’
ketkét̓t	‘dirty’
kóso	‘pig’
kwellk̓múse7	‘cheek’
kw̓elltiyénecum	‘year’
l7ép̓	‘bent down’
le7 xéyem te sítqt	‘happy new year’
legém	‘to drag’
legmín	‘to drag something’
legmíns	‘to haul’
lesél	‘salt’
llekllekwékw	‘to gallop’
m7éll	‘to feel better’
m7éy	‘coming close by’
m7íxw	‘melted’
mé7e	‘yes’
mekwmékw	‘dull’
memélt	‘brown (non-living things)’
menmén	‘shadow’
mesékst te snewt	‘four winds’
m-kítscwes ntsítstcw	‘she has arrived’
m-pegwpégwtsnemes	‘she knocked’
múyem	‘to bend’
n7éq	‘rotten’
necíkwem	‘to stir, for liquids’
nehé7en	‘where’
nen sténes	‘here’

Lexical item	Gloss
net.sellpéte	‘peanut butter’
newí7s	3SG
nkékelc	‘my hand’
ntsétswe7	1 SG
núnxwenxw	‘girl’
pálpelt	‘stubborn’
páq	‘to get caught’
penhé7en	‘when’
pep̓e7súsle7cw	‘earthworm’
pepép̓xe7t	‘thin’
péq	‘white’
peqpéq	‘flour’
petetét	‘to boil, for liquids’
qeq̓iméke7	‘pencil’
qéwten	‘hair’
qmúmet	‘little hat’
qmús	‘sucker (fish)’
qmút	‘hat’
qú7	‘belly button’
qw7ép	‘sack’
qwequ̓́7ll	‘bone’
qweqwéq̓wme7t	‘short, as in a person’
qwetqwétn	‘soft’
qwetspétsets	‘start’
ri7élye	‘this’
s7í7llcw	‘some of them’
scwicwéye	‘ant’
secwepemctsín	‘secwepemctsín’
sér	‘dragon fly’
sesísle7	‘a few’
sespéy	‘skin’
sets.séts.s	‘a whispering person’
séts̓em	‘to whisper’
sítsem	‘blanket’
speqpéq	‘berries’
splútsen	‘mouth’
spséqs	‘nose’
sqéxe	‘dog’

Lexical item	Gloss
sqwéxt	‘foot’
stémi7	‘what’
stíqtem	‘cloudy; with still clouds’
stukstúks	‘quiet’
swéti7	‘who’
tá7k pell	‘no!’
tektémtemt	‘cloudy’
t̓éne	‘ear’
tenép	‘turnip’
stíqtem	‘cloudy; with still clouds’
stukstúks	‘quiet’
swéti7	‘who’
tá7k pell	‘no!’
tektémtemt	‘cloudy’
teqtséqw	‘red-brown, for animals’
texwtúxwt	‘straight’
tíg̓wke	‘bell’
tmícw	‘weather’
tmum̓t	‘to sit at the table’
tmúsmes	‘four (people)’
tmút	‘to sit or perch’
ts7ól	‘has stretched’
tscwinúcwkn	‘good morning’
tséltsel	‘cricket’
tśkénem	‘how’
tskwlóts	‘crooked’
tsólens	‘she stretched it’
túqweqwiqw	‘to gallop’
welánk	‘belly’
wellenwí7emp	2PL
wellenwí7kt	1PL
wellenwi7s	3PL
witsín	‘loud’
wítśke7	‘wedge’
wupupépel̓cken	‘caterpillar’
xe7tsép	‘vegetables’
xexé7	‘smart’
xexetsín	‘loud (voice)’