An Acoustic Analysis of Aspiration in Nłeʔkepmxcín*

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Abstract: Aspiration is a well-documented feature of sound systems cross-linguistically but is under-researched in Salish languages. Unlike many Salish languages, a system of aspiration for Nłeʔkepmxcín was proposed where stops were unaspirated, somewhat aspirated, regularly aspirated, and strongly aspirated in four different environments. However, acoustic evidence for the proposed system was needed to confirm the four-category distinction. I present an acoustic analysis of aspiration for voiceless stops in these four environments from one speaker of the Lytton/Canyon dialect of Nłeʔkepmxcín. My results highlight the need for an updated categorization system to account for the effect of word position rather than surrounding sounds as the main predictor of aspiration.

Keywords: Nłeʔkepmxcín (a.k.a. Thompson River Salish), phonology, aspiration, VOT

1 Introduction

Aspiration is a common feature of phonological systems cross-linguistically. It is a characteristic orthogonal to voicing and is typically measured as voice onset (VOT; Lisker & Abramson 1964). VOT is a measure used to categorize the voicing of stops by determining the time in milliseconds from the release burst of a stop consonant to the onset of the following vowel (as indicated by the first positive or negative movement of periodicity). Using VOT, stops are broken down into four main categories: plain voiced, voiced aspirated, voiceless unaspirated, and voiceless aspirated.[1] The four main categories of stops have been used to identify three groupings of language according to the number of stop categories per language: one-category languages like Blackfoot, two-category languages like North American English and Cantonese; three-category languages like Korean and Thai; and four-category languages like Hindi and Marathi (Lisker & Abramson 1964; Genee & Li 2023).

Evidence from various studies has shown that VOT values are similar cross-linguistically, but that there is still variation across languages. For example, in a study of 19 languages, voiceless unaspirated stops, associated with short lag VOT, have a range from 1.4 to 21ms (Cho et al. 2019). In the same study, voiceless aspirated stops, associated with long lag VOT, range from 57 to 97ms

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[1] There are additional categories of stops that can be distinguished on the basis of glottalization. These are relevant to Salish languages but will not be discussed in this analysis.

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(Cho et al. 2019). Interestingly, the overall distribution of VOT does not correspond to how many voicing-based phonological distinctions a language has. Across two, three, and four category languages, short lag VOT remains in a similar range compared to long lag VOT.

Aspiration is a topic that has been under researched in the study of Salish languages. Many language grammars offer only brief statements about aspiration, typically indicating only its presence or absence, with little or no data offered as evidence. For example, in SENĆOŦEN (Saanich), "obstruents are only rarely and weakly aspirated" (Montler 1986:8) and in St̓át̓imcets (Lillooet), "plain (non-glottalized) plosives are sometimes slightly aspirated" (van Eijk 1997:10). In the Southern Interior language of Séliš (Montana Salish), there have been at least two descriptions of the VOT of voiceless stops. In 1999, one project investigated variation and universals of VOT in 18 languages of the UCLA endangered languages project, including Séliš (Cho & Ladefoged 1999). Approximately ten years later, a small phonetic sketch of the full sound system of Séliš also outlined VOT values for the series of voiceless stops (Flemming et al. 2008). These values are provided in **Table 1** and are consistent across the two publications.

Table 1: Average VOT in ms for voiceless stops in Séliš from Cho and Ladefoged (1999) and Flemming et al. (2008). Standard deviations when available are provided in parentheses.

Consonant	Cho & Ladefoged (1999)	Flemming et al. (2008)
/p/	22	24 (19)
/t/	24	22 (8)
/k/	48	37 (11)
/q/	55	54 (28)

Unfortunately, while the analyses presented by Cho and Ladefoged (1999) indicate that voiceless stops were always recorded word-initially before non-high vowels, Flemming et al. (2008) did not specify the phonological environments in which the voiceless stops were elicited. The described elicitation methods, or lack thereof, mean that it is not possible to determine if the environment within a word could affect the aspiration of each of the voiceless stops. Additionally, neither analysis provided the number of tokens measured. Despite their limitations, these two analyses of VOT in Séliš provide a potential comparison point for the aspiration system of other Interior Salish languages, especially for voiceless stops in word-initial position.

1.1 Aspiration in Nłeʔkepmxcín

The present analysis investigates the aspiration system of Nłeʔkepmxcín. Nłeʔkepmxcín is a Northern Interior Salish language spoken in south-central British Columbia in communities like Boston Bar, Coldwater, Lytton, and Spences Bridge. Based on the 2022 Report of the Status of B.C. First Nations Languages, there are 105 fluent speakers, 312 semi-fluent speakers, and 517 active learners of the language (Gessner et al. 2022). The data presented throughout this analysis comes from Bev Phillips, a speaker of the Lytton/Canyon dialect.

Obstruents in Nłeʔkepmxcín are generally lenis and voiceless (Thompson & Thompson 1992). The lenis nature of obstruents in the language means that in many voiced environments they can sound voiced to the English ear (Thompson & Thompson 1992). An unpublished spectrographic analysis of a speaker of the Nicola Valley dialect conducted by Sharon Mayes and reported in personal communication to Laurence and M. Terry Thompson found no instrumental evidence of voicing of the language's obstruents (Thompson & Thompson 1992). Sounds like /z/, /ɣ/, and /ʕ/

that might be considered voiced obstruents in other languages are categorized as resonants (or sonorants) in Nłeʔkepmxcín (Jimmie 1994).

Within the inventory of voiceless stops in Nłeʔkepmxcín, Thompson and Thompson (1992) outline a system of aspiration with four categories. This system is presented in **Table 2**. Within the proposed system, stops are categorized as "unaspirated before vowels and resonants, but often somewhat aspirated before a spirant and regularly before another stop. In syllable-final position they are strongly aspirated" (Thompson & Thompson 1992:4). No data are provided as evidence for these four categories, and clear definitions of the meanings of *somewhat*, *regularly,* and *strongly* are not provided. In order to avoid overlap between categories from stops in syllable-final position immediately preceding a spirant, stop, or resonant in a following syllable, I assume that the unaspirated, somewhat aspirated, and regularly aspirated environments are restricted to stops followed by segments in the same syllable.

Table 2: Nłeʔkepmxcín aspiration system as outlined by Thompson and Thompson (1992)

Position	Description of Aspiration
_____V; _____resonant	Unaspirated
_____spirant	Somewhat aspirated
_____stop	Regularly aspirated
_____σ	Strongly aspirated

Since this description of the Nłeʔkepmxcín aspiration system as outlined in the grammar, no published works have presented evidence to contest or further clarify the categorizations. However, research has used the described system in other ways. Koch (2010, 2015) looked at lengthening as a prosodic phrase boundary cue. He was particularly focused on how lengthening manifested as aspiration on the first-person plural clitic *kt* in phrase-final position. Measurements of /t/ aspiration in phonological-phrase-final, intonation-phrase-final, and phrase-internal positions showed that /t/ had the longest release burst duration in intonation-phrase-final position (mean 218ms, SD 60ms), the shortest in phrase-internal position (mean 76ms, SD 42ms), and a release burst between those two in phonological-phrase-final position (mean 95ms, SD 42ms). Koch's work offers initial support for syllable-final voiceless stops being aspirated, but the variation across each of the three phrasal positions leads to questions about the environment described for strongly aspirated stops in the language's grammar (Thompson & Thompson 1992). Having a baseline of release burst durations in each of the four positional categories (before vowels, spirants, stops, or syllable boundaries) would help to determine how much the phrasal position affected release burst duration in Koch's (2015) data.

The goal of this research is to answer the following question: What is the pattern of aspiration for plain voiceless stops in Nłeʔkepmxcín? In answering this question, I attempt to clarify the definitions of *somewhat*, *regularly*, and *strongly* aspirated stops outlined by Thompson and Thompson (1992) and connect the resulting aspiration system to the findings of Koch (2010, 2015).

2 Method

Data collection for this project took place over an eight-month period from September 2022 to April 2023. The wordlist consisted of both mono- and multi-syllabic words (four syllables maximum). The four environments of stops outlined by Thompson and Thompson (1992) were all targeted in this word list. For the unaspirated and strongly aspirated categories, I targeted word-initial stops before vowels and word-final stops following vowels to establish the extreme ends of the proposed scale. For the somewhat and regularly aspirated categories, I targeted stop-stop and stop-sibilant sequences in both word-initial and word-final position to see if there was an effect of word-position on release burst duration. In the majority of words, the relevant stop environment was not derived through morphological complexity. However, for stop-obstruent sequences, roughly 25% of the target sequences were created through the addition of a suffix. In particular, many word-final stop-spirant sequences were morphologically derived using the third-person possessive suffix -*s* (e.g., *sq̓ʷoq̓ʷéps* 'his strawberries'). A portion of the word list is provided in **Table 3**. The full word list is provided in Appendix A.

Table 3: Sample of full word list. Targeted sound sequences are bolded and underlined.

Target Environment	Word-Initial	Word-Final
______V	***k****éyx* 'hand'	
	p*éwt* 'swollen'	
______spirant	***tx****íʔeʔt* 'narrow'	*sxáy****qs*** 'coho salmon'
	kɬ*íyxems* 'stop doing something'	*sq̓ʷoq̓ʷy̓é****ps*** 'his strawberries'
______stop	***pt****éyptn* 'rug'	*sƛ̓í****qt*** 'sky'
	pt*éx̣əs* 'spit something out'	*qəqé****pt*** 'something got softer'
______σ		*sɣé****p*** 'tree'
		*néw̓****t*** 'wind'

All morphologically simple words were elicited in isolation by asking the speaker to translate English words into Nɬeʔkepmxcín. Morphologically complex words were elicited by asking the speaker to translate simple English sentences such as *These must be his strawberries* in (1).

(1) c̓e nke xʔe ʔe sq̓ʷoq̓ʷy̓éps.

c̓e	nke	xʔe	ʔe=s-q̓ʷo~q̓ʷy̓=ép-s
EMPH	INFER	DEM	DET=NMLZ-AUG~ripe=bottom-3POSS

'These must be his strawberries.' (BP | 2023-02-22)

2.1 Audio processing and analysis

All elicitation sessions took place over Zoom. The Zoom audio recordings were converted from MP4 to WAV files to allow measurements of release burst duration in Praat (Boersma & Weenink 2022). Before any measurements were taken, all converted WAV files underwent noise reduction in Audacity which uses spectral noise gating to reduce static background noise in an audio file based on a few seconds of each recording where there was no speech. Target words were extracted from the long audio files and textgrids for each targeted sound were annotated to measure the total duration of release burst of the targeted voiceless stops. In words with multiple targeted stops, a separate textgrid was created for each stop for a total of 328 textgrids.

For target sounds before vowels, the unaspirated category, VOT measurements were taken from the stop release burst to the onset of voicing of the vowel. For stops before spirants (the somewhat aspirated category) and stops before stops (the regularly aspirated category), I measured the time from the stop release burst to the onset of the spirant or stop. For target stops in word-final position, I measured from the stop release burst to the visual and auditory end of the release. Because these different environments of aspiration do not all fit into the definition of voice onset time (the duration from release burst to the onset of voicing), I will refer to the measured portion of each target sound as the release burst duration for the remainder of the paper. Examples of the annotated textgrids can be seen in Figure 1 for a stop before a vowel (unaspirated), Figure 2 for a stop before a spirant (somewhat aspirated), Figure 3 for a stop before a stop (regularly aspirated), and Figure 4 for a stop in word-final position (strongly aspirated).

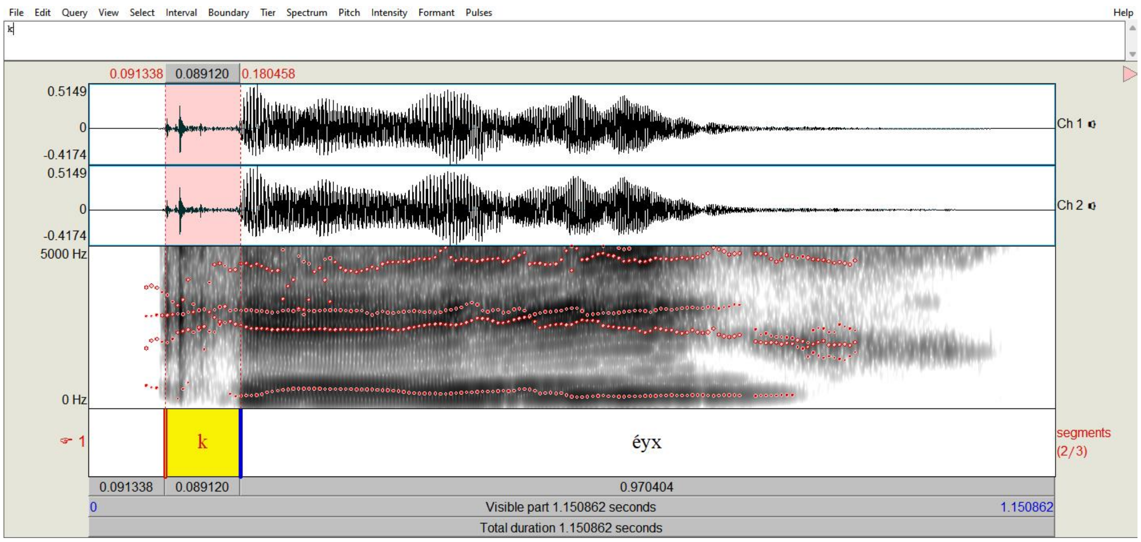

Figure 1: Annotated textgrid for a stop before a vowel in the word *kéyx* 'hand'. The relevant stop environment is highlighted.

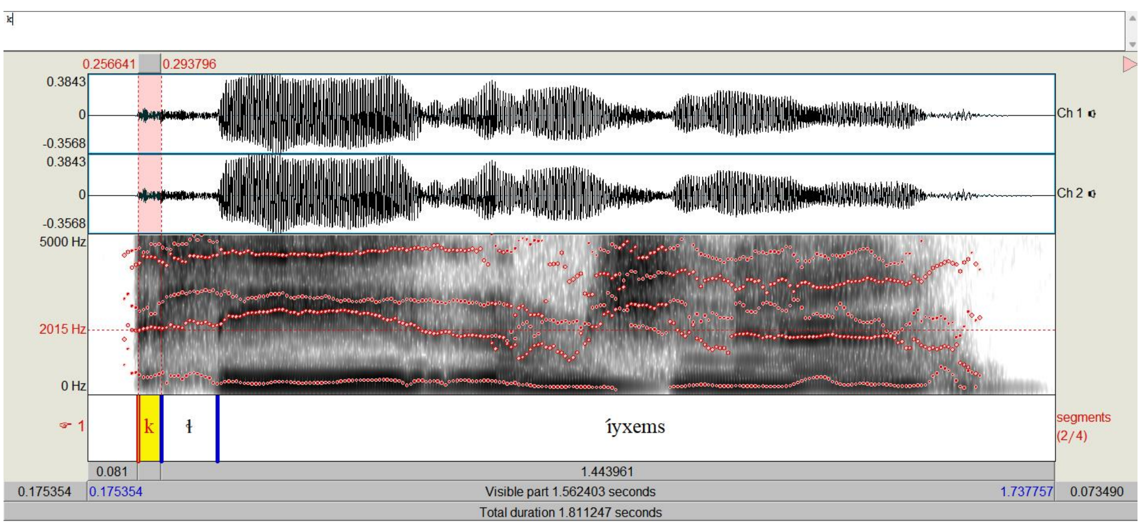

Figure 2: Annotated textgrid for a stop before a spirant in the word *kɬíyxems* 'stop doing something'. The relevant stop environment is highlighted.

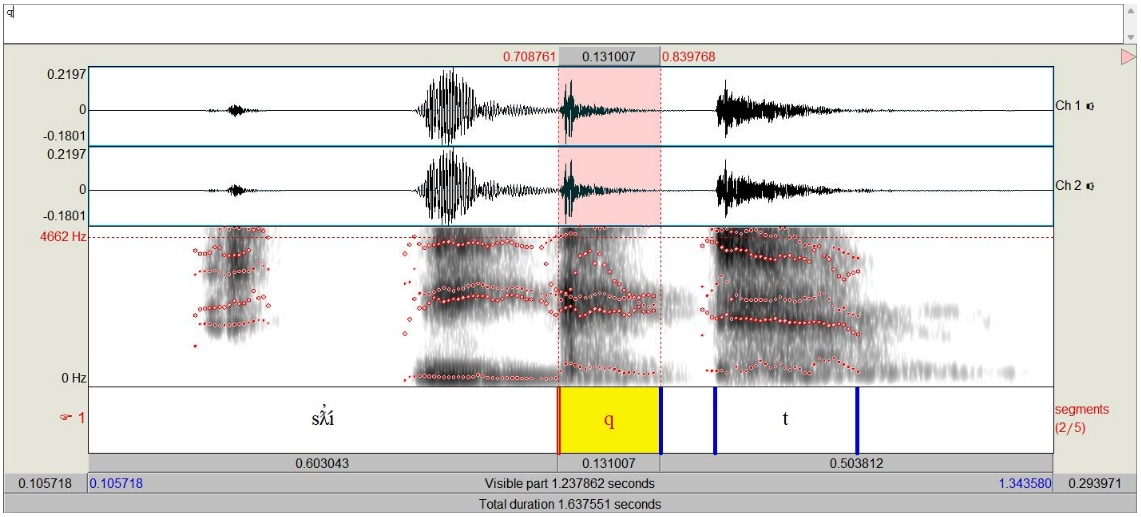

Figure 3: Annotated textgrid for a stop before another stop in the word *sƛ̓íqt* 'sky'. The relevant stop environment is highlighted.

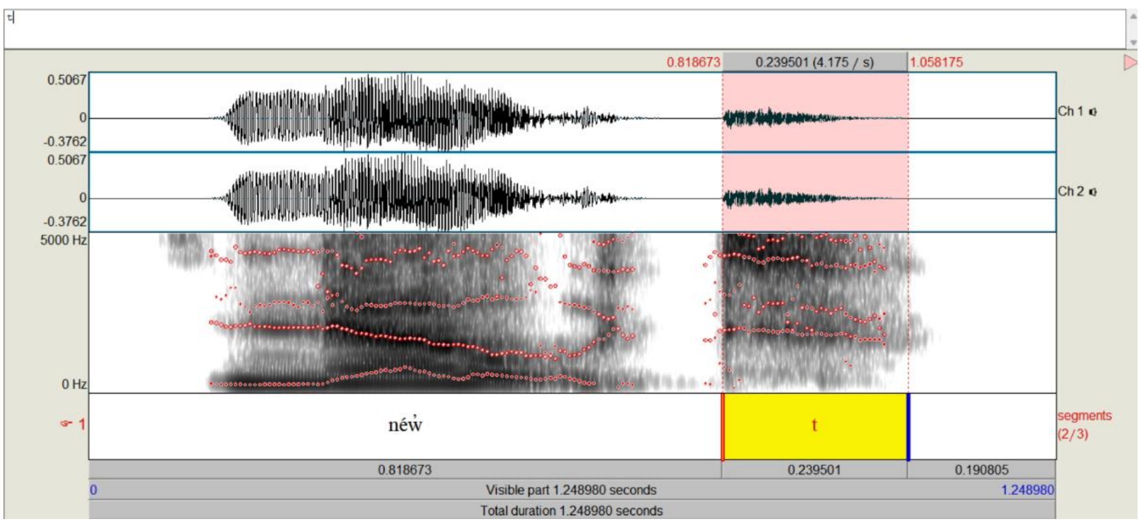

Figure 4: Annotated textgrid for a word-final stop in the word *néẁt* 'wind'. The relevant stop environment is highlighted.

In total, 100 tokens with voiceless stops in word-initial position before a vowel, 37 tokens with voiceless stops before spirants, 28 tokens with voiceless stops before other stops, and 70 tokens with voiceless stops in word-final position were annotated. A breakdown of the place of articulation of these stops based on their position within the target words is provided in **Table 4**.

Table 4: Number of tokens for each environment, word position, and place of articulation. Greyed out sections indicate where the relevant environment would not be possible. Categories with 0s indicate environments where tokens could not be found in the creation of the wordlist.

Target Environment	Word-Initial				Word-final			
	/p/	/t/	/k/	/q/	/p/	/t/	/k/	/q/
______V	41	24	20	15				
______spirant	0	4	6	2	12	2	10	1
______stop	10	2	0	0	4	0	1	8
______σ					32	17	13	8

3 Results

3.1 Overall results

Average release burst durations for each of the four targeted environments pattern closely to the categories outlined by Thompson and Thompson (1992). Word-initial voiceless stops and voiceless stops found before spirants, described by Thompson and Thompson (1992) as unaspirated and somewhat aspirated, respectively, had release burst durations in the range that is considered to be unaspirated in most languages (word-initial: 36ms, SD 3ms; before-spirant: 35ms, SD 5ms). Voiceless stops found before other stops, described by Thompson and Thompson (1992) as regularly aspirated, appear to be aspirated (66ms, SD 7ms), and word-final voiceless stops, described as strongly aspirated, are clearly aspirated (152ms, SD 7ms). Figure 5 provides the visual representation of release bursts for each environment.

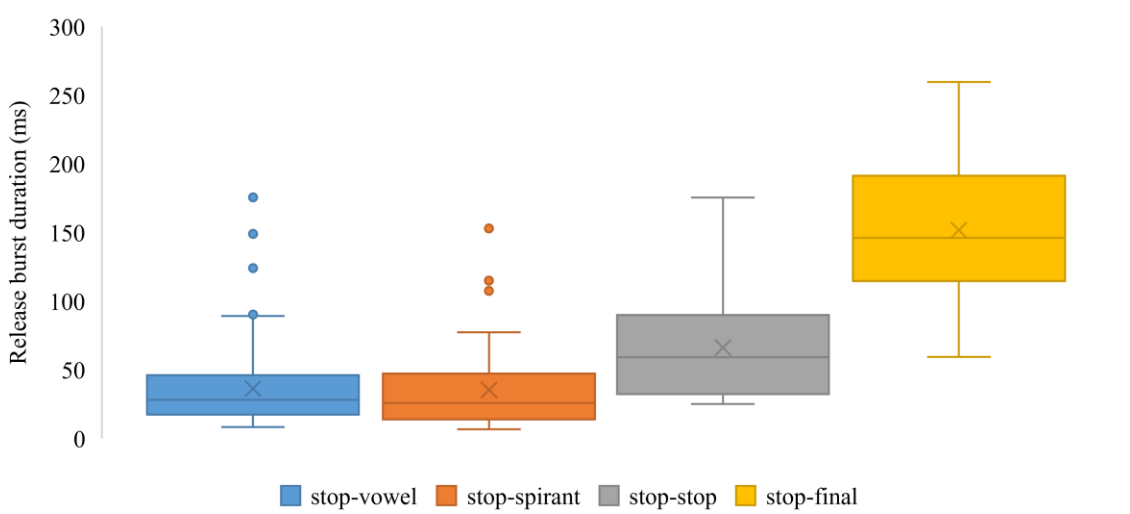

Figure 5: Average release burst duration by Thompson and Thompson's (1992) environments

3.2 Effect of place of articulation

A summary of release burst duration for each place of articulation is provided in **Fehler! Ungültiger Eigenverweis auf Textmarke.** for the environments of stops before vowels and stops word-finally. Place of articulation data for stops before spirants and stops before stops are not included in this analysis because there were insufficient tokens for each place of articulation to draw any conclusions. Variation in the two environments follows patterns seen in the literature that stops produced further back in the mouth like /k/ or /q/ will have a longer duration of release burst compared to stops produced further forward in the mouth like /p/ (Cho & Ladefoged 1999). This difference is related to the volume of the cavity behind the point of restriction. When the cavity behind the point of restriction is smaller, there is a greater amount of pressure which takes longer to fully release. When stops are in an environment before vowels and other voiced segments, this also causes a delay in the initiation of vocal fold vibration required for voicing (Hardcastle 1973; Maddieson 1996).

Table 5: Average release burst duration in ms for each place of articulation. Standard deviations provided in parentheses.

Target Environment	/p/	/t/	/k/	/q/
_____V	19 (7)	37 (13)	53 (25)	58 (45)
_____σ	144 (57)	166 (52)	144 (60)	169 (64)

In the word-final environment, the pattern is less clear, especially between the alveolar stop /t/ and the velar stop /k/. Due to the relatively small number of tokens for specific consonants, no outliers were removed from the analysis. As such, the pattern that is clearly illustrated in the word-initial stops might be masked in the word-final stops due to the use of careful speech or quieter speech not being picked up as well on a Zoom recording. However, between the labial /p/ and uvular /q/, it is clear even in the word-final environment that stops produced further forward in the mouth do seem to have shorter release bursts than those produced further back in the mouth.

3.3 Effect of word position

For stop-spirant (somewhat aspirated) and stop-stop (regularly aspirated) environments, the sequences were targeted in both word-initial and word-final positions to see if there was any effect of word-position on release burst duration. **Fehler! Verweisquelle konnte nicht gefunden w erden.** and **Fehler! Verweisquelle konnte nicht gefunden werden.** show the average release burst duration for these sequences in word-initial and word-final positions.

A univariate ANOVA was run on the release burst duration measures with environment (stop-spirant or stop-stop) and word position (word-initial or word-final) as the fixed effect. This ANOVA showed a significant interaction between environment and position ($F(3, 58) = 10.5$, $p < .001$). To determine which conditions differed from one another, a post hoc Tukey's HSD Test was run to make pairwise comparisons of the different conditions. Tukey's HSD Test for multiple comparisons found that the mean value of release burst duration was significantly different between stops before stops in word-final position and the three other environment positions ($p < .01$). There were no significant differences between stop-spirant sequences in either word-initial or word-final positions. This reflects the visual representations of the data in Figures **Fehler! Verweisquelle k onnte nicht gefunden werden.** and **Fehler! Verweisquelle konnte nicht gefunden werden.** and suggests that the position of stop-stop sequences in a word is driving the overall appearance that stops before other stops are regularly aspirated. An explanation for why the stop-stop sequences behave differently than the stop-spirant sequences is presented in the discussion.

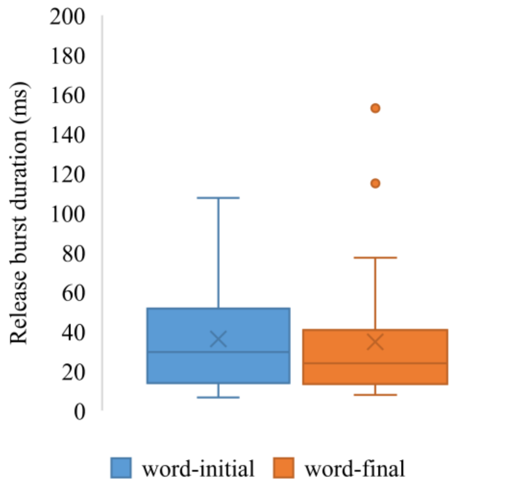

Figure 6: Average release burst duration for stop-spirant sequences in word-initial and word-final positions

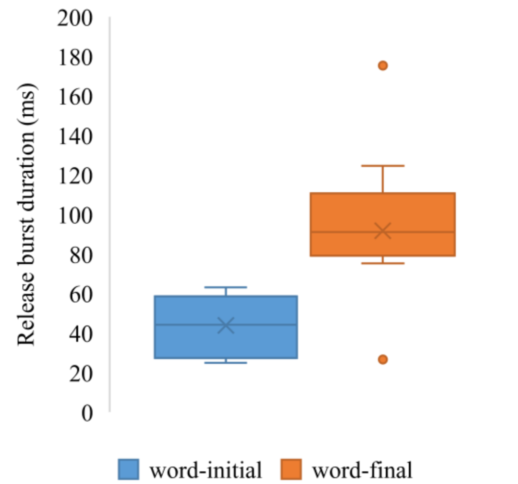

Figure 7: Average release burst duration for stop-stop sequences in word-initial and word-final positions

4 Discussion and conclusion

This study provides the first steps in determining the pattern of aspiration in Nłeʔkepxmcín. The data presented above show that release burst duration of voiceless stops does pattern similarly to the categories of aspiration outlined by Thompson and Thompson (1992). However, these findings suggest that the pattern may be more straightforward than previously documented. Rather than requiring four distinct categories, there seem to be two key categorical distinctions that are based on position within the word. When voiceless stops are found in word-initial position, regardless of the following segment, they are produced as unaspirated, and when found in word-final position, they are produced as aspirated. Further work will be required to determine how word-internal stops fit into this two-category system.

Interestingly, release burst durations for unaspirated and aspirated voiceless stops fall above the ranges found for unaspirated (1.4 to 21ms) and aspirated (57 to 97ms) stops cross-linguistically (Cho et al. 2019). When compared to the VOT measures for Séliš (Cho & Ladefoged 1999; Flemming et al. 2008), these data from Nłeʔkepmxcín suggest that unaspirated voiceless stops in Interior Salish languages might have longer release bursts than are found in Indo-European languages which make up the majority of the “cross-linguistic” sample.

While the two-category system of stops being unaspirated in word-initial position and aspirated in word-final position holds true for the majority of the data, it does not appear to be the case for stops found before spirants. However, there is a potentially simple explanation for this deviation. Throughout the data presented in this analysis, tokens were elicited as words in isolation. As such, the speaker may have been treating these isolated words as their own phrases. This would lend support to Koch's (2015) proposal that lengthening, surfacing as aspiration for stop consonants, is a reliable cue of phrase boundaries in Nłeʔkepmxcín. In the context of stop-spirant sequences, because the second segment of this cluster has the feature [+continuant], I suspect that it would take on the lengthening cue, leaving the release burst duration on the stop to surface as normal. In comparison, for stop-stop sequences, both segments have the feature [-continuant], making neither segment a more viable candidate for lengthening. I would then predict that the lengthening cue would apply to both stops in the cluster, leading to longer release burst durations. While measurements of duration of the second segment in stop-spirant and stop-stop sequences were not possible for the present analysis, they are planned for future investigations.

There are a number of next steps for this work; some include further analyses of the presented data and others require the collection of additional data. With the current data, as mentioned, I plan to measure the duration of the second member of stop-spirant and stop-stop sequences to determine how phrase-final lengthening affects the production of these two types of clusters. I also want to look for word-internal, syllable-final stops in the data to confirm whether Thompson and Thompson (1992) were correct in proposing that syllable-final and not just word- or phrase-final stops are strongly aspirated. The presented analysis also looked at only one measure of aspiration: duration of release burst. While this is a common measure for classifying aspiration as part of sound systems cross-linguistically, additional measures of aspiration could provide more weight behind the reported results. These measures include determining the maximum intensity of the release burst, the time of maximum intensity, and the time of maximum intensity as a percentage of the overall aspiration duration. All three of these measures were reported in Koch's (2015) analysis of phrase-internal and phrase-final /t/. It could also be informative to measure the consonant-induced fundamental frequency and voice quality of vowels following voiceless stops (see Cho et al. 2019 for a discussion of these measures), however, this would only be relevant to a subset of voiceless stops in the data.

Additional data will need to be collected for two further investigations of the Nłeʔkepmxcín aspiration system. With the current speaker, I hope to collect the target words in phrase-internal position to establish whether the proposed two-category system of aspiration holds up or is only appearing as a result of phrase-final lengthening. I also hope to determine whether this pattern of aspiration is replicable in other dialects of Nłeʔkepmxcín by eliciting the word list with speakers of the Nicola Valley dialect.

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Appendix: full wordlist

Table 6: Target words with /p/ in word-initial position

Target consonant	Word Orthography	Gloss
/p/	*páqʷucs*	‘scare’
	páxem	‘peel’
	pə́k	‘flatten’
	péki	‘wagon’
	pə́kʷt	‘spill something dry’
	péłuskú	‘lake’
	pépyeʔ	‘alone’
	petə́le	‘blood’
	péwt	‘swollen’
	píkcə	‘picture’
	píləxəm	‘tell a story’
	piyeʔscút	‘only child’
	púnems	‘find’
	púnəncim	‘you found me’

Table 7: Target words with /t/ in word-initial position

Target Consonant	Word Orthography	Gloss
/t/	*táxem*	‘paddle’
	tékł	‘raining’
	təmłík	‘summer’
	téxʷt	‘bitter’
	téyt	‘hungry’
	təʔép	‘stain something black’
	təʔepékst	‘stain hand black’
	təʔepxín	‘stain foot black’
	toqʷpsténə	‘dent’
	tukʷtúkʷt	‘shelter’
	túlkist	‘hammer’

Table 8: Target words with /k/ in word-initial position

Target Consonant	Word Orthography	Gloss
/k/	*kálec*	‘carrot’
	káze?	‘lie’
	kəkəmíxəms	‘sneak’
	kəncít	‘we helped’
	kénəms	‘help’
	kénm	‘what is the matter’
	kepú	‘coat’
	kewómk	‘belly button’
	kéyx	‘hand’
	kinéyt	‘helper’
	kíye?	‘front’

Table 9: Target words with /q/ in word-initial position

Target Consonant	Word Orthography	Gloss
/q/	*qəqépt*	‘got softer’
	qemút	‘hat’
	qeyméyt	‘nurse, suckle’
	qəłmíns	‘old woman’
	qéck	‘older brother’
	qáznə	‘wave’
	qʷintwáxʷ	‘disagreement’
	qʷincútm	‘talk about someone’

Table 10: Target words with /p/ before a spirant

Target Consonant	Word Orthography	Gloss
/p/	*ṣʕʷláps*	‘bighorn sheep’
	łképs	‘her pot’
	sq̓ʷoq̓ʷẏéps	‘his strawberries’
	sɣéps	‘his tree’
	sp̧éps	‘pond’
	kʷmiʔxʷéps	‘tree roots’
	spéps	‘pond’

Table 11: Target words with /t/ before a spirant

Target Consonant	Word Orthography	Gloss
/t/	*txíʔxeʔt*	‘narrow, thin’
	stx̣éłp	‘diamond willow’
	miʔxétx^{w}	‘you kick him’
	cítx^{w}	‘house’

Table 12: Target words with /k/ before a spirant

Target Consonant	Word Orthography	Gloss
/k/	*stékł*	‘rain’
	tékł	‘raining’
	kłí̦yxems	‘quit’
	sƛ̓ʔéks	‘her arrival’
	łcécks	‘her mother-in-law’
	qécks	‘her older brother’
	ʔə̣́l̓ṣík^{w}*s*	‘her turtle’

Table 13: Target words with /q/ before a spirant

Target Consonant	Word Orthography	Gloss
/q/	*sqłéx*^{w}	‘blanket’
	sx̣áyqs	‘coho salmon’

Table 14: Target words with /p/ before a stop

Target Consonant	Word Orthography	Gloss
/p/	*tpípq*	‘weasel’
	ptéк^{w}*łmne*	‘tell a story’
	ptéx̣əs	‘spit something out’
	ptéyptn	‘rug’
	ptéyq^{w}*tn*	‘tablecloth’
	ptéyxete	‘put something on a table’
	qəqépt	‘got softer’
	sptúk^{w}	‘spring’

Table 15: Target words with /t/ before a stop

Target Consonant	Word Orthography	Gloss
/t/	*tpípq*	‘weasel’
	stpíq	‘white’

Table 16: Target words with /k/ before a stop

Target Consonant	Word Orthography	Gloss
/k/	*sə́ktmintem*	‘get hit’
	zíkt	‘knock over’

Table 17: Target words with /q/ before a stop

Target Consonant	Word Orthography	Gloss
/q/	*cą́qcəqt*	‘spuce grouse’
	sƛ̓íqt	‘sky’
	swəl̓wl̓íqt	‘stinging nettle’
	tóq^{w}t	‘fluffy’

Table 18: Target words with /p/ in word-final position

Target Consonant	Word Orthography	Gloss
/p/	*cnə́p*	‘echo’
	ɬkép	‘pot/pan’
	naʕʔíp	‘always’
	pʔíp	‘lost’
	sɣép	‘tree’
	snkʼy̓ép	‘coyote’
	teqpép	‘dammed’
	təʔép	‘stain black’
	wosíp	‘sunrise’
	x^{w}mə́p	‘lonely’
	ʕáp	‘evening’
	ʕ^{w}iʕ^{w}yə́p	‘burning’
	ʔax̣́iyəp	‘sweep’

Table 19: Target words with /t/ in word-final position

Target Consonant	Word Orthography	Gloss
/t/	*kəncít*	‘we helped’
	kinéy̓t	‘helper’
	néw̓t	‘wind’
	p̓éwt	‘echo’
	piyeʔscút	‘only child’
	weʔwít	‘last’
	xʷesít	‘walk’
	xʷʔít	‘many’

Table 20: Target words with /k/ in word-final position

Target Consonant	Word Orthography	Gloss
/k/	*c̓ék*	‘finished’
	lisék	‘sack’
	ƛ̓ʔék	‘arrive’
	pək	‘flatten’
	sceqpíńek	‘morning star’
	sc̓olíńek	‘evening star’
	təmłík	‘summer’

Table 21: Target words with /q/ in word-final position

Target Consonant	Word Orthography	Gloss
/q/	*kʷl̓íqəq*	‘robin’
	séʔaq	‘fern’
	stpíq	‘white’
	sx̣íq	‘duck’
	ʔesx̣táq	‘hole’
	scíqʷ	‘red’
	wlóqʷ	‘clearing’