On Tone and Length in Tahltan (Northern Athabaskan)*

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1. Introduction

The purpose of this paper is to document and study tone and length in the Northern Athabaskan language Tahltan[1]. Results of instrumental phonetic analyses are examined in light of the historical development of these categories. The results of these studies lead to some inferences about the historical development of low-marked tone into present-day Tahltan, as well as the synchronic status of different sources of vowel length. This work therefore contributes to cross-linguistic studies by providing a detailed description of tone and length, and their interaction, in a particular language.

A second goal, equally important, is to clarify the descriptive categories for tone and length that are relevant for various types of documentation work, e.g., dictionaries, teaching materials, and linguistic research papers. The lack of systematic study of these features has hampered linguistic documentation in the past, especially with vowel length, and so it is hoped that the results of these studies will lead to ideas that will serve descriptive and analytical projects of all types.

Before examining tone and vowel length, it is necessary to establish some background on the larger prosodic system for word-sized units. Tahltan is essentially a stress system, with a residue of low tone that functions independently of stress. Strong syllables are characterized by greater duration than weak syllables, as well as increased intensity and a higher fundamental frequency, and have a rhythmic distribution counting from the stem syllable, which is typically stressed. However, words may also have a low tone on the stem, distinct from stress. Furthermore, the stress system tends to ignore vowel length,

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[1] Tahltan is a critically endangered language of Northwestern British Columbia, spoken in the communities of Telegraph Creek, Iskut, and Dease Lake. While there is a practical orthography and language programs in these communities, Tahltan is in desperate need of linguistic documentation (see Alderete & Bob 1999 for descriptions of existing materials).

which means that vowel length is also independent of stress in the prosodic system (see Cook 1972, Nater 1989, and Alderete and Bob this volume for more details).

In its current state, it is somewhat difficult to study the behavior of tone as it appears that many of its salient properties have been eroded away under pressure from stress and intonation. Moreover, the lack of reliable tonal data also makes the project of studying the development of tone into present-day Tahltan considerably more difficult. The standard account of residual low tone has been to reconstruct low tone in a wider range of contexts in a pre-Tahltan ancestor language (Krauss 1978, Leer 1979). However, the most detailed study of the historical phonology of Tahltan, Nater 1989, assumes that Tahltan is essentially conservative and did bit develop tone in the contexts expected in the Athabaskan Tonogenesis Theory. With its low functional load in the Tahltan, the vestiges of whatever tonal properties of the ancestor language do not provide conclusive evidence.

It turns out that there is an explicit relationship between tone and vowel length, as mentioned cursorily in Nater 1989: xxx from a comparative perspective. In particular, Nater notes that there is a correspondence between tone in certain Northern Athabaskan languages and vowel length in Tahltan, suggesting a correlation between increased length and tone in a common ancestor among these languages. In addition to studying tone and length as independent sound features, this relationship is investigated in more detail in the two major Tahltan dialects, showing that there is indeed a systematic relationship between low tone and increased length, both historically and in the synchronic system of some speakers. This evidence will be taken as empirical support for the presence of marked tone in pre-Tahltan, and ATT in general, despite the lack of direct synchronic evidence for tone.

2. Tone in Tahltan

2.1. Results of an Exploratory Phonetic Study

As stated above, Tahltan has the residue of low-marked tone. Syllables with low-marked tone have a low tonal target whose realization extends through the duration of the syllable. Marked tone therefore forms an opposition with unmarked tone in that the latter does not have a low tonal target, and thus characteristically has a higher pitch. Furthermore, syllables with unmarked tone may rise and fall in pitch under stress, which differs from the level low pitch profile of low-marked tone in stressed syllables. Some good examples illustrating this opposition are given below.

(3) Tone Minimal Pairs (Nater 1989)

Unmarked Tone		Marked Tone	
xɪθ	‘puss’	xɪ̀θ	‘knoll’
ʔaːh	‘snowshoe’	ʔàːh	‘fog’
xeːl	‘pack’	xèːl	‘trap’

To give a rough characterization of the phonetic properties of the tonal opposition, these pairs were examined instrumentally. Three adult males of roughly the same age (ranging from early to late sixties) were asked to produce the above test words in natural sentences. The two major dialect areas were represented: speaker 1 from Telegraph Creek (TC), and speakers 2 and 3 from Iskut (I). In order to avoid the effects of sentence-final prosody, the test words were elicited in preverbal position. The phonetic attributes commonly associated with tone were then measured in the test words and studied for quantitative trends.[2] The phonetic attributes included peaks in fundamental frequency (F_0), intensity, and vowel duration, measured in Hertz (Hz), decibels (dB), and milliseconds (ms), respectively. Intensity is not reported below because it did not reveal important differences in the minimal pairs.

The first pair, [xɪθ] 'pus' versus [xɪ̀θ] 'knoll', contains the reduced vowel [ɪ], and as we shall see, it appears to differ from the minimal pairs given below in that the contrast is not realized with important differences in F_0 and duration. For all three speakers, only speaker 3 showed an important difference in F_0, a difference of roughly 19 Hz, which greatly exceeds the combined standard deviations (sdev) of each member of the pair.[3] Speaker 2 has a large difference of mean (diff-mean) for F_0, but it is not greater than the combined sdev, and further, it is contrary to the expected pattern: the low-marked tone form has a higher F_0 peak. Speaker 1 shows no important differences for either F_0 or duration.

(4)Minimal Pair I, with mean (standard deviation)

	[xɪθ] 'pus'	[xɪ̀θ] 'knoll'	Diff-mean
a. Speaker 1			
F_0	182(2.1)	185(17.7)	**3**
Dur	97(14.1)	110(8.5)	**13**
b. Speaker 2			
F_0	197(15.6)	214(7.8)	**17**
Dur	115(5.7)	124(8.5)	**9**
c. Speaker 3			
F_0	122(2.8)	103(5)	**19**
Dur	103.5(3.5)	95(5.7)	**8**

The minimal pairs with full vowels reveal some more robust phonetic differences, including differences in vowel duration. For example, while speaker 1 does not have an important difference in F_0 for the first pair in (5), there is a striking difference in mean

[2] No claims are made here about the statistical significance of these trends because of the limited sample and uncontrolled nature of the experiment. However, suggestive patterns are noted by comparing the difference of mean with the combined standard deviations of each member of the pair. In particular, a phonetic property is deemed important in marking a contrast if the former is greater than the latter.

[3] Cases where the difference of mean between two values is less than the standard deviation of any member receive dark shading to signify that this contrast is likely to be unimportant linguistically; cells where the difference of mean is greater than the standard deviation of one member, but not the combined value, receive only light shading.

duration: the form with marked tone is far longer than its counterpart. Speakers 2 and 3 also show an important difference in duration, though it is more modest. Speaker 2, and possibly 3 as well, show an additional difference in pitch.

(5) Minimal Pair II

	[ʔaːh] 'snowshoes'	[ʔàːh] 'fog'	Diff-mean
a. Speaker 1			
F_0	164	174(13.4)	**10**
Dur	231	358(2.8)	**127**
b. Speaker 2			
F_0	187(10.6)	161(0)	**26**
Dur	316(1.4)	275(7.1)	**41**
c. Speaker 3			
F_0	190(9.9)	179(5.7)	**11**
Dur	234.5(9.2)	262(7.1)	**28**

The same differences in both F_0 and duration are found again in speaker 2's productions of the third minimal pairs in (6), with roughly the same pitch difference, but an even stronger difference in duration. Like all of the cases above for speaker 1, there is no important difference for F_0. There's also a slight difference in duration, though it is in the opposite direction than expected; in the other pairs with all other speakers, the words with marked tone were greater in duration, suggesting that this pattern is an anomaly.

(6) Minimal Pair III

	[xeːɬ] 'pack'	[xèːɬ] 'trap'	Diff-mean
a. Speaker 1			
F_0	179(9.2)	184(0)	**5**
Dur	212(0)	201.5(6.4)	**10.5**
b. Speaker 2			
F_0	221(2.8)	194(0)	**27**
Dur	217(4.2)	272(5.7)	**55**

To summarize the above results, F_0 is likely to be important in signally a contrast in these pairs, especially for speakers 2 and 3, which we note are Iskut speakers. F_0 is apparently not important for the TC speaker, speaker 1. The differences in F_0 for the Iskut speakers ranged between 19 and 27 Hz. Duration is also likely to be important in marking contrast in these pairs, especially in forms with full vowels. All speakers showed important differences in duration. This difference ranged between 28 and 55 ms for Iskut speakers, and in one case, namely the [ʔaːh] 'snowshoes' versus [ʔàːh] 'fog' pair, was quite striking for the TC speaker. With these phonetic attributes as diagnostics for tone, the next section investigates the development of tone in the two dialects.

2.3. Comparative Correspondences[4]

As is well-known, many Athabaskan languages are tone languages. There is a well-defined hypothesis of how tone came about in these languages, as stated below.

(7) Athabaskan Tonogenesis (Krauss 1978; see also Leer 1979, Kingston this volume, Tuttle 1998)
"The rules for deriving from pre-PA the PA vowel-constriction which gave rise to the later tone-marking are quite simple: Where the vowel was directly followed by ʔ or C' or $R^{ʔ}$, it became constricted, thus
$CV^{ʔ} > CV\overset{ʔ}{:}$, $CV:R^{ʔ} > CV\overset{ʔ}{:}R$, $CV^{ʔ}C > CV\overset{ʔ}{:}C$, $CVR^{ʔ} > CV\overset{ʔ}{R}$, $CVC' > CV\overset{ʔ}{C}'$
but length blocked this process in CV:C', which did not develop constriction …" (p. 23)[5]

According to Krauss 1978, tone developed from Proto-Athabaskan 'vowel constriction' in syllables ending in glottal stop, glottalized obstruents, and glottalized resonants. Vowel constriction, which was probably something like creaky voice (see Kingston this volume for more discussion), gave rise to two different tones: e.g., low tone in languages like Dogrib and Sekani and high tone in Dene Soulene (AKA Chipewyan) and Slavey.

The comparative correspondences give below allow one to test the ATH on the two Tahltan dialects by comparing them with a well-documented low-marked tone language, Minto. With these correspondences, it appears that tone did not develop in all the contexts predicted by the ATH. In particular, low tone cognates with Minto are only reliably found in syllables with syllable-final glottalized resonants and long vowels in Prota-Athabaskan. The need for length in PA is shown by the contrast between (8b) and (8c). Furthermore, the primary difference between Iskut and TC Tahltan is in the presence of tone in Iskut Tahltan, as shown in (8b).

(8) Comparative Correspondences (sorted by constriction context)

PA	Minto		I Tahltan	TC Tahltan
a. CVʔ > CV^ʔ (^ = constriction → marked tone)				
*-ta^{ʔ}ʔ	-tàʔ	'father'	-taʔ	-taʔ
*-qe^{ʔ}ʔ	-kæʔ	'foot'	-keʔ	-keʔ
*tša^{ʔ}ʔ	tsàʔ	'beaver'	tsaʔ	tsaʔ
*q'a^{ʔ}ʔ	k'àʔ	'arrow'	(tʌs)	
b. CV:Rʔ > CV:^Rʔ				
*-t'a:^{ʔ}nʔ	-t'àʔ	'leaf'	et'one	et'one
*-c^{w}a:^{ʔ}nʔ	-tràɴʔ	'excrement'	-tsà:ʔ	-tsa:ʔ
*-ʁa:^{ʔ}nəʔ	-gànæʔ	'arm'	-gà:ne	-ga:ne

[4] The Tahltan data was collected by the author, the data from Minto is from Tuttle 1998, and the reconstructed Proto-Athapaskan (PA) forms here and throughout represent a working model for an internal reconstruction of Tahltan based on the important insights of Krauss 1978, Leer 1979, and Tuttle 1998.

[5] A question often asked, though not the subject of this paper, is why high tone developed in some languages, while low tone developed in others. See Kingston this volume and Tuttle 1998 for a set of proposals and partial answers.

c. CVR’ > CV^Rʔ

*sə^{ʔ}w̃ʔ	sʊ̀nʔ	‘star’	θonʔ	θonʔ
*qa^{ʔ}ỹʔ	-kʊ̀nʔ	‘husband’	kaliːn	kaliːn
*q^{w}ə^{ʔ}nʔ	kʊ̀nʔ	‘fire’	konʔ	konʔ

d. CVʔC > CV^C

*ɬeː^{ʔ}ǯ	ɬæ̀ts	‘dust’	hotɬes	hotles
*teː^{ʔ}ɬ	tæ̀ɬ	‘mat’	teːɬ	teːl

e. CVC’ > CV^C

*-ɢ^{w}ə^{ʔ}t’	-gʊ̀t	‘knee’	-got	-got
*-zə^{ʔ}t’	-ðə̀t	‘liver’	-θet	

These correspondences suggest, therefore, that tone was not continued into present-day Tahltan, except in one context, namely in syllables with glottalized resonants and long vowels.[6]

As a transition to the study of length, let us consider the historical possibilities suggested by these findings. At least two possibilities exist for the development of tone in Tahltan dialects. One possibility, which is closer to Leer’s 1985 proposal, that tone developed from Proto-Athabaskan in a wider set of contexts than it appears today, and that tone was eroded away, except in syllables with long vowels and glottalized resonants in Iskut. I will call this proposal the Residual Low Tone approach Another possibility, which seems to be Nater’s 1989 view, is that tone only developed from the ancestor language in this specific context.

One kind of evidence for the Residual Low Tone approach is the existence of a structure derived from tone in a precursor to present-day Tahltan that remained in contexts where tone was lost. With this type of evidence in mind, I conjecture that pre-Tahltan had a process of tone-induced lengthening, as sketched below.

(9) Tone-induced Length (TIL)

$$CVC_{Glot} > \overset{T}{CV}(C_{Glot}) > \overset{T}{CV\text{ː}}(C_{Glot}) > \overset{T}{CV\text{ː}}(C_{Glot})$$

$$\searrow$$

$$CV\text{ː}(C_{Glot})$$

This process accounts for the correlation postulated in Nater 1989: xxx between tone and length by postulating a pre-Tahltan sound change that brought about increased duration in syllables marked for tone. So TIL predicts cases of low-toned syllables with increased duration. It also allows for the possibility that after TIL tone was lost, as in the lowest

[6] I note that some Athabaskanists are not in agreement with this conclusion. I have played some representative examples for Jeff Leer (University of Alaska) and John Ritter (Yukon Native Language Center), and they do in fact hear tone in some of the expected forms. Thus, while these examples are not classified as tonally marked under instrumental analysis described in 2.1, it remains to be shown whether native speakers have intuitions about tone in these cases.

structure in (9). We have already seen some suggestive evidence for these reflexes: the form *ʔàːh* 'fog' in TC Tahltan has far greater duration than the non-tonal form *ʔaːh* 'snowshoes', and this pair is distinguished by tone in the Iskut dialect. In the next section, vowel duration is examined within an experimental paradigm that is structured to identify tone-induced length. The basic finding below is that there is clear evidence for tone-induced length, distinct from other sources of length, a finding that generally supports the Residual Low Tone theory.

3. Vowel Length in Tahltan

3.1. Background

In order to study vowel length in present-day Tahltan we need to briefly review the historical sources of length. The Proto-Athabaskan vowel system, shown below, makes an important distinction between so-called full and reduced vowels. In some languages, like Navajo, a short versus long contrast developed as a result of this distinction.

(10) Proto-Athapaskan Vowels (based on Krauss 1964 and Leer 1979)

Full:	i	e[æ]	a[ɔ]	u
Reduced:	ə	a	ʊ	

Because of various vowel mergers, Tahltan also has these reflexes, as shown by the examples in (11a). Another type of vowel length, discussed above, is length that is correlated with tone, as shown by the examples in (11b).[7] Other sources for length seem to be compensatory lengthening for the loss of a syllable-final resonant (11c), coalescence with the stem vowel and the possessive suffix (11d), and some other curious cases in (19e).

(11) Historical Sources of Length in Tahltan

a. Reflex of full vrs reduced vowel:
   *wəs > beθ 'riverbank' vrs *weːš > beːs 'knife'
   *wɑxy > bah 'dirty' vrs *waːʔɢ > baːh 'war'

b. Correlated with marked/unmarked tone:
   *ʔaːxy > ʔaːh 'snowshoes' vrs *ʔaːqʼ > ʔàːh 'fog'[8]
   *χeːɬ > xeːɬ 'pack' vrs *heːʔɬ > xèːɬ 'trap'

c. Correlated with lost of syllable-final resonant:
   *caʔ > tsaʔ 'beaver' vrs *cʷaːnʼ > tsàːʔ 'excrement'

[7] I do not distinguish these examples for length in my transcription because it is not clear that the distinction is phonemic.

[8] The precursor to [ʔàːh] may not be PA, but an Northern Athabaskan innovation, since Chipewyan and Navajo do not have the expected tones. However, the abundant tonal correspondences with neighboring languages (Northern/Southern Tutchone, Sekani, Slavey, Kaska) shows that it derived from marked tone.

d. Coalescence with possessive suffix:
*-daʔ > daʔ ‘beak’ vrs *-n(ə)-weːG-eʔ > -daːʔ ‘eye’
*-ɣaʔ > -ɣaʔ ‘hair’ vrs > -ɣaːʔ ‘half’
e. Miscellaneous
*χəngyəˀs > keneθ ‘raft’ vrs Tlingit: kanéːst > keneːθ ‘cross’ (itself borrowed from Russian *krest*)
*-ɲeːn’ > niʔ ‘face’ vrs *ŋyeːn’ > niːʔ ‘moss’

With these distinct sources for length, one might reasonably ask if there are any properties that distinguish one source from the others. For example, tone-induced length differs from other sources in that the word pairs both have full vowels, suggesting that the oppositions that represent this contrast may be quantitatively different. This type of question guides the study of length reported here.

3.2. Methods

Five native speakers of TC Tahltan, ranging from 45 to 82 years of age, participated in the study. Each speaker was asked if s/he knew the test words given in (12) below, and was then asked to produce two repetitions of each at both normal and fast speech rates. The test words were elicited in a Subject _____ Verb sentence frame (see appendix for specific sentences). Using consistent landmarks for the beginning and end point for the vowel structure, the duration of each vowel was measured and compared with the duration of its vowel counterpart in the minimal pair.

(12) Length Minimal Pairs (aggregated by historical source of length)

a. Tone-induced length (t)

ʔaːh	‘snowshoes’	vs	ʔàːh	‘fog’
xeːɬ	‘pack’	vs	xeːɬ	‘trap’

b. Full/Reduced reflexes (fr)

beθ	‘riverbank’	vs	beːs	‘knife’
bah	‘dirty’	vs	baːh	‘war’

c. Compensatory lengthening (cl)

tsaʔ	‘beaver’	vs	tsaːʔ	‘droppings’

d. Coalescence with Possessive suffix (p):

me-ɣaʔ	‘his hair’	vs	me-ɣaːʔ	‘his half’
me-daʔ	‘his beak’	vs	me-daːʔ	‘his eye’

e. Miscellaneous (‘ht’ for first pair, and ‘?’ for second)

keneθ	‘raft’	vs	keneːθ	‘cross’
niʔ	‘face’	vs	niːʔ	‘moss’

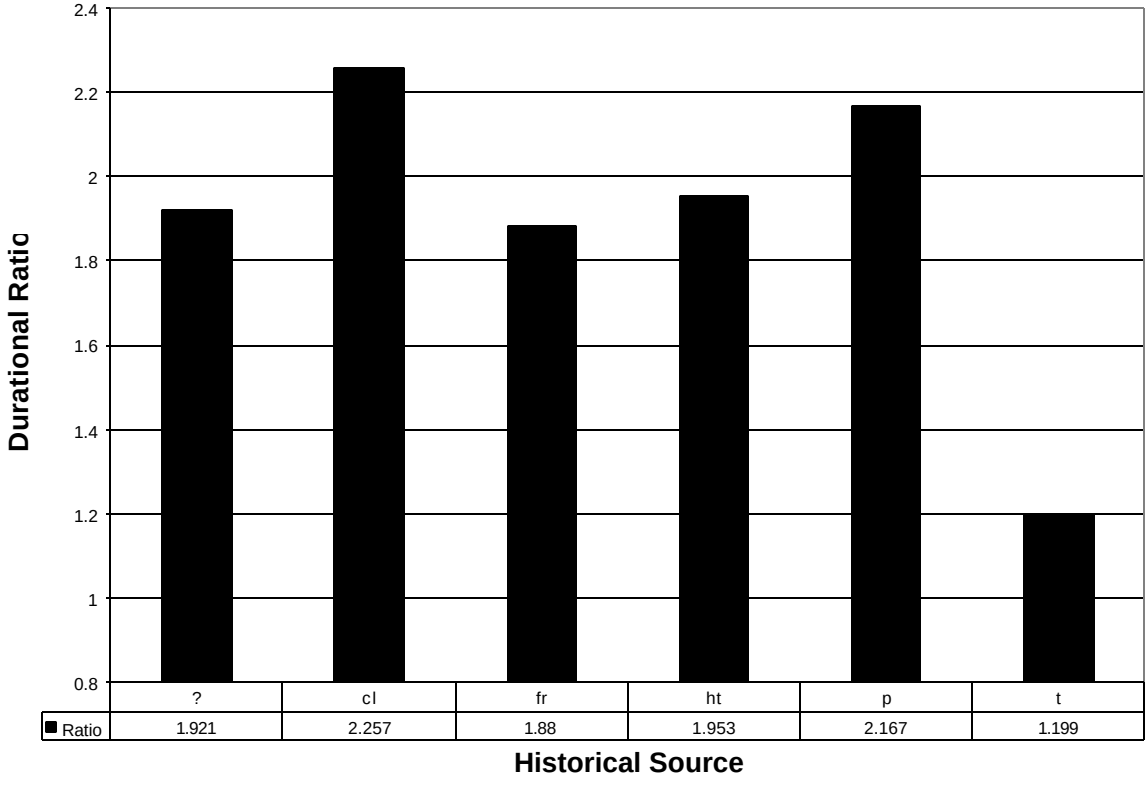
3.3. Results

A four-way ANOVA (5×6×2×2) was performed first, using the absolute value of mean duration as the dependent variable, and speaker (n = 5), historical source (n = 6), speech rate (n = 2), and the length distinction (n = 2) as the independent variables. This analysis showed significant effects for all four independent variables (all had $P \leq 0.0001$), and it also showed significant interactions between speaker and historical source ($P = 0.0005$) and historical source and length ($P \leq 0.0001$).

To eliminate some of these apparently secondary effects, a second ANOVA (5×6×2) was done on the durational ratios between long and short vowels, the idea being that a relational value may factor out some of the effects due to speaker differences and speech rate. This was indeed the case. The second ANOVA eliminated these effects, and retained the effect due to historical source ($P \leq 0.0001$). Scheffe post hoc tests were then used to elaborate on the effect due to historical source, which showed that tone-induced length differed significantly from all other sources of length, but that other sources of length did not differ with any other source.

The chart below illustrates this effect by comparing the durational ratios for the six identified sources for length. As shown by the column for tone-induced length, on the far right, a long vowel is typically 1.2 the duration of its short counterpart. Compare this result with the ratio for the contrast due to the full versus reduced vowel distinction, coded here at 'fr'. The long members of these pairs are almost twice as long as the corresponding short vowel, which is much greater than the difference from tone-induced length.

(13) Comparison of Mean Ratios for Different Sources of Length



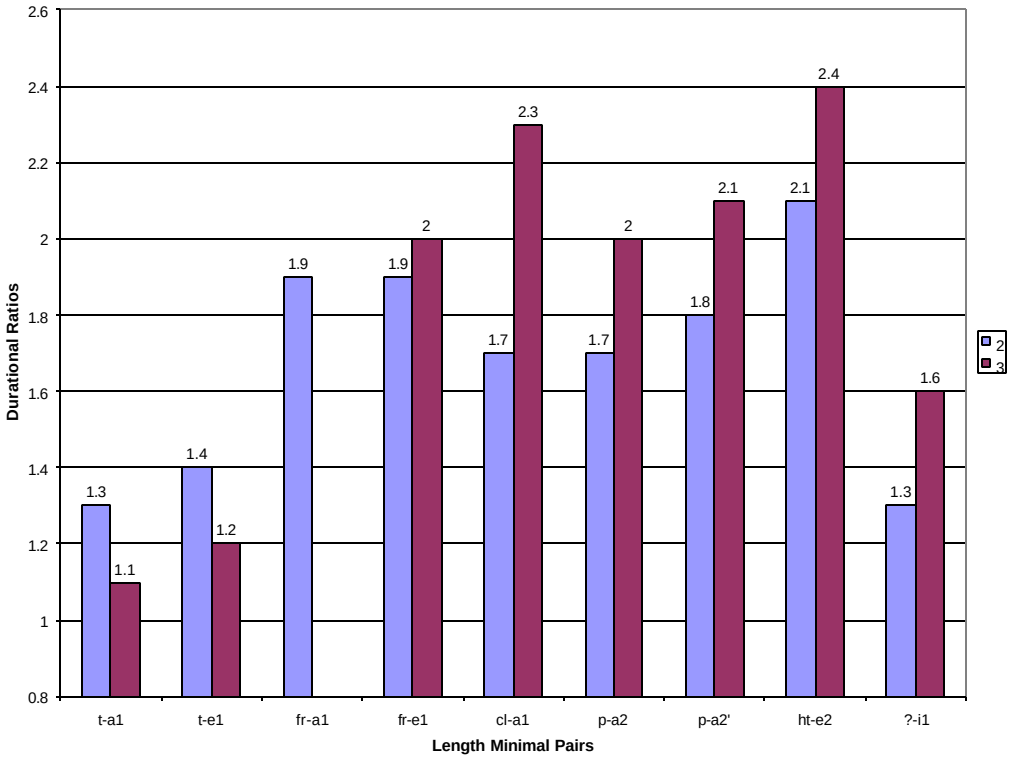
The table below sorts the durational ratios by individual speakers, which reveals some patterns that are not apparent from the composite chart above. Individual differences seem to suggest two classes of speakers, which are charted in (15) and (16).

(14) Durational Ratios Aggregated by Individual Speakers

Code	Word Type	Speaker 1	Speaker 2	Speaker 3	Speaker 4	Speaker 5
t-a1	ʔaːh/ʔàːh	1.4	1.3	1.1	1.3	1.3
t-e1	xeːɬ/xèːɬ	1	1.4	1.2	1	.9
fr-a1	bah/baːh	1.6	1.9	---	---	---
fr-e1	beθ/beːs	1.6	1.9	2	1.9	1.9
cl-a1	tsaʔ/tsaːʔ	2	1.7	2.3	2.4	2.8
p-a2	-ɣaʔ/-ɣaːʔ	1.5	1.7	2	2.5	2.3
p-a2’	-daʔ/-daːʔ	2.8	1.8	2.1	2.7	2
ht-e2	=neθ/=neːθ	1.8	2.1	2.4	1.8	1.6
ʔ-i1	ni/niːʔ	2	1.3	1.6	1.8	1.9

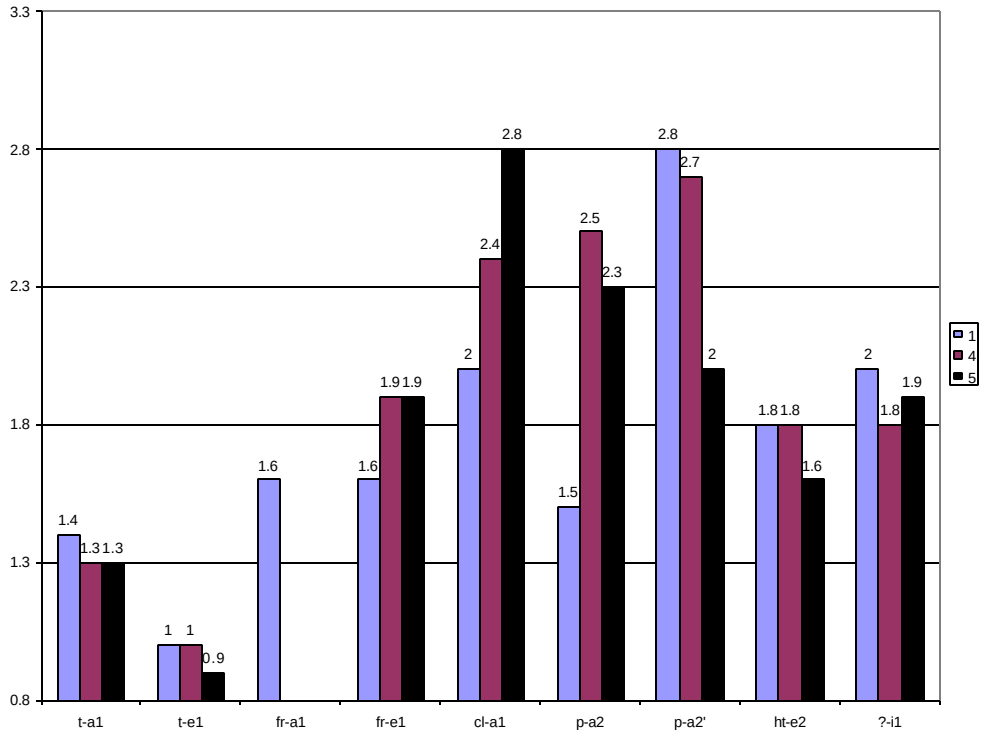
All speakers clearly distinguish tone-induced length from other sources of length. However, the difference due to historical source is more pronounced in speaker 3 than speaker 2, as shown by comparing the first two columns with the later ones below.

(15) Durational Ratios for Speaker 2 and 3



A second difference among the speakers can be seen by examining the durational ratios for *xeːɬ/xèːɬ*, i.e., 't-e1' in (15-16). It seems that speakers 1, 4 and 5 do not have a length contrast in this token, as the test words have roughly the same duration. All speakers, however, clearly have a contrast for the *ʔaːh/ʔàːh* pair, shown by the first column.

(16) Durational Ratios for Speaker 1, 4, and 5

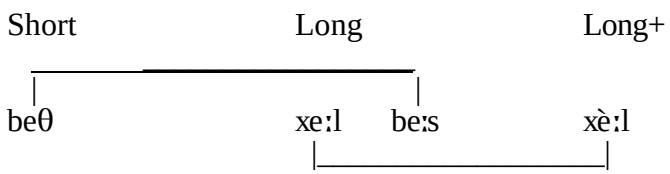


To summarize, all speakers showed significant differences in the ratio for length due to tone and length from other sources. Individual differences were found in the range of each duratonal ratio, with tone-induced length ranging from 1.2-1.4 and other sources of length ranging between 1.5 and 2.8. Also, some speakers do not have a contrast in the word pair *xeːɬ/xèːɬ*.

3.4. Discussion

The exploratory study conducted provides a basic description of the durational properties of short-long contrasts, which are summarized in the next section. It also provides some partial answers to the questions laid out in section 2 concerning the interaction between tone and length. In particular, this study provides evidence for tone-induced length, a correlate to tone that provides evidence for the existence of low marked tone in the ancester language to present day Tahltan. Furthermore, it was shown that tone-induced length differed significantly from other types of length. Thus, in addition to the contrast between *beθ* and *beːs* sketched below in (17), there is a distinct contrast in duration between unmarked *xeːl* and marked *xèːl*.

(17) Two Types of Length Contrasts



One interesting question that this finding raises is how are these two types of length contrasts encoded in the grammar. In a traditional model of the phonetics-phonology interface, we seem to have at least two options. The grammar may distinguish these three categories with distinct phonological categories, for example by mora count. While such a move is not unprecedented, it seems more prudent make such a conclusion once independent evidence is found for such phonological structures. For example, in a recent paper on length and stress in Wtisuwet'en, Hargus 2000 shows that a three-way length distinction is both required by the phonetics of the durational properties of this distinction and the phonology of stress.

An alternative analysis is also possible in which the additional length in tonally marked forms like *xèːl* is a phonetic structure, perhaps the result of a phonetic process that extends the duration of long vowels by the ratios clarified in 3.3. As a gradient phonetic process, however, such an analysis is expected to be rate-dependent (xxx find reference xxx). The second ANOVA presented in 3.3 showed that tone-induced length is not rate dependent, which complicates this analysis if it turns out to be correct.

4. Conclusion

Minimal pairs for length and tone were examined in this exploratory study and a basic characterization of the phonetic properties of these phonological categories was given. As for the tonal minimal pairs, important differences were found in Iskut speakers for F_0 and duration; the ranges for the differences in means are given below. The Telegraph Creek speaker, on the other hand, did not show important differences for F_0, suggesting that this feature is not relevant for tone in this dialect.

(18) Acoustic Correlates in Tonal Minimal Pairs (Iskut Speakers)

Fundamental Frequency:	19-27 Hz
Duration:	28-55 ms

The Telegraph Creek speakers did show important differences for mean duration, which was studied more rigorously for a wider set of minimal pairs. A host of different types of length contrasts were identified on a historical basis, and the durational ratios of each type was studied in five speakers of the Telegraph Creek dialect. Long vowels due to compensatory lengthening showed the most marked durational difference, roughly two and a half times as long as the plain short vowel. Other sources of length, i.e., due to the full versus reduced contrast (fr), high tone (ht), and the possessed versus unpossessed distinction (p), was somewhat less marked: these long vowels were roughly 1.9 to 2.2 the

duration of a corresponding short vowel. Tone-induced length, on the other hand, was much less of a durational difference: long vowels with tone were about 1.2 the duration of the corresponding long vowels, clearly setting these pairs apart from the others.

(19) Durational Ratios for Short/Long Minimal Pairs (TC Speakers)

Compensatory Lengthening:	1/2.6
Other Short/Long Contrasts (fr, ht, p):	1/1.9-2.2
Tone-Induced Length:	1/1.2

If the results above are correct, they contribute to our understanding of the development of tone into present-day Tahltan. For the most part, low marked tone has been eroded away, giving way to the pressures from the stress and intonational system. Indeed, the only reliable contexts for finding low marked tone is in syllables with long vowels that are closed by glottalized resonants. It appears to be the case that pre-Tahltan had tone in a wider set of contexts, however, because of Tone-Induced Length. In particular, the presence of increased duration in syllables predicted to have tone by the Athabaskan Tonogenesis Hypothesis suggests tone did indeed develop in a wider range of contexts than it appears today, and that in some speakers, principally of the Telegraph Creek dialect, tone was lost, but the residual effects on length was left behind.

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Appendix

ʔaːh 'snowshoes' vs ʔàːh 'fog'
e eskiye ʔah enelin 'the boy wants snowshoes'
john ʔaah neʔin 'john see the fog'

tsaʔ 'beaver' vs tsàːʔ 'droppings'
john etsaʔ yeneʔin 'john is looking at the beaver'
john etsaaʔ keʔedee 'john is cleaning up the droppings'

bah 'dirty' vs baːh 'war'
kudži melaʔ bah adadžah 'his hands became dirty'
kudži baah ahudža 'now the war is here'

meɣaʔ 'his hair' vs meɣaːʔ 'half'
etɬiiʔ meɣaʔ utɬ'aan 'the dof has a lot of hair'
dahuni meɣaaʔ eneθʔitɬ'in 'we want our half'

medaʔ 'his beak' vs medaːʔ 'his eye'
estsesk'iye medaʔ ɬeegas 'the crow broke his beak'
john medaaʔ taadah 'john's eye hurts'

xeɬ 'pack' vs xèːɬ 'trap'
john xeɬ enelin 'john wants a pack'
john xeɬ yeneʔin 'john is looking at the trap'

beθ 'riverbank' vs beːs 'knife'
john beθ yeneʔin 'john is looking at the riverbank'
john bees enelin 'john wants a knife'

keneθ 'raft' vs keneːθ 'cross'

john kenеθ etšotš ‘john is paddling the raft’
john keneeθ enelin ‘john wants a cross’

niʔ ‘face’ vs niːʔ ‘moss’
john niʔ yeneʔin ‘john is looking at a face’
john niiʔ kadešyah ‘john is getting the moss’