The Full ~ Reduced Vowel Contrast in Tetsǫ́t'ıné
Evidence for an 8 vowel system

Alessandro Jaker
University of Toronto

Abstract:
Many Dene (Athabaskan) languages, including the reconstructed Proto-Dene language (Krauss 1964), are known to exhibit a contrast between a set of FULL vowels, which are long, tense, and peripheral, and a set of REDUCED vowels, which are short, lax, and centralized. In this paper, I argue that a contrast between full and reduced vowels also exists in Tetsǫ́t'ıné Yatıé, a dialect of Dëne Sųłıné (CHP) spoken in the Northwest Territories, Canada. I report the results of a pilot experiment involving 3 Tetsǫ́t'ıné speakers, which show that this dialect has a total of 8 vowels in morphologically non-derived stems: five full vowels *a* [aː], *e* [ɛː], *i* [iː], *o* [oː], *u* [ʉː], and three reduced vowels, *ä* [ɐ], *ë* [ə], and *ü* [ɵ]. Reduced vowels are both shorter in duration and more centralized than their full counterparts. I also provide distributional evidence that full vowels count as phonologically long, while reduced vowels count as phonologically short, and that the distribution of the reduced vowels is contrastive.

1.0 Introduction

This paper describes the vowel system of Tetsǫ́t'ıné, a dialect of Dëne Sųłıné (Chipewyan) spoken in Canada's Northwest Territories. I will present evidence that this dialect exhibits a vowel system which is substantially different from the vowel system which has been reported for other dialects (Cook 1983). Specifically, I will argue that the Tetsǫ́t'ıné dialect has a system of 8 contrastive vowels in morphologically simple, non-derived stems: five FULL vowels *a* [aː], *e* [ɛː], *i* [iː], *o* [oː], and *u* [ʉː], and three REDUCED vowels, *ä* [ɐ], *ë* [ə], and *ü* [ɵ]. The full vowels are long, tense, and peripheral, while the reduced vowels are short, lax, and centralized. In other words, full vowels are distinguished from reduced vowels by a combination of duration and vowel quality differences.

This paper is the first published paper to focus specifically on the vowel system of the Tetsǫ́t'ıné dialect; an earlier published paper on this dialect, that of Haas (1968) focuses instead on the *t* > *k* shift, which is exhibited by some speakers of this dialect. The lack of previous documentation of this language variety is likely due in large part to the earlier claim that this dialect had gone extinct in the early 20th century (Gillespie 1981: 285). Indeed, given the differences between Tetsǫ́t'ıné and Dëne Sųłıné 'proper', not only in the vowel system, but also in verb morphology (cf. Cook 2004, Jaker & Cardinal to appear) one might indeed question whether these should all be considered dialects of the same language, or distinct language varieties. I will not address this issue directly in this paper, except that I will conclude that, for writing in the Tetsǫ́t'ıné dialect, it is necessary to modify to some extent the standard Chipewyan orthography used by the Government of the Northwest Territories. Specifically, while the standard Chipewyan orthography recognizes only six vowel symbols, *a, e, ı, o, u, ë*, I will argue that the Tetsǫ́t'ıné dialect requires a total of eight vowels symbols: *a, e, ı, o, u, ä, ë,* and *ü*, in order to accurately represent all of the phonological contrasts in this dialect.

2.0 Background on full and reduced vowels

2.1 Historical Background

The original Proto Dene (Proto Athapaskan) language is reconstructed as having had a system of 7 vowels: four full vowels **a·*, **e·*, **i·*, and **u·*, and three reduced vowels **ɑ*, **ə*, and **ʊ* (Krauss 1964). According to Krauss, it is likely that, at a still earlier period, there was a symmetrical system of eight vowels, four full and four reduced, and the reduced vowels were derived from the full vowels by a set of regular rules, most likely conditioned by suffixation after the stem. However, already by the Proto Dene period, these full ~ reduced vowel alternations had become phonemic and contrastive, and the reduced counterparts of the full vowels **e·* and **i·* had merged into a single reduced vowel, **ə*. The resulting system is shown in (1).

(1) Original Proto Dene (Proto Athapaskan) vowel system, according to Krauss (1964, 2005)

Full Vowels	a·	e·	i·	u·
Reduced Vowels	ɑ	ə		ʊ

In comparing the reconstructed Proto Dene forms to modern forms from the Tetsǫ́t'ıné language, it seems to be generally the case that where Proto Dene had a full vowel, Tetsǫ́t'ıné retains a full vowel (the vowels written as *a, e, i, o,* and *u*), and where Proto Dene had a reduced vowel, Tetsǫ́t'ıné also has a reduced vowel (the vowels which will be written in this paper as *ä, ë,* and *ü*). The correspondences between Proto Dene vowels and Tetsǫ́t'ıné vowels, which I am proposing in this paper, are given in (2). The IPA values for Tetsǫ́t'ıné are given beneath the orthographic symbols.

(2) Correspondences between Proto-Dene vowels and Tetsǫ́t'ıné vowels

Proto Dene Vowels	*a·	*e·	*i·	*u·	*ɑ	*ə	*ʊ	au *or* aCu
Tetsǫ́t'ıné Vowels	a	e	ı	u	ä	ë	ü	o
	[ɑː]	[ɛː]	[iː]	[ʉː]	[ɐ]	[ɘ]	[ɵ]	[oː]

The correspondences between Proto Dene vowels and Tetsǫ́t'ıné vowels is generally fairly simple: most of the vowels have stayed the same, in their basic reflexes. The only complication involves the modern vowels *ü* and *o*. In Tetsǫ́t'ıné, *o* is a full (long) vowel in stems, while *ü* is a reduced (short) vowel. The long vowel *o* has two historical sources: it comes either from the historically reduced vowel **ʊ*, as in *k'oth* 'cloud' (from PD **k^{w}'ʊs*), or else it comes from a historical diphthong *au*, or *a* and *u* separated by a consonant, which coalesced to form *o*. An example of this would be the interrogative *ʔedló* 'when?', which comes from the pronoun *ʔedla* 'what' combined with the temporal particle *-ú* 'at that time'. Looking at this another way, we could say that the Proto Dene (PD) phoneme **ʊ* has split into two different phonemes: it is preserved as *ü* (phonetically [ʊ] or [ɵ]) before *n*, as in *kǘn* 'firewood'; elsewhere, it is realized as a long *o* vowel,

as in *k'oth* 'cloud'. Thus, historical **ʊ* has two different reflexes, and modern *o* has two different historical sources, as shown in (2).

Some examples of Proto-Dene words, along with their modern Tetsǫ́t'ıné reflexes, are given in (3). The Tetsǫ́t'ıné examples are from my own fieldnotes. The main point of these tables is to note that, in many cases, vowels which were historically full are still full vowels in the modern language, and vowels which were historically reduced are similarly still reduced in the modern language. Thus, in at least some words, Tetsǫ́t'ıné preserves the historical full ~ reduced vowel contrast, much like other Dene languages (e.g. Jetté & Jones 2000).

(3a) Proto Dene words with full vowels (based on Krauss 1964)

Proto Dene word/stem	**English gloss**	**Tetsǫ́t'ıné word**	**English gloss**
tš**a**ʔ	'beaver'	ts**á**	'beaver'
x̲ʷ**a**	'sun'	s**a**	'sun'
dž̲**e**xʔ	'spruce gum'	dz**é**h	'spruce gum'
gʷ**e**n	'day'	dz**ı̨**	'day'
š**i**	'I, me'	s**ı**	'I, me'
ts**i**ʔ	'head'	setth**í**	'my head'
t**u**	'water'	t**u**, k**u**	'water'
tš**u**	'grandmother'	sets**u**né	'my grandmother'

(3b) Proto Dene words with reduced vowels (based on Krauss 1964)[1]

Proto Dene word/stem	**English gloss**	**Tetsǫ́t'ıné word**	**English gloss**
gʌn	'dry'	ʔeg**ä**né	'dry meat'
xʌx̲	'winter'	x**ä**ı	'winter'
tsənʔ	'flesh'	tth**ə́**n	'meat'
ts'ən	'bone'	tth'**ë**n	'bone'
k̲ən	'stick'	dech**ë**n	'stick'
kʷ'**ʊ**s	'cloud'	k'**o**th	'cloud'
gʷ**ʊ**d	'poke'	theg**o**r	'he/she stabbed'
kʷ**ʊ**nʔ	'fire'	k**ű**n	'wood, firewood'

While Tetsǫ́t'ıné maintains a distinction between full and reduced vowels, as shown in (3), the reason why a word in the modern language has a *particular* reduced vowel—that is, the choice of *ä* vs. *ë* vs. *ü*—is not always entirely clear, from a historical perspective. Consider, for example, the two modern Tetsǫ́t'ıné words *däth* 'driftwood' and *tsës* 'firewood', which form a near-minimal pair. DeReuse (2014) gives the Proto Dene word for driftwood as **dəʒ* and firewood as **čʷəǯʷ*. That is, both words are reconstructed as having the same vowel historically, **ə*. While it is true that the vowel in 'driftwood' is followed by a PD palatal consonant, and 'firewood' by a PD rounded palatal (i.e. retroflex) consonant, it does not seem to be the case, in general, that Tetsǫ́t'ıné *ë* occurs before PD palatal consonants, and *ä* occurs before PD rounded palatal (or retroflex)

[1] A slightly different set of reconstructions, using a somewhat different set of symbols, is given in Krauss (2005). In this later paper, Krauss gives *tuˑ* 'water', *šʷaˑ* 'sun', *ʒʷeˑn(ə)* 'day' (82), *cʼən* 'bone', *k̲ən* 'stick' (90), *qʼʊs* 'cloud' (91), *ciʼ* 'head' (94), *čaʼ* 'beaver' (94), *cəỹʼ* 'flesh', *qʊnʼ* 'fire' (102).

consonants. That is, the sound correspondences for the reduced vowels do not seem entirely regular, based on our current understanding. This problem of seemingly irregular reflexes for reduced vowels was noted early on by Krauss:

> "We are only beginning to untangle the development of the reduced vowels. Apparently, *α and *ə were usually shifted to *ʊ in contexts with labialized consonants, especially labialized back velars....In contexts with the *k̂-series, *α and *ʊ were often shifted to *ə....In many languages, including Chipewyan and Navaho, but not Minto, *ə was shifted to *α before *x, *g. *ə was further shifted to *i* in Chipewyan under the influence of *x̂ (and sometimes *n) (Krauss 1964: 122-123).

In other words, even in Proto Dene, the distribution of reduced vowels was partially predictable, based on neighbouring consonants. On the other hand, when trying to explain the distribution of reduced *ä, ë,* and *ü,* it is also necessary to allow for a residue of cases which are direct reflexes of the historical *α ~ ə* contrast in PD (Michael Krauss, p.c.). In so far as these cases do not match our current PD reconstructions, it is also possible that some of our reconstructions of PD may need to be revised. This is because reconstructions are ultimately derived from primary language data, and, as I will suggest in this paper, Tetsǫ́t'ıné constitutes a potentially large and important source of data for the reconstruction of PD vowels which has been missing up until now. Thus, while knowing the distribution of full and reduced vowels in PD, as they are reconstructed at present (e.g. Krass 2005, DeReuse 2014), can guide the search for full and reduced vowels in Tetsǫ́t'ıné, it is equally true that data from Tetsǫ́t'ıné—in the form of an extensive word list or dictionary making note of full and reduced vowels—could advance our understanding of the PD vowel system.

2.2 Sound system and orthography for Tetsǫ́t'ıné

In this paper, I will use a slightly modified version of the standard orthography for Chipewyan, used by the Government of the Northwest Territories, to present my hypotheses and results. This is for two reasons. The first is that this paper may be of interest to language workers and language teachers concerned with orthography and language revitalization, and so presenting this paper using a version of the orthography, rather than in IPA, will make this paper more understandable and accessible to these interested parties. The second reason is that, since no previous phonetic studies of Tetsǫ́t'ıné vowels have been undertaken previously, we cannot presume to know the precise phonetic quality of these vowels in advance. Orthographic symbols are thus in some sense 'neutral' with regards to the precise phonetic quality of the vowels they represent. However, to anticipate my conclusions somewhat, IPA values are given in square brackets [ ] besides the orthographic symbols which I will use for consonants in (4), and for vowels in (5).

(4) Tetsǫ́t'ıné consonant inventory

		Labial	Interdental	Alveolar	Lateral	Alveo-palatal	Velar/ Uvular	Glottal
Stops and affricates	Plain	b [p]	ddh [tθ]	d [t], dz [ts]	dl [tɬ]	j [tʃ]	g [k]	
	Aspirate		tth [$tθ^h$]	t [t^x], ts [ts^h]	tɬ [$tɬ^h$]	ch [$tʃ^h$]	k [k^x]	
	Ejective		tth' [tθ']	t' [t'], ts' [ts']	tɬ' [tɬ']	ch' [tʃ']	k' [k']	ʔ [ʔ]
Fricatives	Voiced		dh [ð]	z [z]	l [l]		ɣ [ɣ]	
	Voiceless		th [θ]	s [s]	ɬ [ɬ]	sh [ʃ]	x [x]	h [h]
Sonorants	Oral	w [w]		r [ɹ]		y [j]		
	Nasal	m [m]		n [n]		ñ [ɲ][2]		

(5) Hypothesized Tetsǫ́t'ıné vowel inventory

	Stems			Prefixes		
	Front	Central	Back	Front	Central	Back
High	ı [i:]	u [ʉ:]		ı [i]	u [ʉ]	
High-Mid	ë [ɘ]	ü [ɵ]				
Mid	e [ɛ:]		o [o:]	e [ɛ]		o [ɔ]
Low-Mid		ä [ɐ]				
Low			a [ɑ:]		a [ɐ]	

In this paper, I will be claiming, as shown in (5), that, in morphologicaly non-derived environments, Tetsǫ́t'ıné has an inventory of 8 contrastive vowels in stems. In stems, there are five full vowels *a* [ɑ:], *e* [ɛ:], *ı* [i:], *o* [o:], and *u* [ʉ:], and three reduced vowels, *ä* [ɐ], *ë* [ɘ], and *ü* [ɵ]. In prefixes, the full ~ reduced vowel contrast is neutralized, such that all prefix vowels are underlyingly short. Although prefix vowels are not included as part of the phonetic study to be described in this paper, as suggested in (5), short vowels in prefixes do not necessarily have the same phonetic quality as reduced vowels in stems, based on my own subjective impession. Differences in vowel quality between stem vowels and prefix vowels may be a topic for a future phonetic study.

Insofar as the vowel system in (5) may seem somewhat un-balanced, this is largely due to the convention of organizing vowel charts along the two dimensions of height and frontness-backness. If we consider that the vowels *u, ü,* and *o* are actually distinguished from the other vowels by *roundness* (i.e. the feature [round]) rather than backness, the vowel system is actually much more well-balanced and well-dispersed than it would appear in (5). In any case, phonological labels such as 'round' and 'back' are only very general descriptors, and the purpose of this paper is to investigate the precise phonetic quality of these vowels.

[2] This sound does not occur on the surface. Palatal *ñ* surfaces either as nasalization or raising of the preceding vowel, or as plain *n*.

3.0 Previous work on the vowel systems of Dëne Sųłıné dialects

Because the Tetsǫ́t'ıné (Yellowknife) dialect of Dëne Sųłıné was previously declared extinct by anthropologists (Gillespie 1981), there have been no previous studies specifically focused on the vowel system of Tetsǫ́t'ıné. However, there is a brief paper on Tetsǫ́t'ıné by Mary Haas (1968), as well as analyses of the vowel systems of other Dëne Sųłıné dialects. What we will find is that all of the previous sources seem to assume, at least implicitly, some version of the full ~ reduced vowel contrast. However there is dialect variation, and there are also differences in how this contrast has been interpreted from a phonological perspective. That is, the full ~ reduced vowel contrast has been treated sometimes as a length contrast, and sometimes as a vowel quality contrast.

First we will briefly consider the paper by Mary Haas, *Notes on a Chipewyan Dialect*, from 1968. Although very brief, this work is relevant to the present study because it is based on work with a Tetsǫ́t'ıné speaker from Dettah, Northwest Territories, Mr. John Abel. In this word list, there is some very limited evidence for a contrast between full and reduced *a*, if we consider the examples *gani* 'pine tree' (1968: 173) and *sets'á·nɛ* 'my wife'. This contrast which Haas represents orthographically as *a* vs. *a·* does happen to be a reflex of a historical contrast between a reduced vowel and a full vowel, respectively. There is no evidence for a contrast between full and reduced *u* in this wordlist. However, Haas does very reliably record the contrast between full and reduced *e* (i.e. *e* vs. *ë*), as a vowel quality distinction, in a manner which is consistent both with comparative evidence from other Dene languages, as well as with my own field experience with the Tetsǫ́t'ıné dialect. Haas writes *ɛ* or *e* for the full vowel, and *ə* for the reduced vowel, in stems. Thus we observe the full vowel in words such as *tłɛzé* 'grease' and *łés* 'flour' (1968: 172), and the reduced vowel in words such as *dzən* 'muskrat' (1968: 173) and *džən* 'sing' (1968: 174).

All of the remaining sources deal with other Dëne Sųłıné dialects. There are two major works on Dëne Sųłıné by Fang-Kuei Li, his *A List of Chipewyan Stems* (1933) and his grammatical sketch *Chipewyan* (1946). The Dëne Sųłıné vowel system assumed by Li is given in (6).

(6) Vowel system of Dëne Sųłıné (Chipewyan) according to Fang-Kuei Li (1946)

Short Vowels:	a	ɛ	e	i	o	u
Long vowels:	a·	ɛ·		i·		u·
Nasalized short vowels:	ą	ɛ̨		į		ų
Nasalized long vowels:	ą·	ɛ̨·		į·		ų·
Diphthongs:	ai ąi		ei		oi oį	ui uį

While it is clear from (6) that Li believed there was a contrast between long and short vowels in Dëne Sųłıné, it is not immediately obvious if we can equate this contrast with the PD full ~ reduced vowel contrast. That is, it seems that the majority of long vowels recorded by Li are actually secondary the word for 'now', which Li gives as either *dųhú* or *duɛ̨̌* (1946: 422), where the latter variant as a long vowel and rising tone, which is derived from the former by deletion of intervocalic *h* and coalescence of the two neighbouring vowels.

Regarding underlying long vowels, Li does seem to consistently record a long *iˑ* in inflectional prefixes, which does come from a PD full vowel. Li gives the 1du/pl prefix as underlyingly *íˑ(d)* and the 1sg perfective prefix as *iˑ* in Ø-classifier verbs, and *i* in *ɬ*-classifier verbs (1946: 411). Some examples with long *iˑ* include *θiˑɣar* 'I shake it', *niˑyą* 'I have grown up' (1946: 400). The 1st person singular perfective prefix *iˑ* does indeed derive from a full vowel **iː* in Proto Dene (Krauss & Leer 1981). On the other hand, in stems, Li does not seem to consistently mark a distinction between what we would expect to be full and reduced vowels, based on comparative evidence. That is, in many cases Li represents both historical **ə* as well as historical **eː* with the same vowel, *e*. Thus, Li writes *t'θen* 'bone' (1946: 402) and *cen* 'song' (1946: 400), which historically have reduced vowels, as well as *des* 'river' and *bes* 'knife' (1946: 401), which historically have full vowels (cf. Krauss 2005). In so far as the contrast between full and reduced *e* is represented at all, in stems, it seems that Li uses *ɛ* for the full vowel (e.g. *θíˑtɛz* 'we are lying' (1946: 405)) and *e* for the reduced vowel (e.g. *dɛldðér* 'it rattles' (1946: 401)), which is somewhat counter-intuitive, at least orthographically. In the case of *a* and *u*, Li does not represent the contrast between historical full and reduced vowels at all, either as length or as quality. For example, Li writes *yàθ* 'snow (on the ground)' *cás* and 'knot' (1933:146) with the same vowel; in the Tetsǫ́t'ınné dialect, these two words have different vowels: *yäth* (reduced vowel) and *shás* (full vowel).

To summarize, while there is some reason to suspect that the dialect investigated by Fang-Kuei Li may have maintained a contrast between full and reduced vowels in at least some environments, we do not find this contrast marked consistently, in the places where we would expect based on comparative evidence. For the most part, the length contrasts marked by Li represent secondary length, the result if intervocalic consonant deletion and coalescence.

Next, we will review the work of Eung-Do Cook. In his 1983 paper *Chipewyan Vowels*, which later formed the basis for the standardized spelling system adopted by the Government of the Northwest Territories, Cook described the Dëne Sųłınné language as exhibiting the vowel system depicted in (7).

(7) Dëne Sųłınné (Chipewyan) vowel system according to Cook (1983: 416)

i				*u*
	e	*ə*	*o*	
		a		

Cook characterized this system as a vestige of the PD full ~ reduced vowel contrast, in the sense that he regarded *ə* as a reduced vowel, and all of the other vowels as full vowels (1983: 417). However, from a phonological perspective, this full ~ reduced vowel contrast survives only a vowel quality contrast, in Cook's view, and not as a length contrast. The existence of an underlying contrast between long and short vowels, stemming directly from the PD full ~ reduced vowel contrast, is something which Cook explicitly denied:

> "Although there are long vowels which cannot be accounted for in terms of double vowels (see below), there is no clear evidence that length is phonemic on the autonomous phonemic level. The most convincing evidence for phonemic vowel length would be minimal pairs, and it is usually not difficult to gather a fair number of them if length is indeed phonemic. Continued search for such evidence has produced no results" (1983: 424).

In later work, Cook does acknowledge that different dialects of Dëne Sųłıné have different vowel systems, and that an underlying vowel length contrast, similar to the Proto Dene contrast between full and reduced vowels, is retained in Cold Lake dialect (Cook 2004: 28-30). It is not clear, however, why the existence of a full ~ reduced vowel contrast should be restricted to Cold Lake dialect in particular. In this paper, I will present phonetic evidence that there exists at least one other dialect, the Tetsǫ́t'ıné dialect, which maintains a contrast between full and reduced vowels in stems.

Finally, a brief but important study is a set of fieldnotes by Michael Krauss, from 1983, entitled *Vowels in Saskatchewan Chipewyan: Mary Jane Kasyon*. In this set of fieldnotes, Krauss describes a system with a total of 10 vowels: *a, e, i, o,* and *u*, each of which can be either long or short. This long and short contrast derives, to a large extent, from the PD contrast between full and reduced vowels. For example, the words *beˑs* 'knife' and *tθ'áˑy* 'plate, cup', which derive from the PD full vowels **aˑ* and **eˑ*, respectively, versus the words *dɛɬ* 'blood' and *xʌɬ* 'club', which derive from the PD reduced vowels **ə* and **ɑ*, respectively. Importantly, Krauss also notes that there are differences in the vowel systems of different dialects of Dëne Sųłıné; in particular, he notes that Łútsëlk'é (Snowdrift) dialect seems to have a different vowel system from that found in northern Saskatchewan:

> "Other dialects of Chipewyan may be profoundly different, e.g. at Snowdrift there is only one vowel, the same, [e] for both Sask. [eˑ] and [ɛ], and likely there is only one vowel [o] for Sask. [oˑ] and [o] (and [ʊ]? Needs checking; or maybe [ʊ] and [uː]) are alike there. There are probably two different vowels, [ʌ] or [ə] and [a], for Sask. [ʌ] and [aˑ], but that bears checking, too. Some N. Chip. Dialects may have only 6 vowels *i e a o u ə*, or maybe 5 i.e. *a o u* (*ə* = *a*), or conceivably only 4 (*ə* = *a*, *o* =*C*^{w}) (Krauss 1983: 4).

This dialect diversity perspective is important to bear in mind, when considering the evidence to be presented in this paper. 'Dëne Sųłıné' is a cover term for a large number of dialects, historically spoken across a very large geographical area, spanning 3 provinces and 2 territories. There is no *a priori* reason to assume that all dialects belonging to this language-complex should exhibit the same vowel system. The Tetsǫ́t'ıné dialect is the north-westernmost member of this language complex, and, as we might expect, shows effects of language contact with Tłı̨chǫ and North Slavey in its lexicon and verbal morphophonemics. However, we must also be open to the possibility that this dialect preserves some conservative features which may have been lost elsewhere. In particular, I claim that, in stems, Tetsǫ́t'ıné maintains a vowel system very similar to the original PD vowel system, as shown in (2), with a contrast between full and reduced vowels.

4.0 Hypothesis

The vowel system which I propose for the Tetsǫ́t'ıné dialect is given in (9) (repeated from (5)).

(9) Hypothesized Tetsǫ́t'ıné vowel inventory

	Stems			Prefixes		
	Front	Central	Back	Front	Central	Back
High	ı [iː]	u [ʉː]		ı [i]	u [ʉ]	
High-Mid	ë [ɘ]	ü [ɵ]				
Mid	e [ɛː]		o [oː]	e [ɛ]		o [ɔ]
Low-Mid		ä [ɐ]				
Low			a [ɑː]		a [ɐ]	

As shown in (9), an underlying contrast between full and reduced vowels exists only in stems, not in prefixes. The phonetic experiment described in this paper is restricted to stems. Specifically, the set of stimuli were restricted to non-derived, monomorphemic stems, of both nouns and verbs, to investigate whether there exists a contrast between full and reduced vowels. At this point, it is useful to introduce a conceptual distinction between UNDERLYING length, and PRIMARY length. Underlying length refers to the synchronic grammar. A vowel is underlyingly full, if it is full in the underlying representation, and is not made full as a result of some synchronic phonological process. On the other hand, primary length refers to the history of the language. A primary full vowel is a vowel which is reconstructed as being full in PD, whereas a secondary full vowel is a vowel which was reduced historically, but which has become full as the result of later sound change. I do not claim that all of the underlying full and reduced vowels in this study are primary (historically) full and reduced vowels, unchanged from PD. In fact, in the case of the vowel *o*, it seems that in the majority of cases, this vowel comes from the PD reduced vowel **ʊ*. Nevertheless, in this study, the vowel *o* still counts as an underlyingly full vowel in the word *k'oth* 'cloud', even though it is not a primary (historically) full vowel.

In trying to construct a list of experimental stimuli, to measure the acoustic properties of the vowel system, the main limiting factor was the lack of a published dictionary or word list which records the distinction between full and reduced vowels. That is, all of the major published sources on the Dëne Sųłıné language, including Elford & Elford (1981), Cook (2004), and Kaulback, Catholique, and Drygeese (2012) record only the contrast between full *e* and reduced *ë*, but do not distinguish full *a* from reduced *ä*, or full *u* from reduced *ü*. A comprehensive dictionary of the Tetsǫ́t'ıné dialect, with over 7,500 entries, which records the full ~ reduced vowel contrast in all lexical stems, is currently in preparation (Jaker & Cardinal, in preparation). At the time this experiment was conducted, however, in the summer of 2017, I was limited to a small set of high-frequency words which I had come across in my own fieldwork, and which seemed to me to be good illustrations of the full ~ reduced vowel contrast, which will be listed below.

The set of words used in my experimental stimuli, and pronounced by my speakers, is given in (11) for the full vowels, and (12) for the reduced vowels.

(11a) Experimental stimuli using full vowels *a, e, ɪ*

Full /a/		**Full /e/**		**Full /ɪ/**	
hetsagh	‘cry’	bes	‘knife’	heɬk’íth	‘shoot’
heɬtthát̄h	‘whip’	des	‘river’	híʔíth	‘kick’
hegháth	‘carve’	tɬes	‘grease’	xátɬ’ír	‘fall out’
besxáth	‘curved knife’	ʔɻyes	‘bird’	kɪl	‘pail’
dzérét’agh	‘fly around’	ʔeghés	‘egg’	tsɪl	‘snow’
begáné	‘his arm’	ɬés	‘flour’	ʔedets’ír	‘scratch one’s self’
tatsán	‘metal’				
nedáth	‘heavy’				
shás	‘knot’				

(11b) Experimental stimuli using full vowels *o, u*

Full /o/		**Full /u/**	
dzolé	‘ball’	ɬus	‘spoon’
dekoth	‘cough’	ʔezus	‘drifting snow’
k’oth	‘cloud’	denur	‘soft’
tɬ’ogh	‘grass’	dezur	‘smooth, slippery’
chogh	‘big’	theɬchúth	‘it is sitting (cloth)’
thegor	‘he/she stabbed’	náyeɬt’us	‘he/she punches him’

(12) Experimental stimuli using reduced vowels *ä, ë, ü*

Reduced /ä/		**Reduced /ë/**		**Reduced /ü/**	
yäth	‘snow’	chëth	‘duck’	kű̄n	‘fire’
thäth	‘belt’	tsës	‘wood’	ʔoneɬkű̄n	‘blackfly’
däth	‘driftwood’	ʔeɬdzës	‘traps’	yelts’ű̄n	‘she kisses him’
säs	‘bear’	tsádhḗth	‘beaver pelt’	belákű̄n	‘he shakes his hand’
nát’ä́th	‘he/she cuts’	ʔetthḗn	‘caribou’	tthechű̄ncho	‘lapland longspur’
hunék’äth	‘it is cool’	tth’ën	‘bone’		
k’ok’ä́n	‘candle’	dzën	‘muskrat’		
gän ts’u	‘jackpine’	hejën	‘he/she sings’		
łekän	‘sweet’	delzën	‘black’		
xä́l	‘club’				
hak’äl	‘file’				
ʔäl	‘spruce boughs’				
begän	‘skinny’				

In choosing stimuli, I chose, for both full and reduced vowels, words in which, in the citation form, the vowel to be measured occurred in a closed syllable. This was to avoid any potential confound involving vowel lengthening in open syllables. The only exception in the above list was the word *begáné* ‘his arm’. However, for some of the tokens, when the word was actually pronounced by the experimental subjects, the subjects either epenthesized a vowel after the final consonant (for example, *tatsáné* rather than *tatsán*), or in other cases the final consonant was weakly articulated or absent (for example, *tɬ’o* rather than *tɬ’ogh*). In these cases, the token was

retained and included in the set of measurements. In other words, the criterion of vowels occurring in closed syllables was applied only to the selection of stimuli based on their citation forms; however I did not throw out tokens if a speaker produced a variant of the form containing an open syllable.

Regarding the specific phonetic differences between full and reduced vowels, there were three main differences that I hypothesized. The first and most important difference is duration: I hypothesized that full vowels should be 50-100% longer than their corresponding reduced vowels, and that all full vowels should be longer than all of the reduced vowels. This is consistent with what is observed cross-linguistically, in languages in which vowel length is contrastive (Lehiste 1970: 33-35). Secondly, I predicted that reduced vowels should be more centralized than their corresponding full vowels. At the acoustic phonetic level, this predicts opposite effects for the *e* ~ *ë* versus the *a* ~ *ä* and *u* ~ *ü* vowel pairs. That is, since *e* is a front vowel, with a high F2, being more 'centralized' entails that *ë* would have a lower F2. On the other hand, since *a* and *u* are back vowels, being more 'centralized' entails that *ä* and *ü* will have *higher* F2 values. Indeed, this hypothesis of centralization is reflected in the choice of orthographic symbols: <ä>, <ë>, and <ü>. Finally, I predicted that the reduced counterparts of high vowels *ɪ* and *u* will be lower (that is, have a higher F1, intermediate between *ɪ* and *e* or *o* and *u*), and that the reduced counterpart of *a* will be higher (that is, *ä* will have a lower F1 than *a*). The hypothesis could be summed up by saying that I predicted that the three reduced vowels will all be shorter and will be located closer to the 'middle' of the vowel space. In other words, a system of five cardinal vowels, for the full vowels, reduces to a system of just 3 vowels: a front vowel, a rounded vowel, and a low vowel.

5.0 Methods

Three speakers of the Tetsǫ́t'ıné dialect, all middle-aged fluent speakers, all from the same family, and all currently residing in Yellowknife, Northwest Territories, were recruited to participate in this study: Fred Nitah, Georgina Nitah, and Emerence Cardinal. In the remainder of this paper, I will refer to these speakers by their initials: FN, GN, and EC.

To administer the stimuli, I prepared a powerpoint presentation, where each slide consisted of a picture of the word I was trying to elicit, as well as the word itself, written in the slightly modified version of the standard Roman orthography which I have been using in this paper (that is, with eight vowels *a, e, ɪ, o, u, ä, ë,* and *ü*). Some examples of slides used in the experiment are given in (13). Pictured below are the slides for *shás* 'knot', *ɔeghés* 'eggs', *säs delzën* 'black bear', and *chëth* 'ducks'.

(13) Examples of powerpoint slides used in experiment

In the case of stimuli where the target consisted of more than one word, such as *säs delzën*, both stem vowels were measured and included in the results, i.e. both the *ä* of *säs* and the *ë* of *delzën*. The main reason to include writing along with the pictures was that the same picture could potentially yield several different correct responses in the language. For example, the picture of a rope with a knot in it might have produced the response *tł'ule* or *tł'ul* 'rope', while the picture of ducks might have elicited the response *ɂɻyes* or *ɂɻyeze* 'birds', or even the names of specific species of ducks. Thus the written words were something which I, as the experimenter, felt was necessary in order to keep the elicitation 'on task'. In choosing to include a written word along with the picture, there does come the potential risk that the speakers' pronunciation will be influenced by the orthography. For two of the speakers, FN and GN, this risk was rather low, since although both of them are fluent speakers, and are literate in English, they do not often use the standard written form of Chipewyan (Tetsǫ́t'ıné), and thus were not likely to be influenced by it. In the case of the third speaker EC, however, who is highly literate and was formally trained as an interpreter/translator, and worked for several years as a language teacher, this issue was somewhat more of a concern, in particular because of the confusion between the *a* and *ä* and *ë* sounds, which exists in the current orthography. In a previous version of this experiment, EC pronounced almost all of the words written with *ë* with the *ä* sound (for example saying *chäth* instead of *chëth*) and also many of the words which I had written with the reduced *ä* sound using the long *a* sound (for

example saying *ganı* rather than *gänı*, for 'jackpine'). In preparation for this experiment, therefore, I reviewed with EC what exactly I meant by my use of vowel symbols (*a, e, ı, o, u, ä, ë, ü*), and also told her, "say the words the way you would normally say them in real life, don't worry too much about how they're written". In other words, EC was not a naïve subject: she was aware of the purpose of the experiment, but was also aware that she should try to pronounce the words the same way she would pronounce them in real life.

Based on my past experience, I had found that speakers have difficulty in consistently producing the target words within a fixed carrier sentence, and so for this experiment, I simply asked the participants to say each word twice, in isolation. This method does carry the risk of obscuring durational contrasts—in particular, it is likely that reduced vowels will be somewhat phonetically lengthened when a word is emphasized and pronounced in isolation. My participants EC and GN produced the target words as instructed, saying each word twice. Participant FN, however, did not follow instructions, and instead created his own carrier sentence for each word, with each sentence ending in *bóret'ı* 'it seems'. For example, *náke chëth dechën k'e heke bóret'ı* 'two ducks are sitting on a log, it seems', in response to one of the slides in (13). This may be a potentially useful strategy for the future, to embed target words in a carrier sentence using *bóret'ı* 'it seems', which speakers may find more natural than some of the carrier sentences commonly used for phonetic experiments in English (e.g. *'say ____ again', 'I am saying ____'*).

The participants were recorded using a Marantz PMD671 Compact Flash digital recorder, with a sampling rate of 24bit and 48kHz, and using two cardioid condenser microphones, approximately 12 inches from the speaker. The sound files were cut up using *Audacity* and acoustic analysis was conducted in *Praat*. All of the measurements in this study were of vowels: for each vowel, I measured its duration, as well as the first three formants. Vowel formant measurements were taken at the midpoint of the vowel. Vowel duration was determined as follows. For vowels preceded by a stop consonant, I counted the vowel as beginning immediately following the release burst for plain stops, and immediately following the glottal release for ejective stops (or glottal stops). For aspirate stops, which are characteristically accompanied by a great deal of frication noise in Dene languages (McDonough & Wood 2008), I counted the vowel as beginning with the offset of frication noise, and the beginning of complex vowel formants. In other words, the aspiration or frication portion of aspirate consonants was counted as part of the consonant, rather than part of the vowel. For fricative onsets, I counted the vowel as beginning with the end of frication noise and the beginning of complex vowel formants, and conversely with fricative codas, I counted the vowel as ending with the offset of complex vowel formants and the beginning of frication noise. Nasal, lateral, and glide onsets and codas were the most challenging; for these, I looked for the point of most rapid change in amplitude and vowel formants, and I placed the segment boundary as close as possible to the point of most rapid transition between sonorant and vowel or vowel and sonorant.

A total of 460 vowels were measured. The measurements were collected in Microsoft *Excel* tables. Bar graphs and statistics, which consisted of finding the mean as well as two-tailed *t*-tests assuming unequal variances, were done in *Excel*, with the exception of plots of the entire vowel space, which were done in *R*.

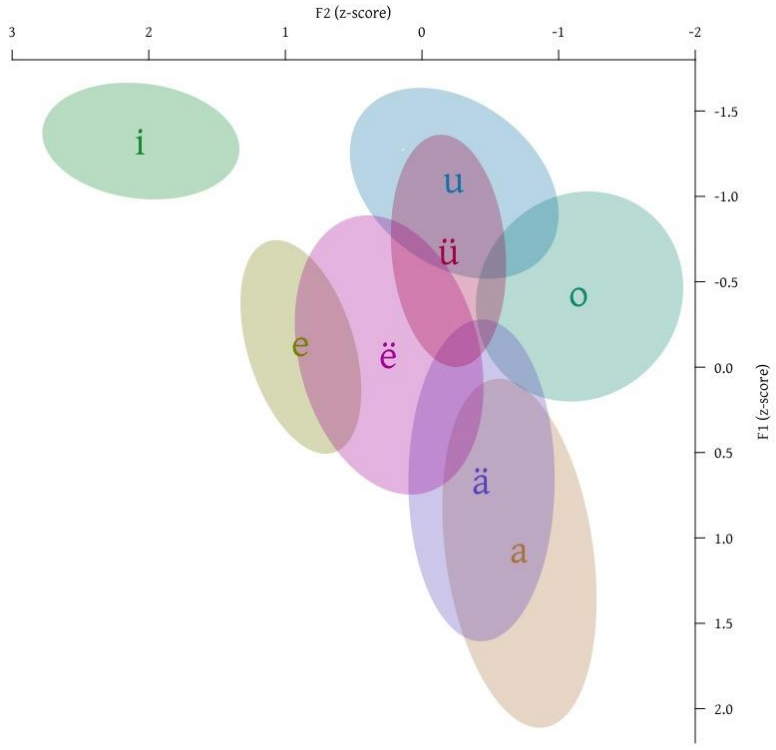
6.0 Results

In this section, I will describe the results of the experiment. This section is divided into two parts. In §6.1 I will describe the general structure of the Tetsǫ́t'ıné vowel space, focusing on just F1 and F2, while in §6.2 I will go into detail regarding each of the three reduced vowels, *ä*, *ë*, and *ü*, and provide statistics to show how each of these vowels differs from its neighbouring vowels, in duration as well as F1, F2, and F3. My goal is to demonstrate the existence of eight discrete vowel phones at the phonetic level.

6.1 General properties of the vowel space

As we can see in (14), which is a normalized, composite graph of the three speakers FN, GN, and EC, the general structure of the Tetsǫ́t'ıné vowel space broadly confirms the set of hypotheses laid out in §4: there are 5 full vowels and 3 reduced vowels; the full vowels *a, e, ı, o,* and *u* are all located towards the periphery of the vowel space, while the three reduced vowels *ä*, *ë*, and *ü* are all located closer to the center, relative to the full vowels.

(14) Illustration of Tetsǫ́t'ıné vowel space: 5 full vowels and 3 reduced vowels



Specifically, the reduced vowel *ä* [ɐ] is both fronter and higher than *a* [ɑː], as predicted. The reduced vowel *ü* [ɵ] is of an intermediate height between *o* and *u*, and is significantly more central (i.e. more fronted) than *o* [oː], but not *u*: this is because *u* itself is also quite fronted, such that it is phonetically actually a central vowel [ʉː], rather than a back vowel [uː]. The vowel *ë* [ə], on the other hand is more central (i.e. backer) than both *e* [ɛː] and *ı* [iː]. However, in terms of

height, it is not, as I predicted, intermediate between *e* and *ɪ*;, rather, it is at approximately the same height as *e*, actually slightly lower (but not significantly so).

6.2 Comparison of specific reduced vowels with their neighbours

The purpose of this section is to describe in detail the precise phonetic quality of each of the three reduced vowels *ä* [ɐ], *ë* [ə], and *ü* [ɵ], and to justify their existence as distinct vowel phones, at the phonetic level. Later, in §7 and §8, I will also consider distributional evidence in support of these vowels having independent, phonemic status. In the following sub-sections, I will report only aggregate results for all three speakers averaged together.

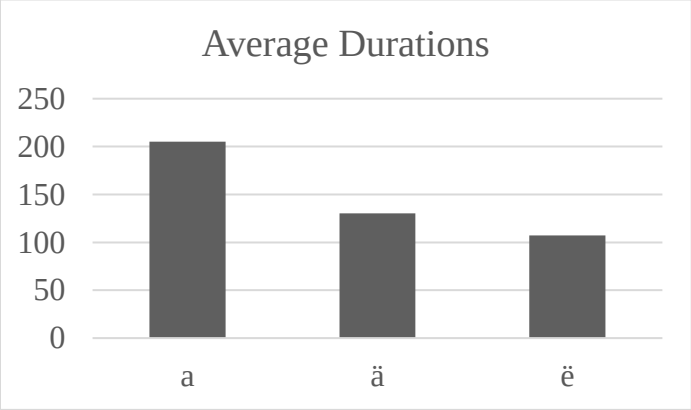
6.2.1 Reduced /ä/

The phoneme /ä/ [ɐ] is assumed not to exist in Dëne Sųłıné, according to the analyses in Cook (1983) and Cook (2004), which form the basis of the standard orthography for Chipewyan. Cook does acknowledge the existence of a vowel phone articulated as [ʌ], which he considers to be an allophone of /ë/ which occurs after velars (Cook 2004: 18-19). That is, he assumes that [ʌ] and [ɛ] are allophones of the same phoneme, with the former occuring after velars, and the latter occurring elsewhere. In §5.0, I will present distributional arguments that, in the Tetsǫ́t'ıné dialect, /ä/ and /ë/ are independent phonemes. In this section, however, I will first seek to establish, based on phonetic evidence, that *ä* is phonetically distinct from both full *a* and reduced *ë*, by comparing these vowels in duration, F1, F2, and F3.

Our hypothesis predicts that *ä* will differ from *a* primarily in duration (but will also be somewhat higher and more central), and we predict that *ä* will differ from *ë* primarily in vowel quality—that is, in the vowel formants F1, F2, and F3. That is, we expect that *ä* should have a higher F1 and lower F2, compared to *ë*.

We will begin by looking at duration. In (15), we see that *ä* has an average duration which is intermediate between *a* and *ë*, although the difference between *a* and *ä* is greater than the difference between *ä* and *ë*. Specifically, *a* was longer than *ä* by an average of nearly 75ms, whereas *ä* was longer than *ë* by an average of only 23.1ms, as shown in (16). The durational contrasts between *a* and *ä*, as well as *ä* and *ë*, were significant according to a two-tailed *t*-test assuming unequal variances.

(15) Comparison of the durations of /a/, /ä/, and /ë/, in milliseconds

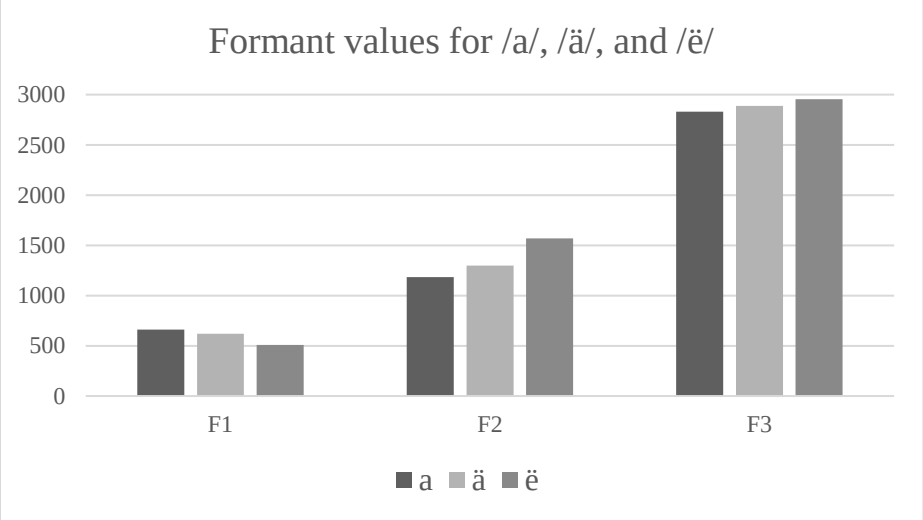


(16) Data table for average durations of /a/, /ä/, and /ë/, in milliseconds

Vowel pair /V1/ vs. /V2/	**Duration of /V1/ (ms)**	***n* =**	**Duration of /V2/ (ms)**	***n* =**	***t*-test**
/a/ vs. /ä/	205	61	130.2	109	p < .0001
/ë/ vs. /ä/	107.1	90	130.2	109	p < .001

Next we will look at vowel quality. A graph summarizing the average formant values for all three vowels is given in (17). As we can see in (17), all of the trends are in the direction predicted by our hypothesis: compared to *a*, *ä* has a lower F1 (i.e. is higher), a higher F2 (i.e. is fronter), and a higher F3 (i.e. is less round). In for all three formants, *ä* has a value which is intermediate between *a* and *ë*.

(17) Comparison of F1, F2, and F3 for /a/, /ä/, and /ë/



Next we will see which of these differences is statistically significant, using a two-tailed *t*-test assuming unequal variances. In (18) we compare *a* and *ä*, while in (19) we compare *ä* and *ë*. For both pairs of vowels, there were statiscially significant differences in F1 and F2, but not F3.

(18) Comparison of formant values for /a/ and /ä/

Formant	**Value for /a/ (Hz)**	***n* =**	**Value for /ä/ (Hz)**	***n* =**	***t*-test**
F1	695.9	61	621.1	109	p < .001
F2	1182.8	61	1299.4	109	p < .01
F3	2831.2	61	2886.4	109	p = .14

(19) Comparison of formant values for /ä/ and /ë/

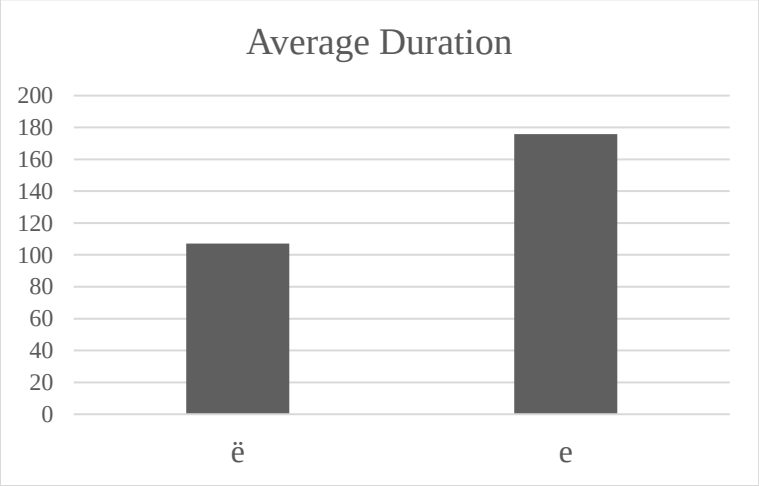
Formant	**Value for /ä/ (Hz)**	***n* =**	**Value for /ë/ (Hz)**	***n* =**	***t*-test**
F1	621.1	109	508.0	90	p < .0001
F2	1299.4	109	1568.4	90	p < .0001
F3	2886.4	109	2954.6	90	p = .08

To summarize, we have seen evidence for the existence of three distinct sounds, or 'phones', in the Tetsǫ́t'ıné dialect: *a* [aː], *ä* [ɐ], and *ë* [ə]. The sound *ä* significantly different from both *a* and *ë* in duration, F1, and F2, but not F3. In terms of duration, it seems that *ä* differs more from *a* than from *ë,* whereas in terms of F1 and F2, *ä* seems to occupy more of an intermediate position between *a* and *ë*. Finally, it seems that F3 most likely does not play a major role in differentiating these three sounds.

6.2.2 Reduced /ë/

In this section we will focus on the phoneme /ë/ [ə]. We have already seen evidence that *ë* is phonetically distinct from *ä*; in this section, we will focus on evidence which shows that /ë/ is distinct from the full vowel /e/. That *ë* is a distinct phoneme from *e* is actually not controversial in the Dëne Sųłıné literature, since nearly all previously published sources assume some type of distinction between two different *e*-like phonemes (Li 1946, Richardson 1968, Elford & Elford 1981, Cook 2004). However, the purpose of this section is to clarify the precise nature of this distinction in the Tetsǫ́t'ıné dialect—that is, whether it is primarily a durational contrast, a contrast in vowel height, in frontness, backness, roundness, or some combination of these.

(20) Comparison of the durations of /ë/ and /e/, in milliseconds

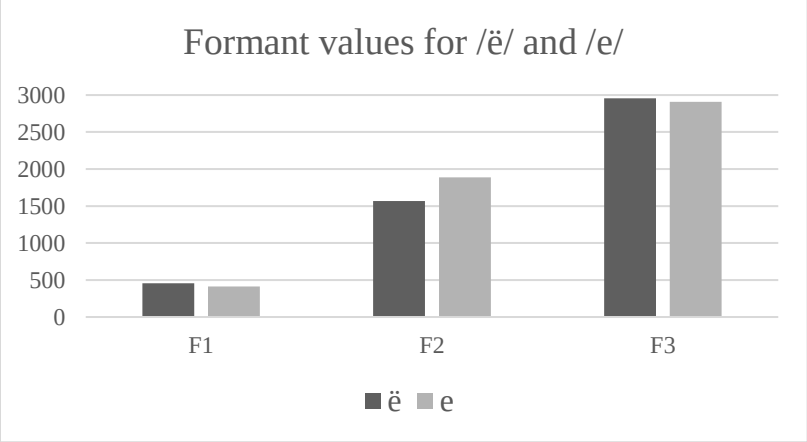


(21) Data table for average durations of /ë/ and /e/, in milliseconds

Vowel pair /V1/ vs. /V2/	**Duration of /V1/ (ms)**	***n* =**	**Duration of /V2/ (ms)**	***n* =**	***t*-test**
/ë/ vs. /e/	107.1	90	175.8	54	$p < .0001$

As we can see in (20) and (21), there is a statistically significant difference in duration between *ë* and *e,* by which *e* is longer than *ë* by nearly 70ms. Next we will look at vowel quality. Our results indicate that *ë* differs from *e* primarily in F2 (frontness)—that is, *e* has a higher F2 (is more fronted) than *ë*. We do not find any significant differences in F1 (height) or F3 (roundness).

(22) Comparison of F1, F2, and F3 for /ë/ and /e/



(23) Comparison of formant values for /ë/ and /e/

Formant	Value for /ë/ (Hz)	*n* =	Value for /e/ (Hz)	*n* =	*t*-test
F1	508.0	90	509.7	54	p = .92
F2	1568.4	90	1889.3	54	p < .0001
F3	2954.6	90	2910.2	54	p = .32

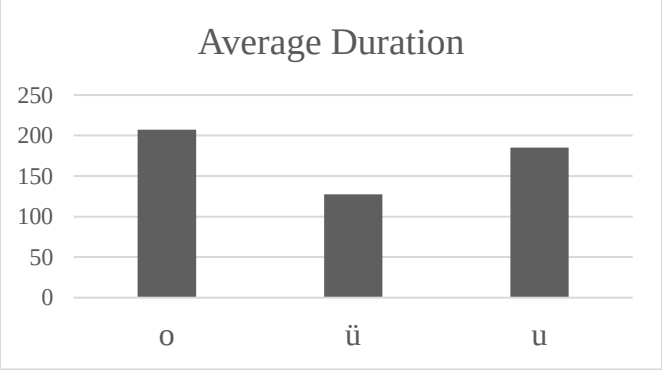
To summarize, it seems that there are two main acoustic properties which distinguish the phonemes /ë/ [ɘ] and /e/ [ɛː] from each other: duration and F2. In terms of duration, the vowel *e* is approximately 64% longer than *ë* on average, which would be consistent with a phonological anlaysis in which the vowel *e* is phonologically long, while *ë* is phonologically short. In terms of F2, the vowel *e* is considerably fronter than *ë*, by over 300Hz on average, which would be consistent with a phonological analysis in which *e* is a front vowel, while *ë* is a central vowel. F1 and F3 do not show a statistically significant difference between *e* and *ë*, based on these data.

6.2.3 Reduced /ü/

Finally we will examine the vowel phoneme /ü/ [ɵ]. Much like the phoneme /ä/ [ɐ] which we examined in §6.2.1, the existence of an /ü/ [ɵ] phoneme has generally not been acknowledged in the Dëne Sųłıné linguistics literature, with the exception of Krauss (1983). In this section I will present evidence that *ü* [ɵ] has shorter duration than both *o* [oː] and *u* [ʉː], which is consistent with the hypothesis that *ü* is phonologically short (i.e. reduced) whereas *o* and *u* are phonologically long (i.e. full). In addition, I will provide evidence that, of the three rounded vowels *o*, *ü*, and *u*, only *o* is a true back vowel [oː]; the vowels *ü* and *u* are actually rounded central vowels, [ɵ] and [ʉː], respectively.

We will begin by looking at duration. As shown in (24), both *o* and *u* were longer than *ü*. The vowel *o* had 63% longer duration than *ü*, on average, while the vowel *u* had 45% longer duration than *ü*, on average. As shown in (25), these differences were statistically significant.

(24) Comparison of the durations of /o/, /ü/, and /u/, in milliseconds

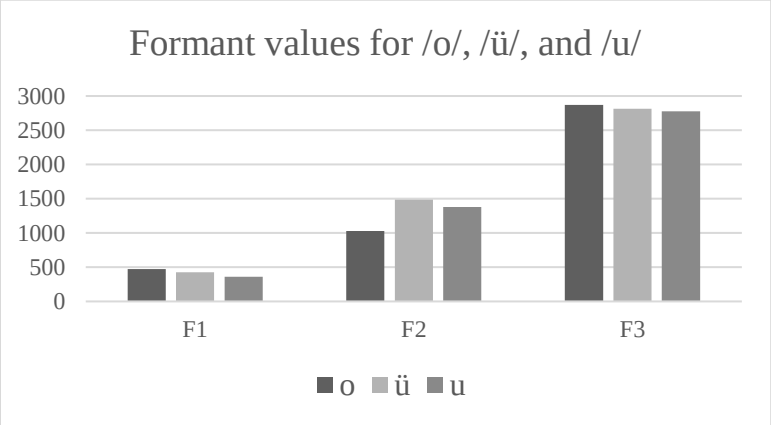


(21) Data table for average durations of /ë/ and /e/, in milliseconds

Vowel pair /V1/ vs. /V2/	**Duration of /V1/ (ms)**	***n* =**	**Duration of /V2/ (ms)**	***n* =**	***t*-test**
/o/ vs. /ü/	207.1	44	127.4	29	p < .0001
/u/ vs. /ü/	185.0	37	127.4	29	p < .0005

Next we will look at vowel quality. In terms of F1 (vowel height), it seems that *ü* is of intermediate height, between *o* and *u*. In terms of F2 (frontness/backness), it seems that *ü* and *u* are both central vowels, whereas *o* is a true back vowel. That is, the F2 of *ü* is significantly higher than that of *o*, but does not differ significantly from *u*. Finally, there are no significant differences in F3 (roundness) between these three vowels, which is consistent with *o, ü*, and *u* all being rounded vowels.

(22) Comparison of F1, F2, and F3 for /o/, /ü/, and /u/.



(23) Comparison of formant values for /o/ and /ü/

Formant	**Value for /o/ (Hz)**	***n* =**	**Value for /ü/ (Hz)**	***n* =**	***t*-test**
F1	472.8	44	427.1	29	p = .05
F2	1027.9	44	1487.0	29	p < .0001
F3	2870.2	44	2814.8	29	p = .56

(24) Comparison of formant values for /ü/ and /u/

Formant	Value for /ü/ (Hz)	*n* =	Value for /u/ (Hz)	*n* =	*t*-test
F1	427.1	29	358.4	37	p < .005
F2	1487.0	29	1379.8	37	p = .08
F3	2814.8	29	2777.1	37	p = .70

To summarize, we have seen evidence for the existence of three different round vowels in Tetsǫ́t'ıné: *o, ü*, and *u*. The vowel *ü* differs from both *o* and *u*, in that *ü* is a short vowel, while *o* and *u* are long vowels. In other words, *o* and *u* are full vowels, while *ü* is reduced. On the other hand, the vowel *o* differs from both *ü* and *u*, in that *o* is a true back vowel, while *ü* and *u* are central vowels. Finally, the vowel *ü* seems to exhibit an intermediate height (F1) between *o* and *u*, such that it is probably best characterized as a close-mid rounded central vowel [ɵ].

7.0 Discussion

In the previous section, I provided evidence for the existence of eight discrete vowel phones in Tetsǫ́t'ıné: *a, e, i, o, u, ä, ë,* and *ü*. Even though the number of tokens measured was relatively small, there were statistically significant differences between all of the vowels, sometimes involving multiple acoustic cues. In some cases, the magnitude of the effect was quite large—for example, the F2 of *ü* is higher than that of *o* by over 450Hz, as we saw in §6.2.3. In particular, since the central claim of this paper is that Tetsǫ́t'ıné exhibits a distinction between full and reduced vowels, here we will briefly review the durational differences between each of the reduced vowels and their corresponding full vowel, as shown in (25).

(25) Summary of average durational differences between full and reduced vowels

Full ~ Reduced Vowel Pair	Duration of Full Vowel	*n* =	Duration of Reduced Vowel	*n* =	Ration of Full / Reduced Vowel Durations	*t* test
/a/ ~ /ä/	205.0	61	130.2	109	1.57 / 1	p < .0001
/e/ ~ /ë/	175.8	54	107.1	90	1.64 / 1	p < .0001
/u/ ~ /ü/	185.0	37	127.4	29	1.45 / 1	p < .0005

From a phonological perspective, my understanding of the full ~ reduced vowel contrast in Tetsǫ́t'ıné, as well as in other Dene languages which exhibit a similar system, is that it is fundamentally a length contrast—that is, where the full vowels are associated with two moras and the reduced vowels are associated wth one mora (Tuttle 1998)—and the additional differences in vowel quality that we have seen (in F1 and F2) are secondary enhancement features (although perceptual studies would be necessary to determine which cues are most important to speakers, in distinguishing these vowels). As we can see in (25), full vowels range from 45% to 64% longer than their corresponding reduced vowels. This most likely falls towards the 'low end' of the scale typologically, in terms of the magnitude of pure durational difference. It makes sense, therefore, that the language would also employ other acoustic cues, from F1 and F2 differences, to help enhance this contrast.

Having provided evidence for eight different 'phones', it nevertheless does not automatically follow that the language has eight distinct PHONEMES—that is, different sounds which are contrastive in the language. A phonological feature is said to be contrastive if its distribution can not be entirely predicted based on the presence or absence of other phonological features, and if that feature can be used to distinguish utterances.

That being the case, there is one alternative hypothesis which I will provide evidence against in this section, namely the hypothesis that *ä* and *ë* are actually two allophones of the same phoneme, /ë/ or /ə/, where *ä*, pronounced [ʌ] or [ɐ], is found after velars, while *ë*, pronounced [ə], [ɘ], or [ɛ], is found elsewhere (Cook 1983: 419; 2004: 18-19). It is true that the distribution of *ä* and *ë* is partially predictable, at least statistically: *ä* tends to be found both before and after velars, while *ë* tends to be found after palatals (*ch, j, ch', sh*), although there are exceptions in both cases. But when they are adjacent to anterior coronals (*t, d, t', s, z, ts, dz, ts', tth, ddh, tth', th, dh*), the two sounds *ä* and *ë* are equally likely to occur. Some examples of the vowels *ä* and *ë* following consonants of different places of articulation are given in (26) below; the examples are arranged so as to highlight minimal or near-minimal pairs, were possible.

(26a) Examples of reduced vowels *ä* and *ë* after velars

Example with *ä*	**English gloss**	**Example with *ë***	**English gloss**
ʔeɬx**ä**l dëné	'soldiers, warriors'	helgh**ë**l	'he/she is drumming'

(26b) Examples of reduced vowels *ä* and *ë* after palatals

Example with *ä*	**English gloss**	**Example with *ë***	**English gloss**
y**ä**th	'snow'	dëne y**ë**dhé	'man's penis'
dëne ch**ä**né	'person's biceps'	dech**ë**n	'stick'
k'ásj**ä**ne	'almost'	hej**ë**n	'he/she is singing'

(26c) Examples of reduced vowels *ä* and *ë* after alveolars and interdentals

Example with *ä*	**English gloss**	**Example with *ë***	**English gloss**
th**ä**th[3]	'belt'	ʔedh**ë́**th	'hide, pelt'
th**ä**ne	'alone, by itself'	ʔetth**ë́**n	'caribou'
tth**ä**lı	'diaper moss'	tth**ë**lı	'groundhog, marmot'
s**ä**s	'bear'	delz**ë**n	'black'

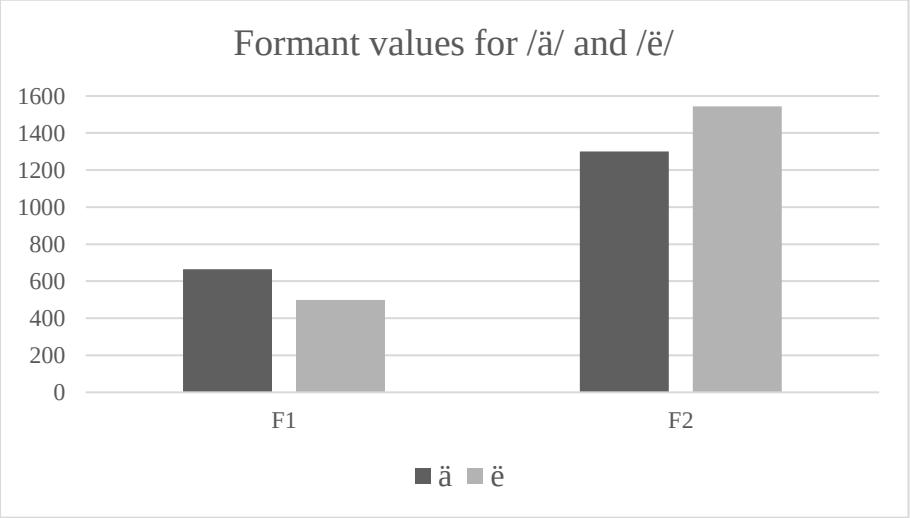
In one case, it is even possible to construct a near-minimal quadruplet: *horelyath* 'flames', *yäth* 'snow', *yëth* 'penis', *yeh* 'building'. While it is possible that some of the vowels highlighted in (26) result from a recent secondary shortening (from full *a* or *e*), and while it is also possible that some reduced vowels may have recently shifted from *ë* to *ä* or vice versa, nevertheless these examples illustrate that, in the modern Tetsǫ́t'ıné dialect, *ä* and *ë* seem to be contrastive with respect to each other, next to consonants of all different places of articulation: velar, palatal, alveolar, and interdental. Based on these examples, it is difficult to see why *ä* and *ë* should not be regarded as separate phonemes in this dialect, based on their distribution.

[3] For some speakers, this word is pronounced *thëth* when in isolation, but *thäth* when possessed, i.e. *bets'ı̨ thäth* 'his belt'.

Nevertheless, it is most likely true, as suggested by Krauss (1964: 122-123), that, in modern Dëne Sųłıné dialects, we expect to find *ë* after the palatal series (*ch, j, ch', sh, y*) and *ä* after the velar series (*k, g, k', x, gh*). Although there are no lexicostatistics currently available, my impression is that this generalization still broadly holds true for the Tetsǫ́t'ıné dialect as well, apart from the small number of counterexamples seen previously. This lexicostatistical tendency introduces a potential confound in the phonetic data presented earlier in §6.2.1: how do we know that the higher F1 and lower F2 of the vowel *ä* was not, to some extent, a coartiulation effect of preceding velar consonants? And conversely, how do we know that the lower F1 and higher F2 of the vowel *ë* was not, to some extent, also a coarticulation effect of preceding palatal consonants?

To address this potential confound, I re-ran the statistics, excluding any tokens which contained a velar or palatal consonant. That is, the tokens analyzed were only those involving an alveolar or interdental consonant, as in (26c). The result is that the same differences between *ä* and *ë* which we observed earlier still hold: the F1 of *ä* was approximately 160Hz higher than that of *ë* on average, as shown in (27). In addition, the F2 of *ë* was approximately 240Hz higher than that of *ä*, and this was also statistically significant, as shown in (28).

(27) Comparison of F1 for /ä/ and /ë/ in the environment of anterior coronals, in Hz



(28) Data table for F1 and F2 of /ä/ and /ë/ in the environment of anterior coronals, in Hz

Formant	Value for /ä/ (Hz)	*n* =	Value for /ë/ (Hz)	*n* =	*t*-test
F1	664.0	61	499.7	68	p < .0001
F2	1300.0	61	1543.3	68	p < .0001

Based on this evidence, it is difficult to see how or why *ä* and *ë* should be analyzed as allophones of a single phoneme. Rather, the evidence indicates that they are separate phonemes, and this pair of phonemes is just one example of how Tetsǫ́t'ıné has preserved the Proto-Dene full ~ reduced vowel contrast: the language has five full vowel phonemes, *a, e, i, o, u*, and three reduced vowel phonemes, *ä, ë, ü*. In the next section, I will present additional distributional evidence in support of this claim.

8.0 Distributional evidence for the Full ~ Reduced vowel contrast

There are two main pieces of distributional evidence which support the existence of a full ~ reduced vowel contrast in stems: the stem minimality, and nasalization. We will examine each of these in turn.

Stem minimality means that, in Tetsǫ́t'ıné, stems must be of a minimum size of at least two moras. If a stem is only one syllable long, then the stem syllable must be heavy (or superheavy). If the stem is two syllables long, it consist of either two light syllables (e.g. ***sechële*** 'my little brother') or a heavy syllable followed by a light syllable, where the first syllable is stressed (e.g. *denıı* ***yané*** 'bull moose'). If we restrict the discussion to monosyllabic stems, this means that full vowels may be found in both open and closed syllables, but reduced vowels are found in closed syllables only. This is illustrated in (29).

(29) Illustration of stem minimality requirements for monosyllabic stems

Good: Full vowel in closed syllable	**Good: Full vowel in open syllable**	**Good: Reduced vowel in closed syllable**	**Bad: Reduced vowel in open syllable**
shás 'knot'	**k'á** 'arrow'	**säs** 'bear'	***sä**
des 'river'	**tthe** 'rock'	**chëth** 'duck'	***chë**
łus 'spoon'	**tu** 'water'	**kű́n** 'firewood'	***kü**

The fact that reduced vowels are not allowed in open syllables (in monosyllabic stems) is evidence that they have only one mora, and thus do not satisfy the stem minimality requirement. On the other hand, the fact that full vowels are allowed in open syllables (in monosyllabic stems) is evidence that they have two moras, and therefore do satisfy the stem minimality requirement (cf. Tuttle 1998). In this study, I deliberately excluded any stimuli involving open syllables, to avoid the potential confound of phonetic lengthening in open syllables.

The other main piece of evidence involves nasalization. In Tetsǫ́t'ıné, although both full and reduced vowels can occur before a nasal consonant, including in closed syllables, *only* full vowels can be nasalized. That is, all nasal vowels (in stems) are full vowels in Tetsǫ́t'ıné, most likely reflecting their historical origins as full vowel + *n* sequences. Some examples include *jǫ* 'here', *yutthę́* 'north, towards water', *łı* 'dog', *nezǫ* 'good', and *dıı́* 'now'. Stated differently, in Tetsǫ́t'ıné stems, there is no such thing as a reduced nasal vowel, as shown in (30).

(30) Distribution of nasality and the full ~ reduced vowel contrast

Good: Full oral vowel	**Good: Full nasal vowel**	**Good: Reduced oral vowel**	**Bad: Reduced nasal vowel**
ts**á** 'beaver'	ch**ą** 'rain'	s**ä**s 'bear'	*s**ą̈**s
tth**e** 'rock'	yutth**ę́** 'north'	ch**ë**th 'duck'	*ch**ę̈**th
t**u** 'water'	d**ųı́** 'now'	k**ű**n 'fire'	*ł**ų̈**s

The main point of (30) is that nasalized reduced vowels are not allowed in the language (in stems). Historically, there is a straightforward explanation for this lexical gap, in that the nasalization rule which converted *Vn* sequences to nasal vowels did not apply to reduced vowels. However, it could be argued that this distribution has a synchronic motivation as well—for

example, that the nasal ~ non-nasal vowel contrast requires a certain minimum duration in order to be perceptible, or that nasalizing the reduced vowels would make them less distinct with respect to each other. Whatever the motivation for this distributional restriction, the fact that full and reduced vowels have a different distribution, with regards to both syllable weight and nasality, is evidence that the full ~ reduced vowel contrast has phonological status in the language.

9.0 Conclusion and directions for future work

In this paper, we have seen that the existence of a contrast between full and reduced vowels in Tetsǫ́t'ıné is supported by several types of phonetic evidence—in particular, duration, F1, and F2—as well as by at least two types of phonological distributional evidence, relating to stem minimality and nasalization. Indeed, in my experience, the full ~ reduced vowel contrast is not at all difficult to hear, even for me as a non-native speaker, and native speakers also have no trouble hearing the contrast, when it is pointed out to them.

As mentioned in the introduction, one of the main limiting factors in doing a phonetic study of this sort has been the lack of a suitable word list or dictionary which records all the full and reduced vowels of the language, which in turn can be used to construct experimental stimuli. In a dictionary currently in preparation, now in the proofreading phase (Jaker & Cardinal, in preparation), we do record all eight vowels in stems. This will hopefully yield a much more accurate representation of the language, and will ultimately make acquisition of literacy much easier, once the writing system matches the actual sound system. This may allow for future phonetic studies which examine the full ~ reduced vowel contrast in relation to other factors, such as tone, nasality, and the difference between stems and prefixes.

More generally, this study highlights the extent to which dialect diversity in Dëne Sųłıné has been underestimated by previous linguists. In the case of Slave, for example, it is widely accepted that different dialects have different phonemic inventories (for example *wh* vs. *f* vs. *th*), whereas in the case of Dëne Sųłıné, it has been widely assumed that a single phoneme inventory (based largely, it seems, on a Northern Saskatchewan dialect) can be used for all dialects. In this paper, I have hopefully demonstrated that the 6 vowel system currently used by the Government of the Northwest Territories (*a, e, ı, o, u, ë*) is not appropriate for the Tetsǫ́t'ıné dialect, which instead exhibits an 8 vowel system (*a, e, ı, o, u, ä, ë, ü*). More broadly, however, this study points to how problematic it can be to try and force all dialects into a single standardized form (Rice 2016). In order to represent a language accurately, we should first and foremost try to represent each dialect on its own terms, including its own unique phonemic inventory, as I hope I have done in this paper.

Acknowledgements

I wish to extend my most heartfelt thanks to the three speakers who participated in this experiment: Fred Nitah, Georgina Nitah, and Emerence Cardinal. Thank you very much for sharing you language with me, and I hope this work may be of benefit to Dene people in the future. Additional thanks to Goyatıkǫ̀ Language Society and the Yellowknives Dene First Nation Land & Environment Office, for their generous support and for providing the space in which to conduct this research. Thanks also to Peter Jurgec, Keren Rice, Siri Tuttle, Elan Dresher, and participants of the University of Toronto Field Methods Group and Phonology Group. All remaining errors are my own.

Bibliography

Cook, Eung Do. 1983. Chipewyan Vowels. *IJAL* 49: 413-27.

Cook, Eung-Do. 2004. A Grammar of Dëne Sųłıné (Chipewyan). *Algonquian and Iroquoian Linguistics Memoir 17.* John D. Nichols & H.C. Wolfart (eds.), Winnipeg, Manitoba.

DeReuse, Willem. 2014. Proto-Athabascan Noun Stem Master List. Available on ANLA (www.uaf.edu/anla), identifier #HN006R2014b.

Elford, Leon & Marjorie Elford. 1981. Chipewyan Dictionary. Prince Albert, Saskatchewan: Northern Canada Evangelical Mission.

Gillespie, Beryl. 1981. Yellowknife. In June Helm (ed.) *Handbook of North American Indians, vol. 6, Subarctic.* Washington: Smithsonian Institution.

Haas, Mary. 1968. Notes on a Chipewyan Dialect. *IJAL* 34: 165-175.

Jaker, Alessandro & Emerence Cardinal. (to appear). Tetsǫ́t'ıné Verb Grammar / Tetsǫ́t'ıné Yatıé K'ízı T'at'ú Henádhër Yatıé ʔełtth'ı ʔełaníílye. ANLC Publications.

Jaker, Alessandro & Emerence Cardinal. (in preparation). Tetsǫ́t'ıné Dictionary / Tetsǫ́t'ıné T'asíe Hudzı ʔErehtł'ís.

Jetté, Jules & Eliza Jones. 2000. Koyukon Athabaskan Dictionary. ANLC Publications.

Kaulback, Brent, Bertha Catholique and Dennis Drygeese (eds.) 2014. *Dëne Sǫłıné ʔerehtł'ís: Łútsëlk'é T'ıné Yatıé* / *Chipewyan Dictionary.* South Slave Divisional Board of Education.

Krauss, Michael. 1964. Proto-Athapaskan-Eyak and the Problem of Na-Dene: Phonology. *IJAL* 30(2): 118-131.

Krauss, Michael. 1982. Proto-Athapaskan **k̓* in Chipewyan, 1742-1800: Philological Evidence. *IJAL* 48(1): 73-82.

Krauss, Michael. 1983. Vowels in Saskatchewan Chipewyan: Mary Jane Kasyon. Manuscript, Alaska Native Language Center (Available at: http://www.uaf.edu/anla/item.xml?id=CA961K1983).

Krauss, Michael. 2005. Athabaskan Tone. In Rice & Hargus (eds.) *Athabaskan Prosody.* John Benjamins.

Krauss, Michael & Jeff Leer. 1981. Athabaskan, Eyak, and Tlingit Sonorants. ANLC Research Papers No. 5. Fairbanks: ANLC Publications.

Lehiste, Ilse. 1970. Suprasegmentals. MIT Press.

Li, Fang-Kuei. 1946. Chipewyan. In Harry Hoijer et al. (eds.) *Linguistic Structures of Native America.* Viking Fund Publications in Anthropology vol. 6. New York: The Viking Fund.

McDonough, Joyce & Valerie Wood. 2008. The stop contrasts of the Athabaskan languages. *Journal of Phonetics* 36: 427-449.

Rice, Keren. 2016. Dene Language Standardization: some historical background and some things I think I've learned. In *Working Papers in Dene Languages 2016*. ANLC Publications.

Tuttle, Siri. 1998. Metrical and Tonal Structures in Tanana Athabaskan. Doctoral Dissertation, University of Washington.