

# **The Phonetics of Tone in Two Dialects of Dane-zaa (Athabaskan)**

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**Abstract**

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This dissertation is an investigation of acoustic properties of lexical tone in two dialects of Dane-zaa (Athabaskan). The noteworthy mirror-image tone systems of the H-marked Doig and L-marked Halfway dialects provide a unique opportunity to explore intrinsic differences in how pitch manifests in specific environments.

The dissertation has three main parts. The first explores effects of various linguistic features on normalized pitch, including tone, lexical and morphological categories. Tone was found to be statistically robust in Halfway, and less so for Doig, indicating that the distinction between tonal categories in Doig is becoming less stable.

The second part investigates effects of word-final glottal stops on the voice quality of preceding vowels, in comparison to vowels of the same quality in open

syllables. Measures used include intensity, pitch, jitter, and spectral tilt. Expected outcomes of lower intensity and increased jitter in vowels before word-final glottal stops were revealed for both dialects. Results for pitch garnered a lack of a significant effect of word-final glottal stops for the Doig speakers, where a pitch raising effect was expected. These findings offer evidence that Doig is changing from a language that originally had pitch raising as a reflex of the PA constriction, to one in which the trigger for marked tone is no longer manifesting in a measurable way, with respect to pitch. Halfway speakers showed the expected pitch lowering before the word-final glottal stop.

The third part explores effects of speech styles on normalized pitch, specifically looking at word list and narrative data of two speakers of the Doig dialect. Results showed that within a given speech style both speakers faithfully retained the difference between H and L tone categories. One speaker used both language-internal and language external cues (eye-gaze and gesture) to mark difference in style, while the second speaker relied upon neither. If one were to consider a broader landscape of style, beyond linguistic cues, it is possible to understand that speakers may draw from a larger repertoire to signify differences in speech style, although it is not necessary in order for a speaker to remain faithful to the communicative event.

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All errors in this dissertation are my own.

**Dedication**

I would never have been able to accomplish this endeavor if it were not for the love and support of my family. This is for you.

---

## **1 Introduction**

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### ***1.1 Goal of dissertation***

The primary aim of this dissertation is to provide a clear examination of the acoustic properties of lexical tone in two geographically close dialects of Dane-zaa,<sup>1</sup> an Athabaskan language of northwestern Canada. The two dialects to be investigated are Doig River and Halfway River. These dialects were chosen due to their unique, mirror-image tone systems; where Doig speakers produce a high tone, Halfway speakers produce a low.

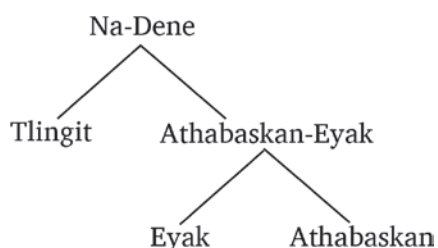
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<sup>1</sup> Throughout this dissertation, I will use the language names Dane-zaa and Beaver interchangeably. The members of the communities I worked with prefer the name Dane-zaa to Beaver; however, they have no objection to the Beaver name, and it is still often used.

Below, I present an introduction to the Athabaskan language family and the tone situation for these languages. I move to more specific details of the Dane-zaa communities and the language situations. I then summarize previous linguistic and anthropological literature for the Doig dialect and offer the phonemic inventory. I then do the same for the Halfway dialect.

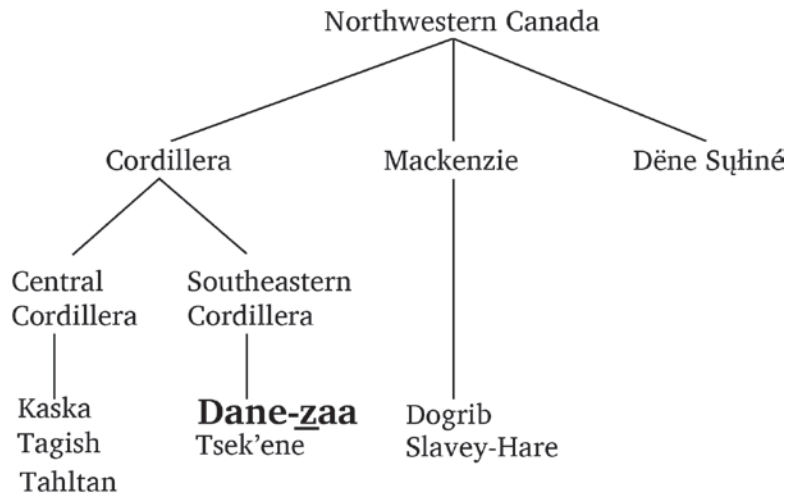
### ***1.2 Tone in the Athabaskan languages***

The Athabaskan language family is a member of the Na-Dene language group. Na-Dene is one of approximately sixty language families of North America (Goddard, 1996). Figure 1 provides a diagram of the Na-Dene language group.



**Figure 1** Na-Dene language family, based on Goddard (1996).

Within the Athabaskan family, there are approximately forty-five languages (Goddard, 1996; Mithun, 1999). Dane-zaa is a member of the Northwestern Canada branch of the Athabaskan language family. This family structure is presented in Figure 2.



**Figure 2: Athabaskan languages of the Northwestern Canada sub-group, based on Goddard (1996) and Mithun (1999), information for family groupings by Keren Rice.**

Pre-Proto-Athabaskan (PPA) and Proto-Athabaskan (PA) have been reconstructed as non-tonal (Krauss, 1964). Of the Athabaskan daughter languages, some have established a tone system, others have not. The source of tone in the daughter Athabaskan languages has been attributed to PA glottalized vowels and stem-final glottalized consonants (Krauss, 1964; Leer, 1979). The shift from glottalization to tone occurs when “a post-vocalic glottal stop or the glottal component of a glottalized consonant becomes suprasegmentalized so as to become a phonation type called

constriction [laryngealization]; this phonation type subsequently evolves into the marked tone in the daughter languages.” (Leer, 1999p. 40).<sup>2</sup>

Additionally, the tonal languages can be further categorized. Some have developed low tones (referred to as *low-marked* languages), where others have developed corresponding high tones (*high-marked* languages). Examples of stem-final glottalization in Proto-Athabaskan and the corresponding tone-marking in select daughter languages are presented in Table 1.

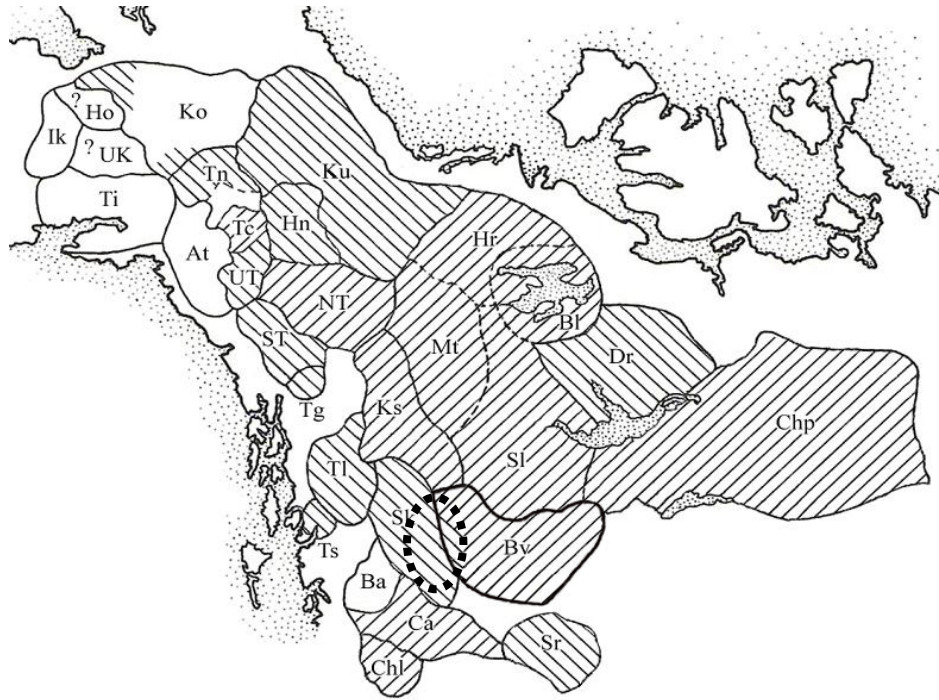
**Table 1** Examples of PA glottalization into selected daughter languages. H-marked: Doig Beaver & Slave data from Krauss (1979, 2005); L-marked: Tsek’ene & Sarcee data from Krauss (1979, 2005); Non-tonal: Upper Kuskokwim data from Collins & Petruska (1979) and Ahtna data from Kari & Buck (1975).

PROTO- ATHABASKAN	HIGH MARKED		LOW MARKED		NON-TONAL	
	BEAVER	SLAVE	TSEK’ENE	SARCEE	U. KUSKOKWIM	AHTNA
*q <sup>w</sup> ə́n’ ‘fire’	[k <sup>h</sup> wáɲ]	[k <sup>h</sup> óʔ]	[k <sup>h</sup> wə̀n]	[k <sup>h</sup> ù:ʔ]	[k <sup>h</sup> wə̀n’]	[k <sup>h</sup> on’]
*ča’ ‘beaver’	[tsh <sup>h</sup> áʔ]	[tsh <sup>h</sup> áʔ]	[tsh <sup>h</sup> àʔ]	[tsh <sup>h</sup> àʔ]	-[tsh <sup>h</sup> oʔ]	[tsh <sup>h</sup> aʔ]
*-wət’ ‘belly’	-[pát]	-[mpéʔ]	-[pət]	-[mìʔ]	-[mit’]	-[peʔt]

The distribution of tone in the modern northern Athabaskan languages, based on Krauss (1979, 2005) is graphically presented in the map of Figure 3. Dane-zaa is

<sup>2</sup> For a detailed account of Athabaskan tonogenesis, see (Kingston, 2005; Krauss, 1979, 2005; Leer, 1979, 1999). Chapter 4 of this dissertation will include additional fundamentals of the tonogenetic process, according to Kingston’s articulatory model.

highlighted and indicated by 'Bv' (Beaver). On the map, acute lines (/) signify high-marked daughter languages, the grave lines (\), low-marked. Notice that some areas of Beaver contain both (/) and (\). The areas that are not filled represent non-tonal Athabaskan languages. Note the high concentration of H-marked languages in the center of the map this reflects the region east of the Cordillera Mountain Range.



**Figure 3** Map showing the northern Athabaskan languages of Canada and Alaska. Acute lines (/) represent H-marked tone, grave lines (\) represent L-marked. Unfilled areas indicate non-tonal languages. Dane-zaa language region is outlined and labeled “Bv” (Beaver). Map based on Krauss (1979, 2005). The convergent area of H- and L-marked Dane-zaa dialects is encircled by the dotted line.

Kingston (2005) notes that some Athabaskan languages with opposite tones, such as the H-marked, Tanacross (‘Tc’ on map) and the L-marked, Northern Athabaskan

Tsek'ene language ('Sk' on map) have no closer common ancestor than PA. These daughter languages derived from two different dialects in which the constriction from stem-final glottalization was pronounced differently.

Other Athabaskan languages with opposite tone marking may have descended from a more recent ancestor. These languages tend to be geographically proximate, and there is some level of mutual intelligibility between the languages, such as H-marked Kaska ('Ks') and L-marked Tahltan ('Tl'), H-marked Northern Tutchone ('NT') and L-marked Southern Tutchone ('ST'); H-marked Slave ('Sl') and L-marked Dogrib ('Dr'). Kingston proposes that if these languages retained a contrast between stem-final glottal stops and open syllables, then a more recent tone reversal may be responsible for this mirror-image tone-marking in closely related languages.

The mechanism for this tone reversal is therefore identical to that for turning these languages into tone languages in the first place: stem-final glottalic articulations cause the preceding vowel to be pronounced with non-modal or "constricted" voice quality. (Kingston, 2005 p. 170).

Kingston describes in detail the functional properties of the larynx and how the co-articulation of vowel and constriction must have occurred, speculating that some speakers 'exercise their control of the articulators to realize a contrast in a different way than other speakers do...' (Kingston, 2005 p. 178). Essentially, the variation in articulation determines whether H or L tone results from the glottalized segment. If the

constriction on the vowel was produced with stiff vocal folds, the F0 would be high; phonation would be modal or tense. The resulting tone would be H. If the constriction was produced with slack vocal folds, F0 would be low and phonation would be creaky. In this case, L tone would be the result.

Leer (1999) puts forth the idea that L tone may have been the first outcome of the transformation of Proto-Athabaskan glottalization into the modern tones and H tones were the result of one or two innovations, resulting in later tone reversals.

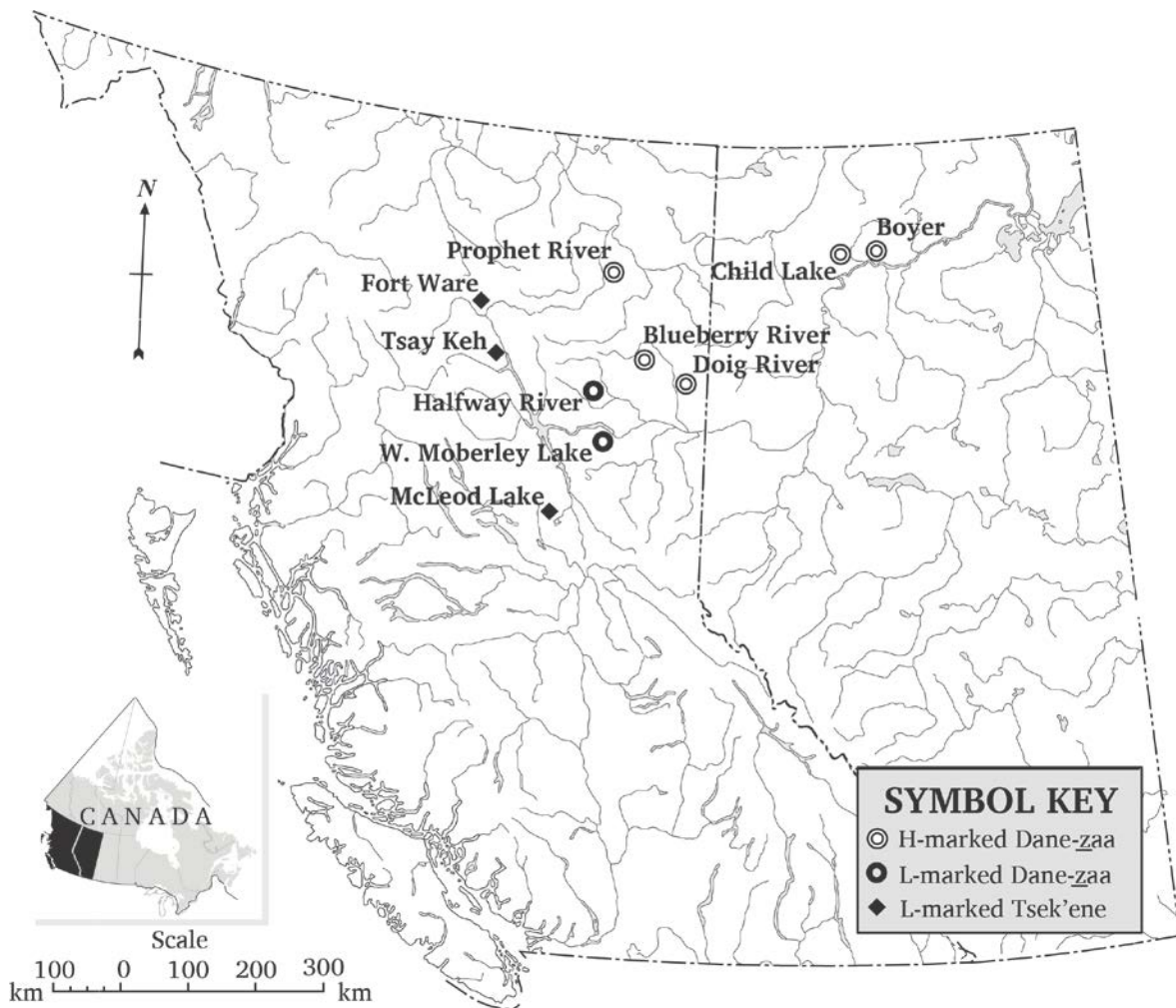
The fact that the high-marked languages form a relatively compact group might lead us to speculate that this grouping represents the spread of an innovation; in other words, that the low-marked system is older, and that the high-marked system somehow evolved from this low-marked system and spread geographically. (Leer, 1999 p. 55)

Whether the PA language first split into non-tonal and L-marked tonal groups (Leer, 1999) or into non-tonal and H- or L-marked tonal groups (Kingston, 2005), is not a question I will pursue in this dissertation. What is noteworthy is that varieties of Dane-zaa are located on either side of the high-marked/low-marked tone isogloss, allowing for a rare exploration into the nature of this noteworthy and unusual mirror-image tone marking system.

### **1.3 Dane-zaa language situation**

Dane-zaa was originally thought to be high-marked (Krauss, 1964; 1996). Recent studies confirm that Doig River and Blueberry River dialects are high-marked (Miller, 2003, 2007a; Story, 1989). Personal communication between Professor Patrick Moore (University of British Columbia) and speakers of Prophet River Dane-zaa also confirm the high-marked status of the Prophet dialect. This high-marking, however, is not present in all Dane-zaa dialects; Halfway River Dane-zaa is a low-marked dialect (Miller, 2007a; Randoja, 1990) as well as W. Moberly Lake, also confirmed by Professor Patrick Moore. In her recent dissertation investigating the intonation and prosody of the northern Alberta dialect, Müller (2009) has confirmed its H-marked status.

A map of the British Columbia and Alberta Dane-zaa speech communities is presented in Figure 4 below. Note the close proximity of the L-marked, closely related Tsek'ene language, specifically the dialects of Tsay Keh and McLeod Lake to the L-marked Halfway River Dane-zaa.



**Figure 4: Map of British Columbia and Alberta Dane-zaa dialect areas. Tsek'ene language sites also included on map for reference.**

The Alberta Dane-zaa dialects, which will not feature in the analyses of this dissertation, are Boyer River and Child Lake. Of the 213 people who live at Boyer Reserve (Statistics Canada, 2012a) and the 188 at Child Lake Reserve (Statistics Canada, 2012b), there are only a total of 25 speakers of the northern Alberta dialect,

with the youngest speaker in his fifties (Müller, 2009). There are no L-marked Dane-zaa dialects spoken in Alberta.

### 1.3.1 *Dane-zaa language use and viability*

Krauss (1996b) outlines the status of Native North American languages, classing the viability of the languages into five categories. I present a summary of these categories below in Table 2.

**Table 2** Categorization of Native North American language endangerment according to Michael Krauss (1996b).

CATEGORY	DESCRIPTION
A:	language is still being learned by children
B:	spoken by parental generation
C:	spoken by middle-aged/grandparental generation
D:	spoken by only a few of the very oldest
E:	extinct

All Dane-zaa dialects fall within Category C; the language is mostly spoken by the grandparental generation and older. The Dane-zaa communities are predominantly English-speaking communities. Open meetings involving younger community members or youth are conducted in English. Children go to school off-reserve to be educated in public Canadian schools, where the Dane-zaa language is not taught; the medium of instruction is English. Generally, back at the band (tribal) hall, day-to-day business is

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conducted in English. Satellite dishes supplying Canadian and American television programming can be found in every household that has a television, which incidentally happened to be every household I visited during the interviews. On home-visits to conduct interviews with the Elders, however, the predominant language heard was Dane-ᓵaa. Telephones were answered using Dane-ᓵaa. People would joke, chat and have discussions in Dane-ᓵaa while watching English-language TV. For the Elders, bilingualism is routine.

Out of a population<sup>3</sup> of 120 residents at the Doig River Reserve (Statistics Canada, 2012c), there are only approximately 30 speakers of Dane-ᓵaa, one-quarter of the inhabitants. Of these speakers, the youngest known speaker was 37 years old at the time of data collection for this study; another was 40. The rest were older than 50. At the Halfway River Reserve, with a population of 170 (Statistics Canada, 2012d), there were more speakers than was found at Doig, though I do not have an exact amount to report. Additionally, there were more younger people who spoke the language than I found at Doig. I was able to enlist the help of three speakers who at the time were under the age of forty.

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<sup>3</sup> All census information was retrieved from the 2011 census reports for British Columbia and Alberta from Statistics Canada (<http://www12.statcan.gc.ca>). Speaker count has been provided by the researcher working in the specific community (or who has had personal communications with community members): Doig, Blueberry, Halfway (Julia Colleen Miller); Prophet, W. Moberly (Patrick Moore); Boyer, Child Lake (Gabriele Schwiertz, née Müller).

During numerous fieldtrips trips, I had the opportunity to attend general band meetings and gas and oil industry conferences. The topics usually pertained to land use, specifically effects of modern industry on traditional lands. In these situations, English was used, with an intermittent switch to Dane-zaa among the elders, chief and councilors. A switch would occur if the speaker's competence of English was not adequate to address the point, or if the speaker became emotionally charged, or if sensitive topics needed to be first discussed and agreed upon before the corporate/industrial representatives were to be included in the conversation. Due to the prevalence of English, and the paucity of Dane-zaa speakers in the younger generation, the settings and functions for Dane-zaa language use are fading. However, despite the predominance of English, the Dane-zaa language is held to be an extremely important part of the Dane-zaa culture. It is feared by community members that their language will not last beyond the lives of their children, the keepers of a passive understanding of Dane-zaa. Fishman (1991) states "Without intergenerational mother tongue transmission, [...] no language maintenance is possible. That which is not transmitted cannot be maintained." (Fishman, 1991, p. 113).

### *1.3.2 Variation between Dane-zaa dialects*

The first social network study of an Athabaskan language (Miller, 2007b) explored the source of tonal variation extant in the results of previous acoustic studies on the Doig

dialect of Dane-zaa, raising the question of whether or not one can predict tone variability by looking to a speaker's social network. One such network score (Subsector Score) measured how connected a speaker is to the Doig community through kinship and participation in culturally relevant activities. The second network score (Dialect Bias) measured a speaker's bias, or relative orientation, through strength of ties of the Doig speaker to members in both the Doig and Halfway communities. Overall results did not entirely support the hypothesis; however, there was a visible trend for the supposition that the higher one's network scores, the lower the tone variability. The conclusion was that there were too few participants interviewed and a larger sample would have greatly benefitted the study.

In my fieldwork I have also explored perceptions of the Doig speakers of their own dialect, and that of the Halfway dialect, and conversely what the perceptions of the Halfway speakers are. During past interviews, I had asked each respondent to describe in what ways their dialect was different from the other Dane-zaa dialect, if at all. Speaker commentary confirmed for me that tone was the most salient feature. All of the speakers mentioned that tone was the main difference between the two dialects. Doig speakers were considered 'low talkers', presumably due to the prevalence of the low, more frequent unmarked tone. Conversely, Halfway speakers were described as 'high talkers'; their unmarked, more frequent tone is high.

Respondents did note that there were slight differences in the sounds of the two languages<sup>4</sup> as well as lexical differences. An informal dialect survey devised by Professor Sharon Hargus (University of Washington) to compare specific lexical items in dialects of Tsek'ene (McLeod Lake, Fort Ware, and Tsay Keh) and Dane-zaa (Halfway, Doig, W. Moberly, and Northern Alberta) was used to explore potential differences along the Tsek'ene-Dane-zaa continuum. Not all target words were collected for each of the languages/dialects; however, of the 75 possible words to compare Doig and Halfway dialects, there was a 77% correspondence between the two. Of the possible 45 words to compare Halfway Dane-zaa to the Tsek'ene of McLeod Lake, there was a correspondence of 62%. For two analyses of tone in this dissertation, the same word list was collected from speakers of each dialect; only four of the 28 tokens needed an alternate; these replacements were due to two younger speakers not knowing the Dane-zaa word.

In addition to phonemic and lexical differences, the speech rate for Halfway speakers was said to be significantly faster than that of Doig, making comprehension for the Doig listeners of the Halfway dialect very difficult, if not impossible;<sup>5</sup> Doig

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<sup>4</sup> These include differences in the phonemic inventories, which will be discussed in the immediately following sections.

<sup>5</sup> This claim is countered by Randoja in her own investigation: "There is intermingling between members of the Halfway River band and other Beaver bands; one of my informants from Halfway River had

speakers referred to the Halfway speakers as ‘fast talkers’. The Halfway speakers reported no difficulties in understanding speakers of Doig Dane-zaa, whom they describe as “slow talkers”. Speech rate is not a linguistic feature I have explored in the past, but these claims do warrant further investigation. That the Halfway speakers have no difficulties in understanding the Doig speakers leads to a possible conclusion that the difficulties do not stem from differences in the lexicon or phonemic inventories; rather, it is an issue of speech rate. This hypothesis would need to be tested in a later study. Another possible explanation for the purported one-way, non-mutual intelligibility could stem from prosodic differences in the tonal or intonational systems of the dialects.

Despite the differences in speech rate, phonemic inventories and lexical items, tone appears to be a conspicuous feature in the dialects of Dane-zaa and one of the most notable ones, when asking speakers to discuss the differences between dialects.

#### **1.4 Doig River Dane-zaa**

As mentioned above, the H-marked Dane-zaa dialects of British Columbia include Prophet, Blueberry and Doig (refer to map of Figure 4). Doig River will be the

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married a woman from Blueberry. Although her speech is distinctive in that it exhibits a reverse tone pattern from HRB [Halfway River Beaver] [...], communication between the Blueberry and HRB speakers appears to be unproblematic.” (Randoja, 1990p. 14)

representative H-marked dialect used in the analyses of this dissertation. The following section summarizes selected linguistic and anthropological works on Doig language and culture. This is followed by an introduction to the phonemic inventory of Doig River Dane-zaa.

#### *1.4.1 Previous research on Doig River language and culture*

As previously mentioned, the Dane-zaa language is seriously endangered and under-documented; the documentation that does exist is sporadic. (Story, 1989) contains a thorough phonological investigation of the phonemic inventory of Doig River Dane-zaa, with some discussion of morphology. (Miller, 2003) is an instrumental investigation of the phonetics of lexical tone in the Doig and Blueberry dialects of Dane-zaa. (Miller, 2007a) is a follow-up investigation of the acoustics of marked and unmarked tone examining the Doig and Halfway dialects.

There has been a variety of anthropological writings on the Doig Dane-zaa people. Anthropologist Robin Ridington has been working since the early 1960s in the following Dane-zaa communities: Halfway, Doig, Blueberry, and Prophet. During this time, he collected numerous Dane-zaa narratives, although they have yet to be transcribed for linguistic analysis (Ridington, 1968, 1969). He has written books that explore the Dane-zaa dreaming tradition including *Trail to Heaven* (1988) and *Little Bit Know Something* (1990). He and his wife recently completed *Where Happiness Dwells: A*

*History of the Dane-zaa First Nations* (Ridington & Ridington, 2013), in which they convey the history of what was once the Fort St. John Band. Using recordings from their own archive, the authors allow the elders to use their own words to tell their histories.

Kate Hennessey, a cultural anthropologist specializing in media, wrote her dissertation (2010) exploring virtual representation of cultural heritage. She and folklorist Amber Ridington (daughter of Robin Ridington) proposed a large, community driven web project that eventually became the *Dane Wajich- Dane-zaa Stories and Songs: Dreamers and the Land* exhibit for the Virtual Museum of Canada. In the summer of 2005, Professor Patrick Moore (University of British Columbia) and I joined the web project team. Our mission was to help document the oral histories told in Dane-zaa. For one month, we traveled with Elders into the bush of the Peace River region to collect their stories. The exhibit has officially launched and can be found at the following link:

<http://www.virtualmuseum.ca/Exhibitions/Danewajich/english/index.html>.

Hennessey summarizes her thesis as having followed “the transformation of intangible cultural expression into digital cultural heritage, and its return in the form of a digital archive to Dane-zaa communities” (Hennessey, 2010p. 2).

All English translations of the web stories and subsequent transcription into the Dane-zaa writing system was funded by the DOBES<sup>6</sup> funding initiative of the Volkswagen Foundation, a private German institute that promotes international collaboration and scholarship. The translation efforts were taken on by the DOBES language documentation team, which included Dr. Dagmar Jung (University of Cologne), Dr. Olga Lovick (née Müller, University of Cologne), Dr. Gabriele Schwiertz (née Müller, University of Cologne), and myself. Community language specialists included Billy Attachie and Eddie Apsassin. We worked in partnership with the Hennessy/Ridington team, as the goals of the two projects were aligned. The DOBES team was established to focus on language documentation from a place names' perspective, highlighting the importance of 'place' in the Doig River Dane-zaa culture. A digital archive has been established and is housed at the Max Planck Institute for Psycholinguistics in Nijmegen, Netherlands. The DOBES project archive, which contains the web project recordings as well as eight years of language documentation efforts of the Doig, Blueberry, Halfway, and Alberta dialects, can be found at the following web address:

[http://corpus1.mpi.nl/ds/imdi\\_browser?openpath=MPI521330%23](http://corpus1.mpi.nl/ds/imdi_browser?openpath=MPI521330%23).

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<sup>6</sup> DOBES is an acronym for Dokumentation Bedrohter Sprachen (Documentation of endangered languages). For more information, follow this link: <http://www.mpi.nl/DOBES/>

The summer 2005 field trip and the collaboration effort will be further discussed in Chapter 4, Section 4.2.3.2 where I introduce the narratives used for the analysis of that chapter.

### *1.4.2 Doig River phonemic inventory*

#### 1.4.2.1 Doig consonants

The large inventory of consonants in Doig Dane-zaa shown in Table 3 is typical for Athabaskan languages; however, there is a dental series of obstruents, which is relatively rare. In the northern Alberta Dane-zaa dialect, free variation exists between interdental and dental obstruents (Müller, 2009). Related languages may have an interdental series instead (e.g. the Kaska dialects of Dease Lake and Lower Post (Honigmann, 1981)).

In the obstruents, there is a three-way distinction between voiceless unaspirated, voiceless aspirated, and ejective. An exception to this is the labial stop, which has only the voiceless unaspirated variant. Fricatives display a voicing distinction. The IPA phonetic symbols are provided within the square brackets. The orthographic<sup>7</sup> representation of each symbol is adjacent.

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<sup>7</sup> The orthography for Doig River was developed by Jean and Marshall Holdstock (Holdstock et al., 1976) in their literacy work for Summer Institute of Linguistics.

**Table 3** Consonant inventory for Doig River Dane-zaa. Segments in square brackets represent IPA transcription; **bolded segments represent the orthography.**

	LABIAL	DENTAL	ALVEOLAR	LAT(-ALV)	(ALV-)PAL	VELAR	GLOTTAL
STOP	[p] <b>b</b>		[t] <b>d</b>			[k] <b>g</b>	
			[t <sup>h</sup> ] <b>t</b>			[k <sup>h</sup> ] <b>k</b>	
			[t'] <b>t'</b>			[k'] <b>k'</b>	[ʔ] <b>ʔ</b>
AFFRICATE		[t͡s] <b>dz</b>	[ts] <b>dz</b>	[t͡ɬ] <b>dl</b>		[t͡ʃ] <b>j</b>	
		[t͡s <sup>h</sup> ] <b>ts</b>	[ts <sup>h</sup> ] <b>ts</b>	[t͡ɬ <sup>h</sup> ] <b>tl</b>		[t͡ʃ <sup>h</sup> ] <b>ch</b>	
		[t͡s'] <b>ts'</b>	[ts'] <b>ts'</b>	[t͡ɬ'] <b>tl'</b>		[t͡ʃ'] <b>ch'</b>	
FRICATIVE		[z̥] <b>z</b>	[z] <b>z</b>			[ʒ] <b>zh</b>	[ɣ] <b>gh</b>
		[s̥] <b>s</b>	[s] <b>s</b>	[ɬ] <b>lh</b>		[ʃ] <b>sh</b>	[x] <b>h</b> [h] <b>h</b>
NASAL	[m] <b>m</b>		[n] <b>n</b>				
APPROXIMANT	[w] <b>w</b>			[l] <b>l</b>		[j] <b>y</b>	

#### 1.4.2.2 Doig vowels

The vowel system in Doig River Dane-zaa is presented below in Table 4. The left column contains IPA transcriptions of the vowels; the right side comprises the orthographic representations.

**Table 4** Vowel phonemes in Doig River Dane-zaa. Vowels on the left represent the IPA transcription; vowels on the right represent orthographic representation.

IPA					ORTHOGRAPHY					
i				u	ii				uu	
e	ẽ <sup>8</sup>	ɪ		ʊ	ẽ	ɛ̣	i		u	ɔ̣
			ʌ					a		
			a					aa		

Vowels in Doig Dane-zaa do not have a phonemic length distinction; however, it is the convention in Athabaskan linguistics to refer to a full/reduced distinction. For Doig, the set of reduced vowels include [ɪ], [ʌ], and [ʊ]. The full oral and nasal vowels include [i], [e], [ẽ], [a], [u], and [õ]. Reduced vowels are typically shorter than full vowels and they are usually restricted to syllables containing a coda. Below in Table 5 are examples of the oral and nasal vowel phonemes for Doig River Dane-zaa.

<sup>8</sup> Throughout this dissertation I will use the nasal hook symbol [ɣ] as well as the tilde [ṽ] for marking tone; transcribing tone and nasal together (using a tilde) often creates a crowded space above the vowel.

**Table 5** Examples of oral and nasal vowel phonemes in Doig River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

ORAL VOWELS			
[i]	[ki.jéh.t̪i]	giyéhjii	<i>'they call it'</i>
[ɪ]	[k'ɪʃ]	k'ish	<i>'birch'</i>
[e]	[k'eh]	k'eh	<i>'track'</i>
[a]	[ʌ.k'a]	ak'aa	<i>'fat'</i>
[ʌ]	[k'ʌt]	k'at	<i>'willow'</i>
[ʊ]	[k'ʊʃ]	k'us	<i>'cloud'</i>
[u]	[ku]	guu	<i>'those'</i>
NASAL VOWELS			
[ē]	[k'éʔ]	k'éʔ	<i>'saskatoon bush'</i>
[ō]	[k'óʔ]	k'óʔ	<i>'quiver'</i>

In the Doig dialect, reduced vowels are contrastive. Examples taken from verb stems are presented in Table 6.

**Table 6** Minimal set of the lax vowel phonemes in Doig River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

LAX VOWELS IN STEMS			
[ɪ]	-[t̪ʰɪt̪]	-tsits	<i>'sg/du eat'</i>
[ʌ]	-[t̪ʰʌt̪]	-tsats	<i>'sg. fall (habitual)'</i>
[ʊ]	-[t̪ʰʊʃ]	-tsus	<i>'feathers'</i>

There are additional vowels that are phonologically contrastive, but are uncommon. Story (1989) notes that these vowels, which are not direct reflexes of PA vowels, are of limited distribution and frequency. Examples of these segments are presented in Table 7.

**Table 7** Examples of rare vowels in Doig River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

UNCOMMON PHONEMES			
[o]	[ko.kóʃ]	gogósh	'pig'
[ã]	[k <sup>h</sup> wã]	kwą	'house'
[ã̃]	[ʌ.zã̃]	aząą	'yes'
[æ]	[dʌ.pæh]	dabeah	'sheep'
[æ̃]	[k'æ̃.tatʃ]	k'ęądaach	'he walks about'

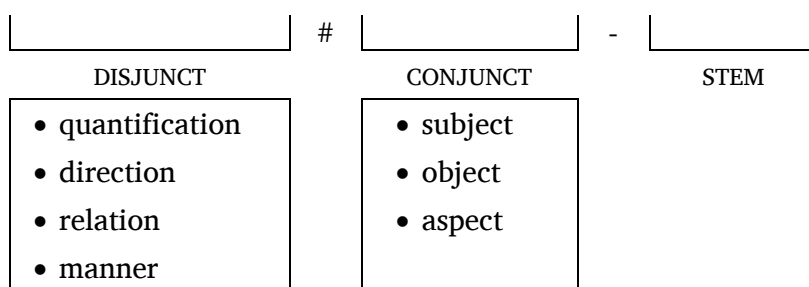
In the Doig dialect, the oral [o] occurs only in lexical borrowings (e.g. gogosh 'pig' is a Cree (Algonquian) loanword). The nasal reduced vowel [ã] is only found following labialized consonants. [ã̃] has a very low frequency;<sup>9</sup> I have only encountered two words with this phoneme. [æ] and [æ̃] are typically found in diminutive forms, such as [dʌ.pæh] 'sheep', from [dʌ.pe] 'mountain goat' + -/ah/, one

<sup>9</sup> According to Hargus (In preparation) [ã̃] is also rare in McLeod Lake Tsek'ene, as there is the rule a → o / \_n; however, in Fort Ware Tsek'ene, there is an innovation of nasalization, resulting in more synchronic instances of [ã̃].

form of the diminutive suffix. It is also found in the second person duo plural form [kwæh.ʔás] ‘you two come in’.

#### 1.4.2.3 Phonotactics of Doig prefix and stem domains

Fang-Kuei Li was first to comment on the existence of two separate verbal prefix domains in Athabaskan languages, disjunct and conjunct (Li, 1946). Disjunct prefixes are situated farthest from the stem and typically have functions that mark the oblique object, reflect quantification, or carry adverbial meaning (e.g. direction, relation, and manner) (Hargus & Rice, 2005). Conjunct prefixes occur closest to the verb stem and often coalesce with neighboring conjunct prefixes (Hargus & Rice, 2005). Figure 5 offers a very simplified representation of the verbal complex.<sup>10</sup>



**Figure 5: The Dane-zaa verb disjunct, conjunct and stem domains with functional features listed below.**

<sup>10</sup> For a detailed description of the intricate Athabaskan verbal morphology, I suggest the following sources: (Hargus, 1988, 2007; Holton, 2000; Leer, 1979; Randoja, 1990; Rice, 1989).

There is a restriction on what phonemes can occur in stem-final coda position.<sup>11</sup> Of the stops and affricates, only voiceless stops, the glottal stop, and the alveolar nasal may occur ([t], [k], [tʃ̥], [ts̥], [tʰ], [tʃ̥], [ʔ], [n]). Somewhat confusingly, the practiced orthography uses the voiceless aspirated symbols for these syllable-final voiceless stops.<sup>12</sup> In the case of fricatives, only the voiceless occur in coda: ([s], [ʃ̥], [ʃ], [x], [h]).<sup>13</sup>

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<sup>11</sup> Sources used to investigate the phonotactics of Doig River Dane-zaa include (Holdstock & Holdstock, 1984), (Story, 1989), and the two Doig texts used for the analysis in Chapter 4 (see appendix). These texts yielded 600 words, though not all were unique.

<sup>12</sup> Having closely viewed the spectrograms of each token used in the experiments of this dissertation, I can confirm that there is a great amount of final devoicing and neutralization in both dialects and that the surface representations of these final obstruents are voiceless and unaspirated.

<sup>13</sup> [x] can only occur in onset position, despite it belonging to the set of voiceless fricatives.

**Table 8** Examples of licit stem-final consonants in Doig River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

STOPS AND AFFRICATES			
[t]	[ná.ʔsát]	náádzat	'he is hunting' <sup>14</sup>
[k]	[ʌ.tsʰʌk]	atsak	'she is crying'
[ʔ]	[ʔsʰáʔ]	tsááʔ	'beaver'
[n]	[nʌn]	nan	'land'
[ʈ]	[ʈsʰitʂ]	ʈsits	'duck'
[ʈs]	[ʌ.pɛʈs]	abets	'it's boiling'
[ʈʂ]	[na.ʎʌ.tés.tʂitʂ]	naaghadésjiitl	'they went back'
[tʃ]	[wʌ.tʃitʃ]	wajich	'story'
FRICATIVES			
[s]	[sʌs]	sas	'bear'
[ʂ]	[ʌ.zíʂ]	azís	'hide'
[ʃ]	[teh.kʌʃ]	dehgaash	'it is black'
[ʈ]	[mɛ́ʈ]	mɛ́lh	'snare'
[h]	[ʎʌ.tah]	[ghadaah]	'he is alive'

The disjunct domain prefixes do not allow for coda consonants. The conjunct domain, however, allows a reduced subset of licit phonemes for word-medial coda position, ([s], [ʂ], [ʃ], and [h]) at the right-most boundary immediately preceding the

<sup>14</sup> Dane-zaa, as with the other Athabaskan languages, does not distinguish gender. Glosses for the third person examples used in this dissertation are arbitrarily assigned a "she", "he", "his", "her", "him".

stem domain. Figure 6 provides an example of the coda [s], in the verb [mʌ.tas.ʔáʔ] ‘I bought it’.

madaashááʔ			[mʌ.tas.ʔáʔ]	‘I bought it’	
mʌ	ta	#	s	-	ʔáʔ
3sO	PP	#	1sS	-	buy.PERF
DISJUNCT			CONJUNCT		STEM

**Figure 6:** Example of Doig Dane-*zaa* verb madaashááʔ [mʌ.tas.ʔáʔ] ‘I bought it’. The morpheme [s] is realized as the coda of the preceding syllable.

In the above example, the disjunct domain includes the oblique third person singular object marker [mʌ]- and the post-position [ta]-; conjunct domain includes the first person singular subject conjugation [s]-; the stem domain comprises the perfective stem form of ‘buy’, -[ʔáʔ]. Below in Table 9 are more examples of word-medial coda consonants in Doig.

**Table 9** Examples of licit conjunct domain coda consonants in Doig River Dane-*zaa*. IPA transcription, orthographic representation and gloss are provided.

FRICATIVES			
[s]	[ʌs.k <sup>h</sup> a]	askaa	‘boy’
[ʃ]	[jʌʃ.k <sup>h</sup> ih]	yaʃk’iih	‘wintertime’
[ʃ]	[ʌ.tʃ.tʃ <sup>h</sup> ʔ]	adishtl’ish	‘book. paper’
[h]	[ʏa.zéh.xeʔ]	ghaazéhhel	‘they kill O’

As for complex onsets, the only allowed consonant cluster contains a stop or affricate with the labial approximate [w] as the second segment.<sup>15</sup> Story (1989) posits that this [w] is an onglide for the following vowel. In her analysis, the underlying representation of the phonetic [ʷa] is a combination of vowels, /ua/. The labial onglide does not occur before round vowels in the Doig dialect. Table 10 offer examples of some CwV combinations. These examples are not an exhaustive presentation of all combinations of consonants and vowels that have been found to occur.

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<sup>15</sup> Story (1989) refers to underlying clusters involving s + a stem initial dental, alveolar or palatal-alveolar affricate. She posits that the surface representations involving the dental and alveolar reduce to a fricative (e.g.  $st\text{ʃ}^h > \text{ʃ}$  nΛʃok, 'I am scraping it'). Only the proposed cluster involving the palatal-alveolar does not reduce to a single fricative vs. a fricative + affricate in its surface form. There is no other evidence that [s] clusters with other segments, or in other locations, such as the relatively robust stem-initial onset slot).

**Table 10** Some examples of clusters involving [w] in Doig River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

STOPS AND AFFRICATES + [w]		
[pwiʂ]	bwiʂ	'river bank'
[k <sup>h</sup> wã]	kwã	'house'
[kwi.jéh.tʃi]	gwiiyéhjii	'he told them'
[eh.t'wah]	eht'waah	'.22 shell'
[mΛ.tse.tʂwéʔ]	madzedzwéʔ	'his lung'
[Λ.t'õ.tʃwã]	at'otl'wã	'autumn'
[ẽ.tʃweh]	ejweh	'no'
[tʃ <sup>h</sup> wæ]	chwë	'bird'
[hwã]	hwã	'near (time, loc.)'
[tʂ <sup>h</sup> esʔwah]	tʂesʔwaah	'.22 gun'

I analyze this combination as a series of two segments rather than a single consonant with secondary articulation (labialization), following Hargus' analysis of these segments in Tsek'ene of Fort Ware (In preparation). Some Athabaskan languages have a phonemic series of labialized consonants [C<sup>w</sup>] allowing these segments to occur word finally. For example, Witsuwit'en [hɛk<sup>w</sup>] 'go ahead' (Hargus, 2007). Doig Dane-zaa and the closely related Tsek'ene do not allow labialized consonants to occur in this position.

The consonants that combine with the [w] include voiceless unaspirated, voiceless aspirated, and ejective segments. The vowels that follow [Cw] include oral

and nasal, full and reduced, monophthongs and diphthongs. As Story noted, the only vowels that are excluded from following [Cw] are the round vowels [o] and [u].

#### 1.4.2.4 Tone

As noted in Section 1.2, tone is phonemic in Dane-zaa. Tones contrast in stems, as in the H-marked [t̃ú] júú ‘these’ versus the unmarked [t̃u] juu ‘now’. Tone is also contrastive in some prefixes. For example, the adverbial disjunct prefix [t̃á] ‘uphill’ in [t̃á.té.ʒa] táádézhāa, ‘he started to go uphill’ contrasts with the momentaneous disjunct prefix [t̃a] in [t̃a.té.ʒa] taadézhāa ‘he got lost’.

In addition to the high-marked and low-unmarked tones in Doig, I have come across a few occurrences of surface-level contour tones, specifically falling tones. Some morphemes in which this tone has been found to occur are the yes/no question morpheme [h̃ô]<sup>16</sup> and the uncertainty morpheme [s̃ô] which translates to ‘it must be’, ‘I think’ or ‘I wonder’. This falling tone is also found in one form of the diminutive suffix -/ê:/ -[ê:]. When it is added to a noun stem, regardless of the stem tone, for example, a H-marked stem ‘fire’ [kw̃án] becomes [kw̃á.nê:] ‘little fire’. A L-unmarked stem such as ‘lake’ is [m̃e.ʒe], becomes [m̃e.ʒê:] ‘little lake’. Hargus (p.c.) points out that this

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<sup>16</sup> For Doig, the orthographic convention for marking a falling tone resulting from the coalescence of the H-marked [é] and the L unmarked [e] is [ê]. If in the orthography the vowel is a digraph, then the outcome would be the following: [áá] + [aa] ⇒ [áa].

might be attributed to a word-final allomorph of H tone in an open syllable.

Occurrences of a H tone in a final syllable are typically followed by a coda consonant in Doig.

A contour tone has been found to occur in verbal prefixes as well. In the verb *zêhhe* [zêh.xɛ], ‘you killed it’ a falling tone occurs in the prefix. Leer (1979) posits that the syllable carrying the contour tone was originally two syllables. The contour resulted from the coalescence of two ambisyllabic vowels with different tones; in the case of the L-marked Tsek’ene, the first vowel carried a L-marked tone, the second, a H-unmarked tone, creating a rising tone. In the Ft Ware Tsek’ene verb *zìnhkhe*<sup>17</sup> [zĩŋ.xɛ] ‘you killed it’, the first syllable shows the rising tone. Contour tones in Doig River Dane-zaa will not be further discussed in this dissertation.

### 1.5 Halfway River Dane-zaa

The L-marked dialects of Dane-zaa are spoken at the Halfway River Reserve, with approximately 80 speakers from a population of 170 (Statistics Canada, 2012d) and W. Moberly Lake Reserve, having 10 speakers from a population of 95 (Statistics Canada, 2012e). (For the locations of these reserves, please refer to the map in Figure 4).

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<sup>17</sup> For Tsek’ene, the convention for writing a rising tone resulting from the coalescence of the L-marked [ì] and the H-unmarked [i] is to write it as [i].

The following section reviews some of the literature pertaining to language and culture of the Halfway River Reserve. After that, I present the phonemic inventory of Halfway as the representative L-marked dialect to be used in the analyses of this dissertation.

### *1.5.1 Previous research on Halfway River language and culture*

Linguistic research on L-marked Beaver is limited to the Halfway dialect. Randoja (1990) examined the phonology and morphology of verbs in the Halfway River Beaver for her Ph.D. dissertation. It is the most detailed study of the morphology of any Beaver dialect thus far, exploring the complexities of Athabaskan verbal morphology and morphophonemic phenomena.

Randoja (1990) brought up a thought-provoking point in her dissertation when she hinted at her desire to refer to the Halfway dialect as ‘Halfway River Sekani (Tsek’ene)’ named for the L-marked Tsek’ene language of the near-by McLeod Lake Reserve. Her comment was based on various phonological properties including tone marking and similarities in phonemic inventories. However, my consultants in Doig and those interviewed in Halfway, consider the language to be Dane-zaa, not Tsek’ene. Group identity in these situations can be rife with political agenda, but in such a scenario I feel obliged to defer to the speakers in these two communities as to what they would like call their language.

As mentioned in the above section summarizing research on Doig Dane-zaa, Miller (2007a) also investigated acoustic properties of lexical tone in the Halfway dialect. More details of the results of that study will be provided in Chapter 2, when I introduce the tone experiments of this dissertation.

Hugh Brody, an anthropologist and filmmaker, had spent time out in the bush and on the reserves with the Dane-zaa. His book *Maps and Dreams* (1981, 1988) discusses land use issues pertaining to the Halfway and W. Moberly native lands and peripherally to the Doig and Blueberry lands. He shares a glimpse of the struggle of retaining native practices in the face of industrial development. Hunting, trapping, mapping, and burial practices are a few of the topics covered in his writings.

## *1.5.2 Halfway River phonemic inventory*

### *1.5.2.1 Halfway consonants*

The consonant inventory of Halfway is very similar to Doig, with the exception of a lack of the dental series of obstruents, also absent in the nearby L-marked Tsek'ene language. I provide the phonemes below in Table 11.

**Table 11** Consonant inventory for Halfway River Dane-zaa. Segments in square brackets represent IPA transcription; bolded segments represent the orthography, based on Randoja (1990).

	LABIAL	ALVEOLAR	ALV(-LAT)	(ALV-)PAL	VELAR	GLOTTAL
STOP	[p] <b>b</b>	[t] <b>d</b> [t <sup>h</sup> ] <b>t</b> [t'] <b>t'</b>			[k] <b>g</b> [k <sup>h</sup> ] <b>k</b> [k'] <b>k'</b>	[ʔ] <b>ʔ</b>
AFFRICATE		[ts] <b>dz</b> [ts <sup>h</sup> ] <b>ts</b> [ts'] <b>ts'</b>	[tʃ] <b>dl</b> [tʃ <sup>h</sup> ] <b>tl</b> [tʃ'] <b>tl'</b>	[tʃ] <b>j</b> [tʃ <sup>h</sup> ] <b>ch</b> [tʃ'] <b>ch'</b>		
FRICATIVE		[z] <b>z</b> [s] <b>s</b>	[ʃ] <b>ʃ</b>	[ʃ] <b>sh</b>	[ɣ] <b>gh</b> [x] <b>x</b>	[h] <b>h</b>
NASAL	[m] <b>m</b>	[n] <b>n</b>				
APPROXIMANT	[w] <b>w</b>		[l] <b>l</b>	[j] <b>y</b>		

### 1.5.2.2 Halfway vowels

Moving on to the vowels of Halfway, I offer the inventory in Table 12.

**Table 12 Vowel phonemes in Halfway River Dane-zaa. Vowels on the left represent the IPA transcription; vowels on the right represent orthographic representation.<sup>18</sup>**

IPA		ORTHOGRAPHY	
i	ĩ	u	
ɪ	ĩ		
e	ẽ	o	õ
	ə	ã	
	a	aa	

The vowels diverge from those of Doig more so than did the consonants. Looking at the full oral and nasal vowels, there are a few additions. The full oral vowels are similar, with the exception of the added oral [o]. In the Doig dialect, this phoneme is typically only found in borrowed words, such as the Cree (Algonquian) word for ‘white person’ [mo.ni.jʌs]. In the Halfway dialect, the [o] may occur in nouns and verbs, stems and prefixes. Other full oral vowels include [i], [e] [a], and [u]. Where Doig only has two nasal vowels, Halfway has three common nasal vowels: [ĩ], [ẽ], and [õ]; three are infrequent: [ũ], [ã], and [ə̃]. Below are examples of the Halfway vowel phonemes.

<sup>18</sup> Randoja (1990) devised an orthography; however many speakers have expressed the desire for their orthography to resemble the one designed for Doig (Holdstock, et al., 1976). Differences include using more recognizable symbols: a for [ə], lh for [ʎ]; digraphs for full vowels: aa for [a].

**Table 13** Examples of vowel phonemes in Halfway River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

ORAL VOWELS			
[i]	[tʃi]	jii	'this'
[ɪ]	[jì.tʃɪ.ke]	yìjige	'up'
[e]	[əs.k <sup>h</sup> e]	aske	'boy'
[a]	[k <sup>h</sup> a]	kaa	'for'
[o]	[ʔə.tə.tʃò]	ʔadadlò	'she laughs'
[u]	[ku]	guu	'those'
[ə]	[k'wəs]	k'was	'sky'
NASAL VOWELS			
[ĩ]	[tʰĩ.tʃ <sup>h</sup> o]	tli̯icho	'horse'
[ẽ]	[tʰẽ.za]	tłe̯zaa	'dog'
[õ]	[su.zè.tʃ'õ]	suzèts'õ	'he heard me'
[ã]	[ʏə.jě.k <sup>h</sup> ãjɬ]	ghayəkaylh	'they are heavy'
[ə̃]	[sãs]	sąs	'bear'
[ũ]	[ʔəʏətɬ'ũ]	ʔaghatl'ũ	'they're knitting'

According to Randoja (1990) [ə] is the sole lax vowel, having the following phonetic variants, [ə], [ɪ], [ɛ], and [ʌ]; however, I have found motivation for adding the front lax vowel [ɪ] to the inventory. Examples of contrasts between [ɪ] and [i], [ɪ] and [ə] are offered below in Table 14.

**Table 14** Contrasting examples for [i], [ɪ], and [ə] in Halfway River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

[ɪ] VERSUS [i]			
[ɪ]	[jì.t̪ɪ.ke]	yìjige	‘up’
[i]	[t̪i]	jii	‘this’
[ɪ]	[wə.k <sup>h</sup> a.ɣɪ.li]	wakaaghilii	‘she is scraping O’
[i]	[ɣi.ta.t̪ʼe]	ghiidaach’e	‘they let her go’
[ɪ]	[ts <sup>h</sup> ɪts]	tsits	‘duck’
[i]	[ʔəs.t̪s <sup>h</sup> ɪts]	ʔəs.tsiits	‘I eat O’
[ɪ] VERSUS [ə]			
[ɪ]	[t <sup>h</sup> ɪs]	tìs	‘crutch’
[ə]	[t <sup>h</sup> əs]	tas	‘arrow’
[ɪ]	[ts <sup>h</sup> ɪts]	tsits	‘duck’
[ə]	[sə̃s]	sąs	‘bear’
[ɪ]	[kwɪ.le]	gwile	‘maybe’
[ə]	[k’wəs]	k’was	‘sky’

In the first set of paired examples above, [i] versus [ɪ], the target vowel falls within the stem domain with the exception of [ɣi.ta.t̪ʼe]. /ɣi/ falls within the disjunct prefix domain.

Unlike Doig Dane-zaa, Halfway does not have the lax vowel [ʊ]. In corresponding lexical items from Doig, where the phoneme [ʊ] manifests, Halfway manifests the fully rounded [o]. This is also the case for the closely related L-marked Fort Ware Tsek’ene. Examples of this correspondence are offered below in Table 15.

**Table 15** Correspondences between Doig [u] and Halfway and Tsek'ene [o]. IPA transcription and gloss are provided.

DOIG	HALFWAY	FT WARE TSEK'ENE
[ts'ʊ.tse] 'fly'	[ts'o.tse] 'fly'	[ts'o.tse] 'fly'
[tʰẽ.tʃʰʊk] 'horse (big dog)'	[tʰẽ.tʃʰo] 'horse (big dog)'	[tʃʰo] 'big'

### 1.5.2.3 Phonotactics of Halfway prefix and stem domains

Stem-final coda positions in Halfway River Dane-zaa can only be filled with voiceless unaspirated stops and affricates and select fricatives. Using the Randoja dissertation and a narrative that I collected from a Halfway speaker (300 words), I have found the following word-final coda stops and affricates: ([t], [ts], [tʃ], [tʃʰ], [ʔ], and [n]) and the following fricatives: ([s], [ʃ], [ʃʰ], [l], and [ɣ]).<sup>19</sup> Examples of these licit stem-final codas are presented in Table 16.

<sup>19</sup> According to Randoja (1990), syllable-final [h] does not occur in surface representations.

**Table 16** Examples of licit stem-final consonants in Halfway River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

STOPS AND AFFRICATES			
[t]	[nà.nə.tsət]	nàànadzat	‘stand up!’
[ʔ]	[ts <sup>h</sup> àʔ]	tsààʔ	‘beaver’
[n]	[na.ne.kwən]	naanegwan	‘you dry O’
[ts]	[ts <sup>h</sup> its]	tsits	‘duck’
[tʃ]	-[kwòtʃ]	-gwotl	‘hit O’ <i>PERF</i>
[tʃ]	[nàis.tʃ <sup>h</sup> utʃ]	nàischuch	‘I always catch O’
FRICATIVES			
[s]	[t <sup>h</sup> às]	tààs	‘arrow’
[ʃ]	[te.kàʃ]	degààsh	‘it is black’
[ʎ]	[mìʎ]	mìlh	‘snare’
[l]	[ts <sup>h</sup> ə.ts <sup>h</sup> əl]	ts’atsal	‘we are crying’
[ɣ]	[wə.ts <sup>h</sup> ay]	watsaagh	‘she is crying’ <sup>20</sup>

There was one occurrence of the labial approximate [w] in a coda position in Randoja’s data: ùnit’ow [ù.ni.t’ow] ‘I shot at O’. A similar form in Doig, yúúneht’uk [jú.nēh.t’uk] ‘he shot at it’, has a stem-final [k].

<sup>20</sup> Randoja (1990) transcribes this as [wə.ts<sup>h</sup>ay]. This surface representation contradicts her statement that all final fricatives are voiceless. In my word lists and narratives, I have found no occurrence of voiced fricatives; however, the form in Fort Ware Tsek’ane ends with the voiced fricative: [ə.ts<sup>h</sup>ay] she is ‘crying’ (Hargus, In preparation).

Regarding other coda consonants, Randoja states that for verbs, codas are licit in only two locations: word-finally and at the end of the conjunct domain. She notes that both locations mark the edge of a domain. The only example of a conjunct domain coda in her thesis data was [s]. As for nouns, my corpus yielded no additional word-medial codas. I attribute this to a dearth of examples, and am unwilling to commit to the idea that [s] is the only licit coda word-medially at this time. More data will need to be collected.

The infrequency of word-medial coda consonants can be attributed to the highly complex rules of epenthesis in the conjunct domain discussed by Randoja in her dissertation (1990). Table 17 offers an example of a conjunct coda consonant.

**Table 17** Example of licit word-medial coda consonants in Halfway River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

FRICATIVE			
[s]	[na.nes.tʃ̣'i]	naanesch'i	<i>'I see you again'</i>

According to Randoja (1990), disjunct and stem domains in the Halfway dialect share some phonological characteristics. Both can begin with nearly any consonant and may include any vowel. Conjunct prefixes, on the other hand, have a limited set of licit onsets [t], [n], [z], [s], [ʈ], [tʃ̣<sup>h</sup>], [tṣ<sup>h</sup>], [ʔ], and usually [ə] emerges as the vowel.

As for complex onsets, the occurrence of [CwV] appears to have an expanded distribution in the Halfway dialect, including occurrence before rounded vowels. Examples are offered below in Table 18.

**Table 18** Some examples of clusters involving [w] in Halfway River Dane-zaa. IPA transcription, orthographic representation and gloss are provided.

STOPS AND AFFRICATES + [w]			
[t <sup>h</sup> wə̀]	[u.t <sup>h</sup> wə̀n]	utwà̀n	'she holds O'
[t <sup>h</sup> wə̀]	[se.t <sup>h</sup> wəs]	setswas	'it springs (mousetrap)'
[t <sup>h</sup> wə̀]	[ẽ.t <sup>h</sup> wə̀]	ɛchwe	'no'
[k'wõ]	[də.k'wõ]	dak'wɔ	'he is midget sized'
[k'wə̀]	[k'wəs]	k'was	'sky'
[k <sup>h</sup> wo]	[də.k <sup>h</sup> wo.nèʔ]	dagwonèʔ	'his elbow'
[ɣwə̀]	[jə.we.xwə̀.se]	yawexwà̀se	'she wants to tickle her'
[xwə̀]	[əs.xwə̀s]	asxwà̀s	'I itch'

## 1.6 Chapter summary

This preliminary chapter offered an introduction to the Athabaskan language family and tone situation for these languages, specifically pertaining to the mirror-image tone marking found in dialects of Dane-zaa. I reviewed previous anthropological and linguistic research on the language and culture of Doig and Halfway Dane-zaa communities that have aided my own investigations. Additionally, I offered an introduction to the phonemic inventories of Doig and Halfway. The similarity in

inventories and lexical items between these two dialects allows for a unique investigation of tone.

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## **2 Tone and Morphological Factors**

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### ***2.1 Introduction***

This chapter presents results from an instrumental analysis designed to investigate acoustic properties of lexically marked and unmarked tone in Doig River and Halfway River Dane-zaa. Given the notable mirror-image tone systems of Doig and Halfway, I am interested in exploring differences in how marked tone is expressed in each dialect, as well as differences that manifest on an individual level. In addition to examining the effects of Tone category on the manifestation of pitch, I also explore the effects of Lexical category and Morphological category.

Organization of the chapter is as follows. Section 2.2 provides background on Athabaskan tone, offering a brief review of the literature pertaining to phonetic work

on Athabaskan languages, generally, and Dane-zaa specifically. Section 2.2.1 investigates effects of Tone category on the manifestation of pitch. This includes tone categorizations of H and L as well as marked and unmarked. Section 2.2.2 summarizes the motivations behind the question of effects of Lexical category on normalized pitch. Section 2.2.3 outlines the motivation for investigation of effects of Morphological category on pitch. Section 2.3 describes the methodology involved in the data collection and instrumental analyses, notably, in 2.3.5.2 I describe the normalization procedure used in experiments of this chapter and Chapter 4. Section 2.4 presents results of the various experiments designed to investigate tone in the Doig and Halfway dialects. Results are presented for the dialect groups, as well as for individual speakers. Section 2.5 discusses the implications of the experimental results.

## ***2.2 Background and research directions***

My research has been informed by previous qualitative, transcriptional-based studies, as well as quantitative, instrumental studies. Additionally, results from my own prior investigations of tone in Dane-zaa are summarized. Research questions for each experiment in this current study will be presented directly following the summaries of the relevant literature.

### *2.2.1 Effects of Tone category on pitch (H vs. L)*

As mentioned in the introduction in Chapter 1, many of the Athabaskan languages are tonal languages, showing categorical differences between H and L tones (Krauss, 1979, 2005). There have been few instrumental studies pertaining to the manifestation of pitch within these tonal categories for these languages. This section is dedicated to summarizing the findings from these experiments.

In an instrumental study of Navajo (de Jong & McDonough, 1993), a L-marked language of the Southern Athabaskan family, the authors provide results indicating that the unmarked H tone syllables do not show more effects from the surrounding segments than do the marked L tone syllables. Surrounding segments include the glottalic features of flanking segments, as well as the tones of the neighboring syllables. The authors conclude that they are not underspecified for tone, compared to the marked syllables; there are two distinct tone categories, H and L.

Tuttle (1998) provides results of an instrumental text-based study of two dialects of Tanana: the L-marked Minto and the non-tonal Salcha. Regarding lexical tone in Minto, Tuttle confirmed the status of this dialect as low-marked, though tone-marking was not clear for every stem. As for the select prefixes investigated in the study, she found that those that are historically low-marked were slightly lower than those that were not historically low, but the difference was not significant.

An earlier qualitative, non-instrumental study of Doig (Story, 1989) contains a detailed treatment of the contrastive sounds and segmental sequences in the Doig dialect, with some discussion of the morphology. She corroborates Krauss' assertions (Krauss, 1979, 2005) that the tone system is H-marked, though she admits that throughout her study, tone is inconsistently transcribed.

The dissertation by Randoja (1990) provides a detailed qualitative analysis of the phonology and morphology of the Halfway dialect of Dane-zaa. The author maintains that the marked tone in Halfway is L and that the unmarked is H. She further explores the behavior of tone within the verbal complex, specifically the conjunct and disjunct prefixes.

My own instrumental studies of the Doig and Blueberry dialects provided acoustic evidence corroborating Story's assertions that Doig is high-marked (Miller, 2003). Results indicated a significant effect of tone category on pitch across speakers (both Doig and Blueberry dialects) and significance for three of the five speakers, individually. However, the fact that the expected tone categories of H and L were not found to be significantly different across all speakers suggests that variation in the production of lexical tone is extant. The outcome of that study prompted me to create an improved word list and to explore additional dialects to try to determine if this is a pattern across both H- and L-marked dialects of Dane-zaa, or if this was merely the result of a flawed word list design.

In a later instrumental study comparing the tone of the Doig and Halfway dialects (Miller, 2003, 2007a), results not only verified that the Halfway dialect was L-marked with acoustic evidence, but also showed the two dialects had a significant difference between H and L tones. It was also the case that there was a between-group interaction; Halfway L-marked tone was significantly lower than Doig L-unmarked tone. Individual results for this experiment yielded significant differences between H and L tone for six of the nine participants. It is interesting to note that the three Doig females had no significant difference between H and L tone categories.

The notable amount of variation in the expected tone categories points to at least two possible explanations. The first is that there may not be two separate tone categories, rather a system of one marked tone (H in Doig, L in Halfway) and the other merely a default tone, with a range of pitch that is relatively wide and without a specific tonal target unlike Navajo. Another possible scenario is that variation may be due to contact with languages having the opposite tone patterns. For the H-marked Doig speakers, this could be contact with the L-marked Halfway dialect or the Sekani language (indicated by the “Sk.” on the map of Chapter 1). For the Halfway speakers, this could be contact with the H-marked Doig dialect or the Kaska or Slave languages (“Ks” or “Sl”, respectively, also on map of Chapter 1). These dialect areas are geographically adjacent, suggesting opportunity for possible social interaction.

A detailed examination of the second scenario falls outside the realm of the current study, as it would require further sociolinguistic research beyond my previous study exploring tonal variation and social networks (Miller, 2003, 2007b). Specifically, this potential study would need to address the influence of non-Dane-zaa languages on the manifestation of tone. In addition, further explorations of language use, language attitudes and group identification or affiliation would be necessary. This prospective investigation would also benefit from a perception study, which would explore allowable variation in lexical tone by speakers of both H- and L-marked dialects. Such a study of inter- and intra-speaker variation would certainly add to what is known about tone in Athabaskan languages.

In the first experiment of this dissertation, I investigate the possibility of significant differences in the manifestation of pitch between syllables that are expected to have a H tone associated with them, and those with a L tone. A follow-up question to that explores the possibility that there is a distinct difference in the level and span of pitch range between the H-marked syllables of the Doig dialect and the H-unmarked syllables of the Halfway dialect, and conversely, L-unmarked Doig syllables and the L-marked of Halfway. I posit that the marked tone syllables will have a more distinct pitch target than the unmarked tone syllables, thus a more narrow range.

- (1) **Research Question for Tone Category:** What is the nature of the acoustic differences between H and L tone?
- a) What are the pitch-targets for the H and L syllables for the Doig dialect speakers?
  - b) What are the pitch-targets for the H and L syllables for the Halfway dialect speakers?
  - c) Do both dialects have a significant difference between the H and L tone categories?

This first research question was designed to revisit effects of expected tone category on the manifestation of pitch on both marked and unmarked target syllables. This question was first explored in Miller (2003) and again in Miller (2007a). The word list in the (2003) study was recorded with only sixteen tokens per speaker, recording five speakers. In an attempt to improve upon the previous study, the (2007a) study included approximately 50 tokens per speaker, using nine speakers. The current study includes data from fourteen speakers. The number of tokens ranges from 75 to 90. Due to the increased number of data points, I expect variation to have less of an effect on the statistical outcome. The increased data will provide sufficient power to find a significant effect of tone category, both within and across subjects.

### *2.2.2 Effects of Lexical category on pitch (Verb vs. Non-verb)*

It has been proposed in the literature that pitch in verbs manifests differently than in nouns. This section will present findings for studies in Athabaskan languages, as well as those pertaining specifically to Dane-zaa.

In other tonal Athabaskan languages, such as Minto and Hare, lexical category interacts with tone in varying ways. In the case of L-marked Minto (Krauss & Golla, 1981; Tuttle, 1998), the distinction between H and L tones of noun stems is clearer than on verb stems. In H-marked Hare (Rice, 1990), the manifestation of lexical tone is dependent upon the lexical category of the word. Tones of verb stems always manifest as phonetically L.

In the Miller (2003) study, both Doig and Blueberry dialects had significantly lower normalized pitch values in verbs, both H and L syllables, than in non-verbs. This was the case for the group as a whole, as well as each individual in the group, with the exception of one of the five speakers, indicating variation needing further investigation. In Miller (2007a), results of the Doig and Halfway study, there was a significant difference between the tones in verbs than in non-verbs. All of the speakers in the study produced a lower pitch in verbs than non-verbs; however, this difference was significant for only five of the nine speakers.

To further explore the effects of Lexical category on pitch, I propose the following research question in (2).

(2) **Research Question for Lexical Category:** What are the effects of lexical category (verb, non-verb) on pitch?

For this research question, I hypothesize that there will be a significant difference between the tone of a verb and that of a non-verb. Targeted syllables that fall within verbs will have a significantly lower pitch value than those of non-verbs, for both the high-marked and low-marked dialects. The hypothesis follows from the above summary of results as well as the fact that Athabaskan languages are verb-final and that intonational pitch contours have been found to fall as an utterance proceeds.

In her dissertation investigating intonation and prosodic structures in the Dane-zaa dialect of Alberta Beaver, Müller<sup>21</sup> (2009) found that declaratives had a low final boundary tone, which leads to decreased pitch and devoicing at the end of an utterance; however, this decrease in pitch does not obscure the difference between H and L tone. The effect is that tone will manifest lower on verbs due to their sentence-final position.

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<sup>21</sup> Müller is now publishing under her married name, Schwiertz.

### *2.2.3 Effects of Morphological category on pitch (Prefix vs. Stem)*

The suggestion that the pitch falling on a stem might be different than the pitch that falls on a prefix has been explored in various studies. This section will present findings for experiments in Athabaskan languages, generally and Dane-zaa, specifically.

An instrumental study of tone in Ft. Ware Sekani (Hargus, In preparation), found that normalized H and L tones were significantly different in both prefixes and stems. In Tanacross, (Holton, 2000, 2005) prefix vowels may be H or L; however, there are four possible lexical tones that may appear on the stem. Although Dane-zaa has only two tones, and tone assignment is not affected by morphological category, Holton's findings are still relevant for this investigation in that for a tonal Athabaskan language, morphological category does have a direct effect on tone.

These findings motivated my previous investigation of the Doig and Blueberry dialects. In (Miller, 2003) the type of morpheme of the tone-bearing syllable in both Doig and Blueberry had no significant effect on the realization of tone for individual speakers. The majority of speakers produced stem tones slightly lower for both L and H tone categories, but there were some speakers who produced slightly higher stem tones, as well. In the study of the Doig and Halfway dialects (Miller, 2007a), five of the nine speakers followed the expected pattern of lower normalized pitch on stems, three more did so, but only for one of the tone categories (two for H and one for L);

however, the effect of Morphological category was only statistically significant for one speaker.

To investigate effects on pitch due to Morphological category, the following research question in (3) will be pursued.

**(3) Research question for Morphological Category:** What are the effects of Morphological category (prefix, stem) on pitch?

For Research Question 3, I anticipate that there will be significant differences in pitch, depending on the type of morpheme in which the target syllable falls. Pitch values for stem tones will be lower than those of prefix tones, for both the high-marked and low-marked dialects, regardless of tone category. The declarative intonation pattern of L%, again, is predicted to play a role in this; as prefixes come earlier in the verbal complex and are less likely to be as affected by the gradual pitch lowering as an utterance proceeds.

### **2.3 Methodology**

This section focuses on the specific methodologies employed in data collection and data analysis for the investigation into effects on normalized pitch. Section 2.3.1 provides information about the speakers that participated in this study. Section 2.3.2 describes the specific data that were gathered to address the research questions. Section 2.3.3 summarizes the technical details of the recording equipment and the subsequent data

processing. Section 2.3.4 outlines the measuring criteria employed for these tests. In Section 2.3.5 is a description of the statistics used to obtain the findings that will be presented in the following results section.

### *2.3.1 Speakers*

Data was collected from fourteen speakers of Dane-zaa. I started with an individual in the Doig community with whom I had worked before. He provided me with names of others in both the Doig and Halfway communities who might want to participate in the study. Because of the friend-of-a-friend approach, I was able to successfully recruit the suggested individuals, who then offered names of others who might have wanted to participate. Each participant in the study is, therefore, confirmed to be fluent in Dane-zaa by fellow speakers. All are bilingual in English; speakers stated that they learned English at various ages: some were as young as seven, others as old as fourteen. Eight are speakers of the high-marked Doig dialect, including four males and four females. The six remaining are speakers of the low-marked Halfway dialect, four women and two men. Ages of the participants ranged from 30 years to 68 years. All but three of them are literate in English. Two are additionally literate in Dane-zaa, as they have worked with literacy efforts in the Doig community.

### 2.3.2 *Materials*

#### 2.3.2.1 Word list design

The word list as an elicitation device is located at the formal end of the stylistic continuum (Labov, 1966). It is an important tool to elicit specific tokens that show the linguistic phenomena of choice. One limitation is that it is rather unnatural speech. The speaker focuses specifically on what is perceived to be the ‘correct’ pronunciation of the token. Subsequently, if there is a tone contrast, it is highly likely to manifest in word list data.

There are certain factors that can influence pitch to be aware of when designing a word list to elicit data for a tone study. One such factor is the influence of flanking consonants of the tone-bearing vowel.

Considering the fact that tone carries lexical information and is unchanged across syllables that are different with respect to segments, its underlying pitch target should remain intact despite F0 perturbations by consonants. Nevertheless, the implementation of the pitch target is likely to be influenced by the consonant effect. (Xu & Xu, 2003 68, p. 168).

Consonants can raise or lower pitch (Hombert, 1978). For example, in the case of prevocalic plosives, the voicing distinction of voiced and voiceless obstruents can lower or raise the pitch, respectively, of a following vowel. Specifically, in a study of Yoruba, a tone language of Africa, Hombert (1977) found that voiced stops caused more pitch

lowering on high tones and voiceless stops caused more raising on low tones than either did on mid tones. However, the effect of the voiced consonant on the high tone was greater than that of the voiceless consonant on the low tone. Additionally, in an acoustic study of the effects of aspiration on tone in Mandarin, (Xu & Xu, 2003) noted that aspirated stops create a lower F0 onset on the following vowel than do the unaspirated stops (Hombert, 1978), meaning there is less perturbation. However, this significant effect does not change underlying pitch targets, only the onset contours. And finally, in an instrumental study of the tonal Athabaskan language Dene Sų́liné, Gessner (2005) shows that although there is no significant effect of preceding consonant on the pitch of the following high tone, there was a significant effect of voiceless fricatives on following low tone.

In situations pertaining to post-vocalic consonants, Hombert (1978) points out that the perturbation of a following plosive can be seen up to 70 ms. into the preceding vowel, therefore it is best to control for following segments as well as the prevocalic ones. According to Hombert, regarding the effects of postvocalic laryngeal consonants, the glottal stop, [ʔ], acts to raise pitch of preceding vowels and [h] lowers it. Historically, when a glottal stop disappears from a given language, what usually remains is a rising tone. When a language loses an [h], what tends to develop in its place is a falling tone (Hombert, 1978). These statements were corroborated in a study of the effects of post-vocalic [h] and [ʔ] on the fundamental frequency in Arabic.

Hombert concluded that “an [h] produces a drop in F0 (varying from 25 to 50 Hz), while the [ʔ] produces a rise in F0 (from 9 to 48 Hz)” (Hombert, 1978, p. 95).

Kingston (2005) proposes that in Proto-Athabaskan, word-final glottalization and subsequent tone were pronounced in two different ways, either with tense or slack constriction of the glottis. If speakers produced the glottalization with a tense voice quality, a high tone would result. If the speakers came to produce a voice quality that showed more creak, the tone would become low. The changes would occur only on lexical items which had this syllable final glottalization. Hombert’s findings do not support Kingston’s hypothesis that both H and L tones could have come from the same source.

In an instrumental study of the effects of word-final glottalization in the non-tonal Athabaskan language Witsuwit’en (Hargus, 2007), Hargus found clear synchronic evidence to support Kingston’s findings that Proto-Athabaskan may have developed both H and L tones from glottalic consonants. I will address the topics of voice quality, word-final glottal stops, and Athabaskan tonogenesis in greater detail in Chapter 3.

The quality of the tone-bearing vowel can also be a factor in raising or lowering pitch. In a study of Navajo tone (de Jong & McDonough, 1993) the authors found that the height of the vowel had an effect on pitch. Results indicated that high vowels had

significantly higher F0 than low vowels. The difference in pitch between high and low vowels was not found to interfere with distinctions of tonal categories.

Table 19 below outlines some of the criteria for designing a balanced set of words for an analysis of tone; information is taken from (de Jong & McDonough, 1993).

**Table 19** Criteria for creating a balanced set of words for tone study, after de Jong and McDonough (1993).

Tone Criteria	preceding syllable	H or L
	target syllable	H or L
	following syllable	H or L
Vowel Criteria	vowel height	high, mid, low
	vowel quantity	full or reduced
Flanking Consonant Criteria	preceding consonant: • <i>laryngeal setting</i>	voiceless, voiceless unaspirated, glottalic
	preceding consonant: • <i>manner</i>	stop, fricative, sonorant
	followed by ?	yes or no
	followed by h	yes or no

Using a word list for elicitation allowed me further control via a sentence frame, which enabled me to avoid the influence of unwanted intonational patterns.

Word lists for each experiment are illustrated below. Each experiment has a set of tokens designed to address effects of the specific linguistic category on normalized

pitch. For this reason, each set is slightly different. The word list to explore effects of Tone category on pitch can be found in multiple tables, beginning at Table 25. There are 28 tokens in total. The set of tokens used to investigate effects of Lexical category is found beginning at Table 31. There were 24 tokens used for this experiment. And finally the word list for effects of Morphological category can be found starting at Table 41, with a total of 16 words.

#### 2.3.2.2 Carrier phrases for word list

In order to control for potential interference of phrasal intonation on pitch, the target words were embedded in a non-phrase final position within a carrier phrase. There were approximately 10 different carrier phrases for the different tokens. Examples of carrier phrases for nouns and verbs are listed below in (4) and (5), respectively. The first line is presented in the Doig orthography, below that is the phonetic transcription within square brackets, and the translation in italics.

- (4) Askaa gaah gha?é?.<sup>22</sup>  
 [ʌs.k<sup>h</sup>a kah ɣa.ʔéʔ].                      ‘The boy sees (land/a rabbit/the sky).’
- (5) Alááʔ dááslááʔ dasii.  
 [ʌ.láʔ tás.láʔ tʌ.si]                      ‘I said I bought a boat’

Ideally, three repetitions were recorded from each speaker for each target token and all speakers were to record the same tokens. In some cases only two repetitions were used for the study, mostly due to final devoicing. Sentences were presented in a randomized order in order to avoid list intonation when repeating the same utterance three times. Additionally, a substitute word of comparable tone and segment shape replaced any tokens unknown to the speaker being recorded. For example, the Halfway speakers did not use the word *man* [mʌn] for ‘*wall*’, so the chosen replacement word was *dane* [dʌ.ne] ‘*man, person*’, bolded syllable indicating the target. Such changes to the design were infrequent.

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<sup>22</sup> The complete lists of tokens elicited for both the H- and L-marked dialects for the experiments are provided in the relevant subsections of Section 2.4.2. Doig River orthography was developed by SIL linguists, Jean and Marshall Holdstock. I use this system for both dialects, as community members at Halfway have informed me that they are beginning to adopt it as well. For the IPA transcriptions, when transcribing nasal vowels, I will use the nasal hook [ɣ] rather than the tilde [ṽ] to avoid a crowded transcription when tones are also present.

### *2.3.3 Recording procedure and audio processing*

Recordings were made in the field with the Marantz CDR300 portable CD recorder at a sampling rate of 48,000 Hz and a bit depth of 16, with an AKG C 520 unidirectional (cardioid polar pattern) head-mounted microphone. Using the head-mounted microphone allowed me to control its distance from the speaker. I recorded speakers individually in various environments. Due to the difficulty in mobility for many of the consultants, I brought the recording equipment to the speakers for our sessions, usually in their homes or at the band office. All sound recordings were down-sampled to 22 kHz files in Sound Forge 7.0 and then each utterance was segmented into the separate .wav files.

### *2.3.4 Pitch measurement criteria*

All F0 measures were collected using PRAAT version 5.0.23. I controlled the size of the analysis window for consistency, 400 ms., after reviewing a substantial subset of target syllables and finding the longest one. In PRAAT, I changed the default spectrogram settings<sup>23</sup> in the following ways. I set the view range for 0.0-1,300 Hz, the window length for 0.08 and the number of time steps for 9,000. These altered settings allowed

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<sup>23</sup> PRAAT 5.1.23 default spectrogram settings are the following: View range: 0.0-5,000 Hz.; Window length: 0.005; Number of time steps: 1,000.

me to use a narrow-band spectrogram in order to confirm that no pitch halving or doubling occurred in the analysis.

For the pitch settings in PRAAT, I made the following changes.<sup>24</sup> For the male speakers, I set the analysis range to 75.0-300.0 Hz, the view range to 50.0-300.0, the octave-jump cost to 2.0, and the voiced-unvoiced cost to 0.5. For the female speakers, I set the analysis range to 75.0-600.0 Hz, the view range to 50.0-600.0, the octave-jump cost to 2.0, and the voiced-unvoiced cost to 0.5. These adjustments were made to accommodate the varying pitch ranges for both genders and to help the pitch tracker overcome errors due to creaky voicing that was present in many of the speakers' utterances.

Measures of pitch were taken at the midpoint of the target vowel, averaged across 30 ms. These values were set aside to be used for the raw pitch analyses. All token measurements were then averaged together within a speaker's data set to calculate mean ( $FO_{\text{mean}}$ , discussed below) and standard deviation (s) values for each speaker. These figures were then used to normalize the speakers' pitch measures, using a z-transform. The method for normalization will be further explained in Section 2.3.5.2.

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<sup>24</sup> PRAAT 5.1.23 default pitch settings are the following: Analysis range to 75.0-500.0 Hz.; View range: 'auto', Octave-jump cost: 0.35; Voiced-unvoiced cost: 0.14.

### 2.3.5 Statistics

This section describes the statistics that were used in this study. The normalization was carried out using MS Excel, while all other descriptive and inferential analyses were performed with the StatView statistics package, version 5.0.1.

#### 2.3.5.1 Descriptive statistics

Descriptive statistics are presented to illustrate in general terms the distribution of pitch ranges for the speakers in raw F0 Hz. and normalized pitch values. Following (Ladd, 1996), in order to describe the pitch range in a comprehensive manner, I will supply both the value of F0, the *level*, as well as the range of frequencies used, the *span*. The level tells us how high the speaker's voice is and the span tells us if the speaker is using a wide or narrow range of frequencies. Using both level and span gives us a better idea of how each speaker is using their pitch range. These raw values for F0, however, do not allow for an appropriate method of comparing speakers to one another because of speaker intrinsic factors. In order to abstract away from differences in F0 due to age, gender, height, etc., a type of normalization procedure needs to be employed. I will now briefly explain this procedure.

#### 2.3.5.2 Z-score normalization procedure

In (Rose, 1987, 1991) the method employed to normalize pitch was a z-score transform. The formula is given below in (6):

$$(6) \quad FO_{\text{norm}} = \frac{(FO_i - FO_{\text{mean}})}{s}$$

In this formula,  $FO_{\text{norm}}$  is the normalized pitch value, a z-score;  $FO_i$  is the target pitch measure,  $FO_{\text{mean}}$  is the mean pitch of all target syllables,  $s$  represents standard deviation from the mean, and  $i$  represents the individual token. This transform normalizes within the set of all target measures for a speaker. Essentially, it sets the mean to zero, then measures the variations in standard deviations. A negative score indicates a measure below the mean, a positive score, above the mean.

### 2.3.5.3 Inferential statistics

In these experiments, the independent variables are qualitative, representing categories, such as Expected tone category, Lexical category and Morphological category. The dependent variable is normalized pitch, a quantitative variable. For all ANOVA experiments in this dissertation, I used an  $\alpha$  value of .05.

Two types of analysis of variance were performed. The first was a repeated measures ANOVA, which investigates between-speaker variations. A repeated measures design is beneficial when there is a limited supply of participants. Using this method of analysis was a way to avoid Type I error. Each speaker's mean is the dependent variable. For example, the repeated measures experiment investigating the effect of Tone category and Lexical category on normalized pitch used each speaker's

average pitch for H tone verbs, H tone non-verbs, L tone verbs and L tone non-verbs as dependent variables.

The second type of analysis of variance used in this study is a factorial ANOVA. This test allowed me to explore the possibility of within-speaker variability, which was not possible in the repeated measures design. I submitted the data to the factorial ANOVAs in order to consider any main effects on normalized pitch values for individual speakers. I used a one-factor analysis to test the effect of Expected tone category and a two-factor approach for the tests pertaining to effects of both Lexical category and Morphological category, depending on the experiment.

For the results of factorial tests to be as accurate as possible, the sample size needed to be large; there is a greater chance of missing significant effects when the sample size is too small. Factorial designs also allow manipulation of more than one independent variable in the same experiment. The outcomes are independent results for each variable and a combined result for joint influence, or interaction.

## **2.4 Results**

Up to this point, I have introduced my research questions, providing summaries of the acoustic studies that have informed my hypotheses. I have outlined the methods of collecting, measuring and analyzing the data. In this section, I present the results. In

each section, where applicable, I will first provide group results, and then explore the individual findings. In Section 2.4.1, I present the raw F0 results and those from the examination of normalization procedures. In Section 2.4.2.1 I give the findings of the effect of Tone Category on normalized pitch. Section 2.4.2.2 provides the outcomes of the investigation into the effect of Lexical Category on normalized pitch. In Section 2.4.2.3 are the results for the question of possible effects of Morphological Category on normalized pitch. A summary of my findings are presented in Section 2.4.3.

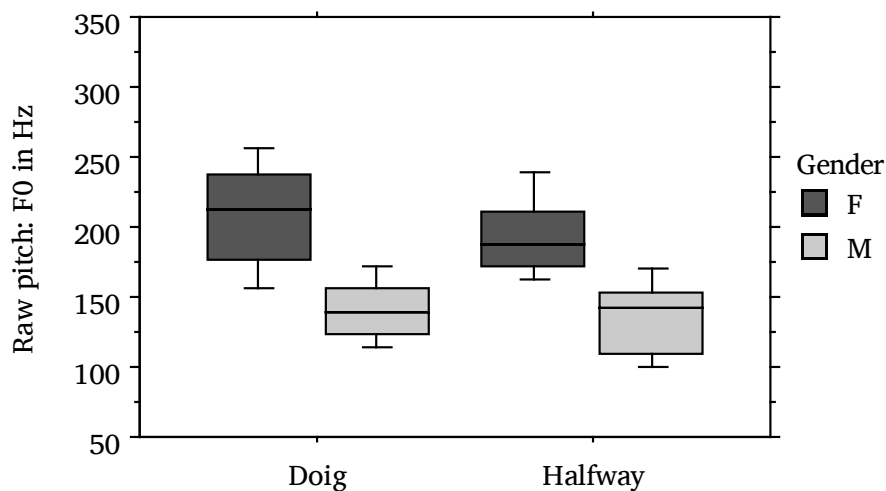
#### *2.4.1 Raw pitch and normalization*

This section presents pitch ranges of the speakers, focusing on pitch level and span. I present descriptive results for tone using raw pitch measured in Hz. This section also provides evidence motivating why it is important to normalize pitch data for cross-speaker analysis.

##### *2.4.1.1 Raw F0 results: Group results*

This section provides the group results for pitch range. Because men and women have distinctive ranges, I divided the results by gender. I then split the groups by dialect, in order to illuminate any differences in pitch range between the two groups of men and two of women.

The anatomy of a box plot is as follows. The median is represented by the horizontal line bisecting the box. The part above the median is the upper quartile of measure, the part below is the lower quartile. The lower and upper error bars, or whiskers, represent measures between the 10<sup>th</sup> - 25<sup>th</sup> percentiles and 75<sup>th</sup> - 90<sup>th</sup> percentiles, respectively. Extreme outliers in the outer 10<sup>th</sup> percentile are not represented.



**Figure 7** Box plot showing group means of raw pitch measures (in Hz) for Doig females and males and Halfway females and males; error bars represent  $\pm 1$  standard deviation(s). Pitch measures averaged over 30 ms. of tone-bearing vowel.

As can be seen in the above box plot, both groups of women have higher pitch ranges than their male counterparts. The Doig males have a more compressed pitch range than the Doig females and Halfway males. It would appear that this is the case for the Halfway females as well; however, when taking into account the error bars,

particularly representing variation above the mean range, it is apparent that the span is actually quite wide.

Table 20 shows the pooled H and L tone results in order to provide a clear picture of the pitch levels and spans for the four groups. The numbers represent the absolute minimum and maximum pitch measure for the groups. The Halfway males have the lowest minimum pitch measure of 86 Hz, and a maximum measure of 219 Hz. The average pitch for this group is 136 Hz,  $s = 27.8$ . Their pitch span is 133 Hz. The Doig males have a similar minimum pitch of 88 Hz. and a maximum of 215 Hz. This group has a pitch average of 141 Hz,  $s = 22.7$  and the narrowest pitch span of the groups, 127 Hz. The Halfway females have a minimum pitch measure of 106 Hz. and a maximum of 340 Hz. Their pitch average is 196 Hz,  $s = 33.7$ . The Halfway females show the widest pitch span at 234 Hz. The Doig females have the highest minimum of 122 Hz. and the highest maximum, 342 Hz., resulting in the highest average of 209 Hz,  $s = 39.0$ . Their pitch span is 220 Hz.

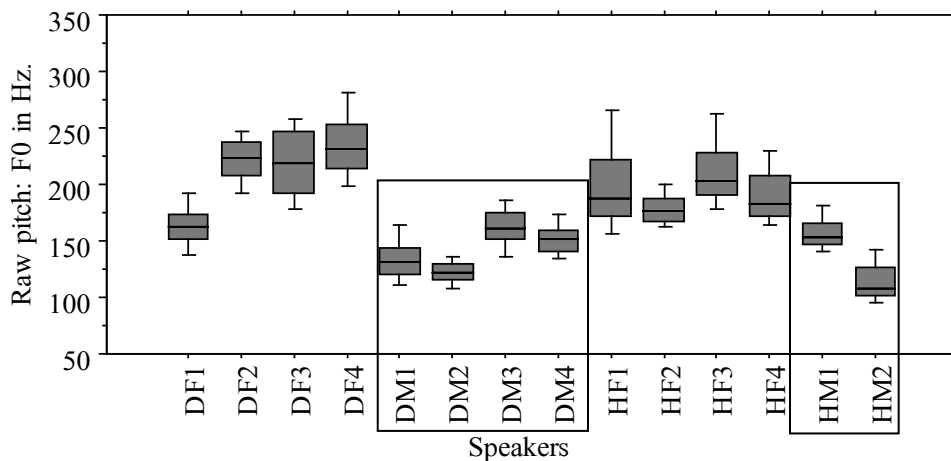
**Table 20** Numeric group raw pitch results showing level and span, mean and standard deviation, figures in Hz measured over 30 ms. of the tone-bearing vowel.

DIALECT	GENDER	MINIMUM	MAXIMUM	MEAN	STD. DEV.	SPAN
Doig	male	88	215	141	22.7	127
	female	122	342	209	39.0	220
Halfway	male	86	219	136	27.8	133
	female	106	340	196	33.7	234

These results offer a generalization of pitch use within the four groups. In order to explore between-speaker differences, which may highlight speakers who are vastly different from other members in their group; it is necessary to look at the individual results. Subtle speaker differences that were otherwise hidden due to averaging across groups will emerge.

#### 2.4.1.2 Raw F0 results: Individual results

The box plot in Figure 8 represents pooled measures of tokens for each of the speakers. This graphic is meant to provide an overall visual representation of both pitch range and span for each individual.



**Figure 8** Box plot showing individual raw pitch measures (in Hz) for the pooled tone categories; error bars represent  $\pm 1$  standard deviation(s). Male speakers are outlined.

Generally speaking, the males tend to have a lower, more compressed pitch range than the females. Two exceptional females are revealed: DF1 and HF2. These two women have lower pitch ranges and narrower spans than the rest of the females.

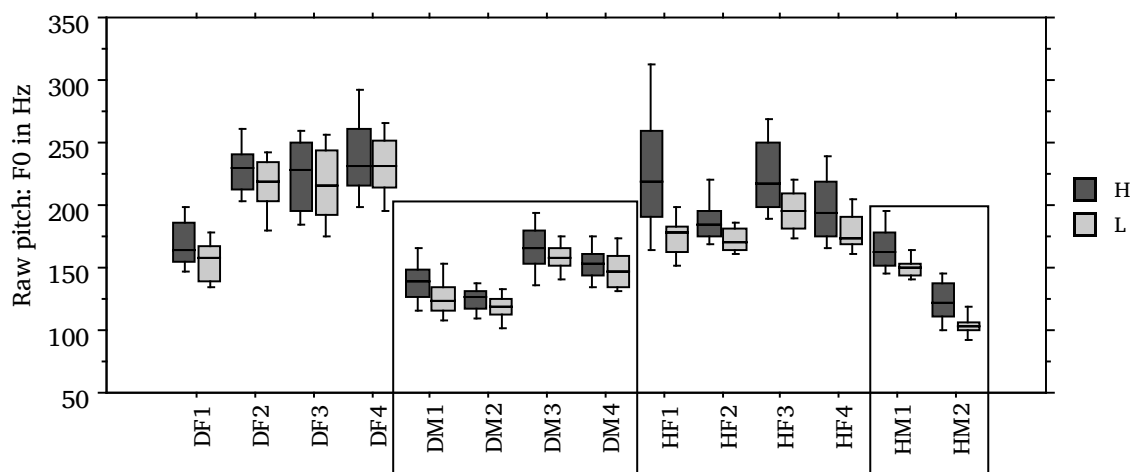
Numeric results are offered in Table 21 below, providing the levels and spans for each speaker. These findings are comparable to those of Table 20, as the tone categories are pooled. Only the absolute minimum and maximum pitch measures for each speaker are given, regardless of tone category. The male speakers tend to have lower pitch ranges. The minimum measures for the men range from 86 Hz to 103 Hz. and the maximum, from 145 Hz – 219 Hz. The pitch spans for the males vary from 57 Hz – 105 Hz. As for the females, the minimum measures range from 106 Hz. to 168

Hz, the maximum, from 228 Hz to 342 Hz. The female pitch span varies from 78 Hz. to 207.

**Table 21 Raw F0 results of pitch level and span for individual speakers. H and L tone categories are pooled. Measures are in Hz.**

GENDER	SPEAKER	MINIMUM	MAXIMUM	SPAN	DIALECT
Male	DM1	105	195	90	Doig
	DM2	88	145	57	Doig
	DM3	130	215	85	Doig
	DM4	100	205	105	Doig
	HM1	132	219	87	Halfway
	HM2	86	157	71	Halfway
Female	DF1	122	228	106	Doig
	DF2	165	291	126	Doig
	DF3	156	281	125	Doig
	DF4	168	342	174	Doig
	HF1	136	340	204	Halfway
	HF2	155	233	78	Halfway
	HF3	106	287	181	Halfway
	HF4	151	257	106	Halfway

In order to distinguish if the category of tone has an effect on the ranges and spans, the pitch measures have been separated into tone categories and presented below in the box plot in Figure 9.



**Figure 9** Box plot showing individual raw pitch measures (in Hz) for the H and L tone categories; error bars represent  $\pm 1$  standard deviation(s). Male speakers are outlined.

As can be seen in the graphic above, the H tone tokens tend to have a wider pitch span than the L tokens. Additionally, there is greater variation for speakers such as DF4, and HF1, shown in the longer error bars.

Table 22 below provides the average H and L tokens for each speaker in numeric form. Standard deviations are given in parentheses. The average tone measures for the men range from 105 Hz. to 166 Hz. Of the men, DM3 has a relatively high L tone average at 158 Hz. as well as a high H average of 166 Hz. HM2 shows the lowest L average of 105 Hz. and the lowest H average of 123 Hz. For the women, tone averages have a range of 157Hz. to 241 Hz. DF1 has the lowest L tone average of 157 Hz. as well as the lowest H average of 170 Hz. Speaker DF4 has the highest L average of 232 Hz. and the highest H tones, averaging 241 Hz.

**Table 22 Individual mean results for raw F0 measures for H and L tone categories. Measures are in Hz. Standard deviations provided in parentheses.**

GENDER	SPEAKER	L	H	DIALECT
Male	DM1	127 (16.7)	141 (20.3)	Doig
	DM2	118 (11.7)	124 (10.2)	Doig
	DM3	158 (13.1)	166 (22.8)	Doig
	DM4	149 (16.7)	154 (16.8)	Doig
	HM1	150 (9.9)	166 (19.5)	Halfway
	HM2	105 (12.5)	123 (17.2)	Halfway
Female	DF1	157 (18.1)	170 (21.9)	Doig
	DF2	216 (22.5)	229 (23.8)	Doig
	DF3	215 (31.3)	222 (30.5)	Doig
	DF4	232 (28.3)	241 (37.5)	Doig
	HF1	175 (18.6)	227 (49.4)	Halfway
	HF2	172 (11.2)	188 (19.5)	Halfway
	HF3	202 (26.7)	225 (30.5)	Halfway
	HF4	180 (19.2)	199 (28.1)	Halfway

These differences will make across-speaker comparisons difficult, if not meaningless. It is evident from the raw pitch data that there are sex differences that need to be addressed before moving on to comparing pitch across speakers.

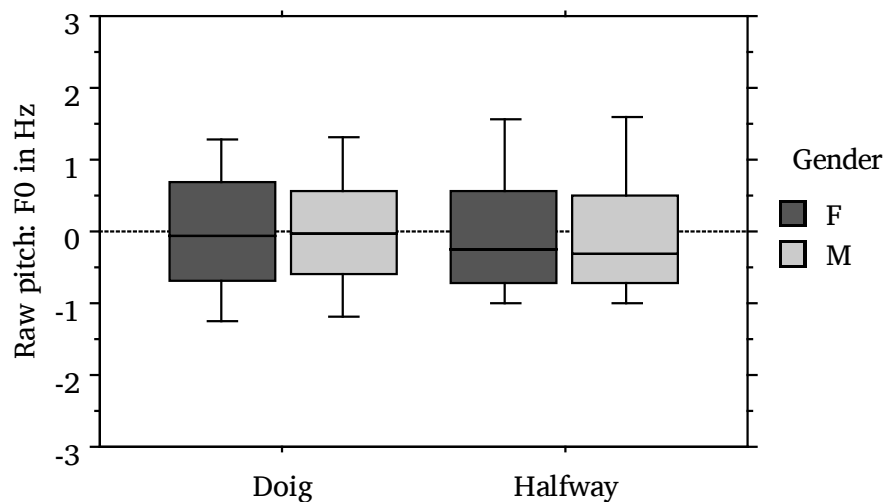
### 2.4.1.3 Normalized pitch results

In order to compare pitch measure across genders, the raw data needs to undergo normalization. The process of using the z-transform was outlined in Section 2.3.5.2.

This section presents the normalized data.

#### 2.4.1.3.1 Z-score: Group results

The box plot in Figure 10 presents group pitch averages for male and female speakers; the same data seen in Section 2.4.1.1, now normalized into z-scores.



**Figure 10** Box plot showing group normalized pitch measures (z-score) for Doig and Halfway females, Doig and Halfway males. H and L tones are pooled. Error bars represent  $\pm 1$  standard deviation(s).

The above box plot shows pitch means from the four groups: Doig men and women and Halfway men and women. This graphic is comparable to the raw F0 means

of Figure 7. In this figure, it can be seen that the medians have been brought closer together due to the normalization process.

Table 23 contains the pooled H and L tone normalized group results. The numbers represent absolute minimum and maximum normalized pitch measures for each group; this data is comparable to those of the raw pitch measures of Table 20. Because the z-transform sets means to zero, with standard deviations of 1.0 these categories are no longer relevant and thus not featured in Table 23.

After normalization, the Doig males have a minimum pitch measure of -3.07, and a maximum pitch measure of 3.20. The pitch span for this group is 6.27. The Halfway males have a minimum pitch of -1.62 and a maximum measure of 3.58, with a normalized pitch span of 5.20. The Doig females have a minimum pitch measure of -2.38 and a maximum of 3.21. Their pitch span is 5.59. The Halfway females have a minimum of -3.24 and a maximum of 3.05. The Halfway women's pitch span is 6.29.

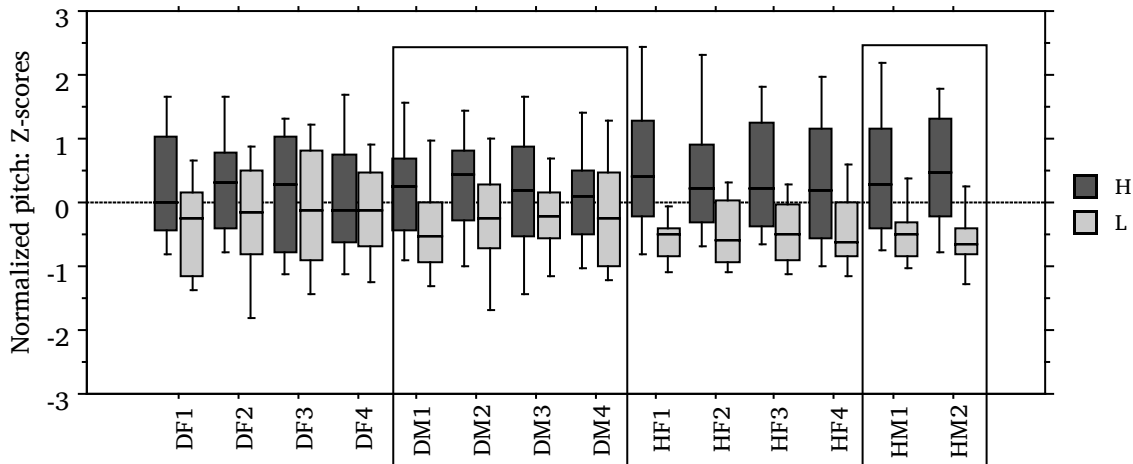
**Table 23** Numeric group pitch results of level, span, normalized with z-score.

DIALECT	GENDER	MINIMUM	MAXIMUM	SPAN
Doig	Male	-3.07	3.20	6.27
	Female	-2.38	3.21	5.59
Halfway	Male	-1.62	3.58	5.20
	Female	-3.24	3.05	6.29

As a means to investigate normalized pitch ranges for each speaker, I present individual results in the following section.

#### 2.4.1.3.2 Z-score: Individual results

Pitch results for the individuals, normalized using the z-score transform, are shown in Figure 11, along with the standard deviations.



**Figure 11** Box plot showing individual normalized pitch measures (z-score.); error bars represent  $\pm 1$  standard deviation(s). Male speakers are outlined.

As can be seen, the H and L tones are closer than those of the non-normalized raw data seen in Figure 9. This set of transformed data will allow for the best possible between-speaker comparisons.

Table 24 contains the average H and L means for the normalized z-scores; the data is comparable to that of Table 22. The normalized pitch measures for H and L tones are averaged for each speaker. The male speakers have normalized L tone

averages that range from -0.53 to -0.18. They have a normalized H tone average ranging from 0.16 to 0.48. Standard deviations range from 0.6 to 1.2. The female speakers have normalized L tone averages that range from -1.26 to -0.24. They have a normalized H tone average ranging from 0.13 to 0.56. The standard deviation for the women ranges from 0.6 to 1.1.

**Table 24 Individual mean results for H and L tone categories. Standard deviations provided in parentheses. Measures are normalized pitch: Z-scores.**

GENDER	SPEAKER	L	H	DIALECT
Male	DM1	-0.35 (0.8)	0.34 (1.0)	Doig
	DM2	-0.26 (1.0)	0.27 (0.9)	Doig
	DM3	-0.21 (0.7)	0.21 (1.2)	Doig
	DM4	-0.18 (1.0)	0.16 (1.0)	Doig
	HM1	-0.45 (0.6)	0.48 (1.1)	Halfway
	HM2	-0.53 (0.7)	0.38 (1.5)	Halfway
Female	DF1	-0.32 (0.9)	0.29 (1.0)	Doig
	DF2	-0.24 (0.9)	0.28 (1.0)	Doig
	DF3	-1.26 (1.0)	0.13 (1.0)	Doig
	DF4	-0.13 (0.9)	0.15 (1.1)	Doig
	HF1	-0.58 (0.4)	0.56 (1.1)	Halfway
	HF2	-0.45 (0.6)	0.46 (1.1)	Halfway
	HF3	-0.40 (0.9)	0.43 (0.9)	Halfway
	HF4	-0.36 (0.7)	0.36 (1.1)	Halfway

## 2.4.1.3.3 Summary of normalized pitch

In order to visualize the effect of normalization on the raw pitch measures, I return to the box plots of Figure 9 and Figure 11, reprinted below as Figure 12.

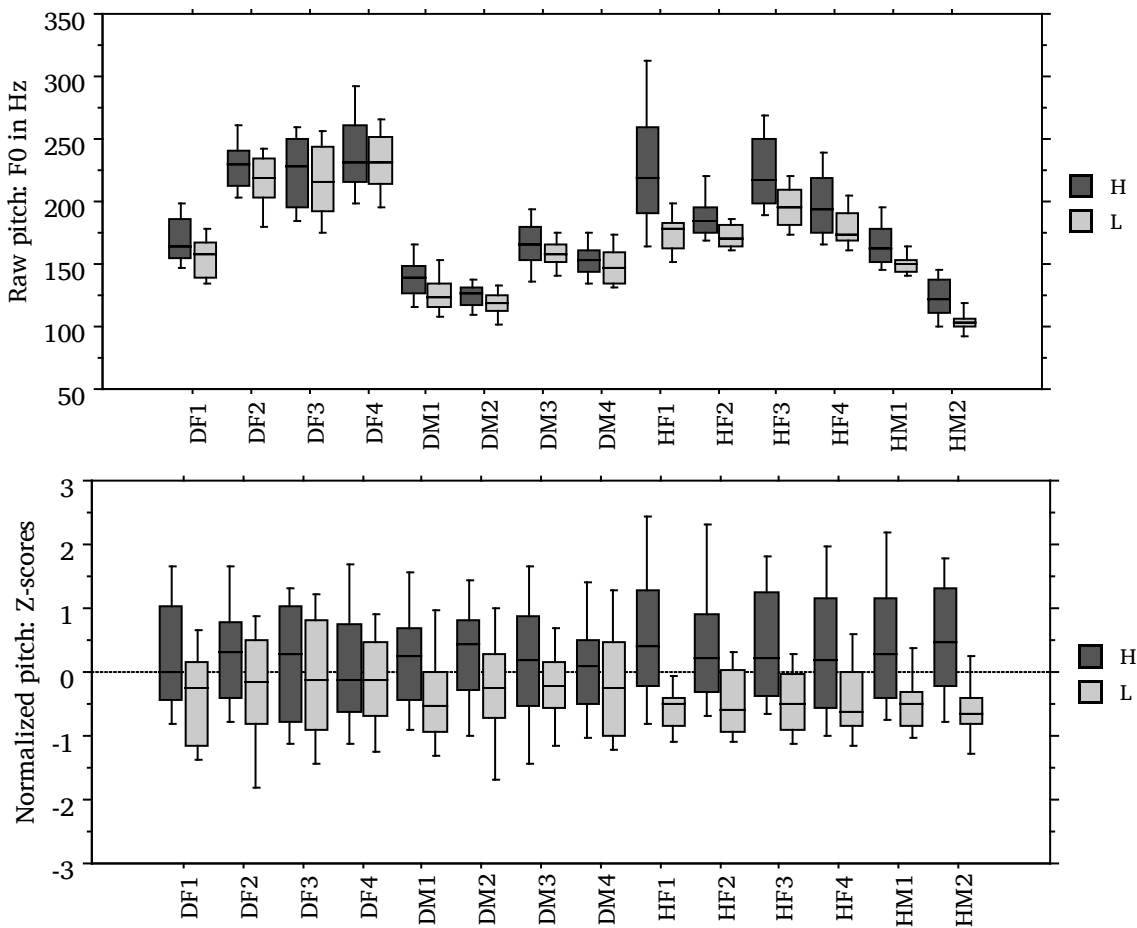


Figure 12 Comparison of box plots showing individual raw F0 (top) and normalized (bottom) pitch measures; repeated from Figure 9 and Figure 11, respectively.

The top box plot represents the raw pitch measures for each speaker. The bottom box plot shows the same data after normalization. The most apparent change in the data post-normalization is that the speaker medians are closer aligned than in the original

raw data. Also, the spans have been increased for most of the speakers, retaining the relative differences between the tone categories and for the individuals, themselves. Normalization simply shrinks the disparity between speakers due to sex differences, allowing for a better cross-speaker examination. It is for this reason that I will use the z-score normalization technique for the remainder of the statistical tests.

Now that the pitch measures have been transformed to normalized figures that allow for between-speaker comparisons, I will turn to presenting individual results of the experiments that were designed to explore effects of specific linguistic categories on normalized pitch measures.

#### *2.4.2 Effects on normalized pitch*

This next section presents findings from the various inferential tests that were run to determine any effects of Expected tone category, Lexical category or Morphological category on normalized pitch. In these experiments, I divide the group results by dialect only. As I will be using the normalized z-scores, it is no longer necessary to present male versus female results.

##### *2.4.2.1 Effects of Expected tone category on normalized pitch*

As Dane-zaa is considered a tonal language, it is expected that there will be systematic patterns of pitch distribution with respect to tone category. That is to say, it is

expected that a syllable having a H tone associated with it will manifest a different pitch value than a target with an expected L tone. My hypothesis is repeated below in (7).

- (7) **Hypothesis for expected tone category:** There will be a significant main effect of tone category on normalized pitch value: syllables carrying H tone will manifest a significantly higher normalized pitch value than those carrying a L tone, for both the high-marked and low-marked dialects.

The word lists used for this experiment for the Doig speakers are presented below in Table 25 through Table 28.

Table 25 Marked tokens elicited from Doig speakers: EXPECTED TONE CATEGORY X NORMALIZED PITCH

Categories	MARKED TOKENS		
	IPA	Dane-zaa	Gloss
N, stem	[t <sup>h</sup> ás̩]	tás̩	'arrow'
N, stem	[mɛ́t̩]	mɛ́lh	'snare'
N, stem	[nán]	nán	'land'
N, stem	[tsááʔ]	tsááʔ	'beaver'
N, stem	[tjú]	júú	'these'
N, stem	[t <sup>h</sup> íʃ̩]	tíʃ̩	'crutch'
N, stem	[jáʔ]	yááʔ	'louse'
N, stem	[na.xʌ.káh]	naaxagááh	'beside us'
V, stem	[sʌ.k <sup>h</sup> éʔ.tʌ.tʃíh]	sakéʔ dajíh	'my foot hurts'
V, stem	[tás.láʔ]	dááslááʔ	'I bought O'
V, prefix	[t <sup>h</sup> á.té.za]	táádézhāa	'he went up'
V, prefix	[há.jé.la]	hááyélaa	'he gave us O'
	alt: [ná.nʌ.zʌt]	náánazat!	'stand up!'
V, prefix	[ná.tʃ̩'ẽ]	náách'ẹ	'it's raining'
V, prefix	[ká.ná.tsʌt]	káánáádzat	'he is hunting for O'

Table 26 Unmarked tokens elicited from Doig speakers: EXPECTED TONE CATEGORY X NORMALIZED PITCH

Categories	UNMARKED TOKENS		
	IPA	Dane-zaa	Gloss
N, stem	[xΛs̩]	has̩	'pus'
N, stem	[ts̩ <sup>h</sup> ɛ̩]	ts̩ɛ̩h	'axe'
N, stem	[mΛn]	man	'wall'
N, stem	[sa]	saa	'month'
N, stem	[t̩ju]	juu	'now'
N, stem	[ts̩ <sup>h</sup> it̩s̩]	ts̩its̩	'duck'
N, stem	[ja]	yaa	'sky'
N, stem	[na.xΛ.ka.héʔ]	naahagaahéʔ	'your rabbit'
V, stem	[k <sup>h</sup> a.sú.tas.t̩ji]	kaasúúdaasjii	'I want'
	alt: [ke.nas.t̩ji]	kénaasjii	'I remember'
V, stem	[t̩ás.ɬeh]	dááslheh	'I buy O'
V, prefix	[t <sup>h</sup> a.té.za]	taadézhaa	'he got lost'
V, prefix	[ha.jé.la]	haayélaa	'he did it'
V, prefix	[na.t̩j̩ <sup>h</sup> ẽ]	naach'ɛ	'he dreams'
V, prefix	[ná.nΛ.t̩s̩ʌt]	náánadz̩at	'stand up!'

Table 27 Marked tokens elicited from Halfway speakers: EXPECTED TONE CATEGORY X NORMALIZED PITCH

Categories	MARKED TOKENS		
	IPA	Dane- <u>z</u> aa	Gloss
N, stem	[t <sup>h</sup> às]	tàs	'arrow'
N, stem	[mìt]	mìlh	'snare'
N, stem	[nèn]	nàn	'land'
N, stem	[ts <sup>h</sup> àʔ]	tsààʔ	'beaver'
N, stem	[tʃù]	jùù	'these'
N, stem	[t <sup>h</sup> is]	tìs	'crutch'
N, stem	[jàʔ]	yààʔ	'louse'
N, stem	[na.xə.kà]	naahagàà	'beside us'
V, stem	[sə.k <sup>h</sup> èʔ.tə.tʃi]	sakèʔ dajì	'my foot hurts'
V, stem	[tàs.làʔ]	dààslààʔ	'I bought O'
V, prefix	[t <sup>h</sup> à.tè.ja]	tààdèyaa	'he went up'
V, prefix	[hà.jè.la]	hààyèlaa	'he gave us O'
	[nà.nʌ.zət]	nàànazat!	'stand up!'
V, prefix	[nà.tʃ'ẽ]	nààch'ẹ	'it's raining'
V, prefix	[k <sup>h</sup> à.nà.tsət]	kàànààdzat	'he is hunting for O'

Table 28 Unmarked tokens elicited from Halfway speakers: EXPECTED TONE CATEGORY X NORMALIZED PITCH

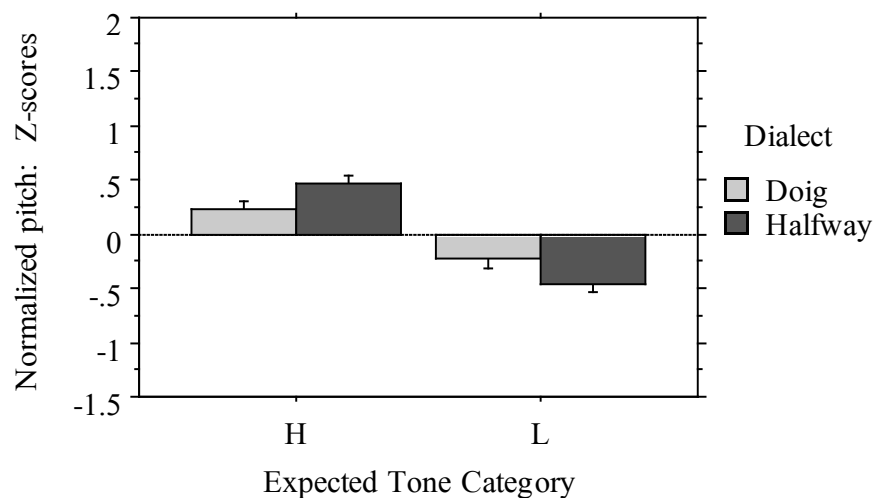
Categories	UNMARKED TOKENS		
	IPA	Dane-zaa	Gloss
N, stem	[xΛs]	has	'pus'
	alt: [s̄s]	sas	'bear'
N, stem	[ts <sup>h</sup> ɪ]	tsɪlh	'axe'
N, stem	[tΛ.ne]	dane	'man'
N, stem	[sa]	saa	'month'
	alt: [ka]	gaa	'rabbit'
N, stem	[t̄u]	juu	'now'
N, stem	[ts <sup>h</sup> ɪts]	tsits	'duck'
N, stem	[ja]	yaa	'sky'
N, stem	[na.xə.ka.hèʔ]	naaxagaahèʔ	'your rabbit'
V, stem	[k <sup>h</sup> a.sù.tas.t̄ʃi]	kaasùudaasjii	'I want'
	alt: [k <sup>h</sup> è.nas.t̄ʃi]	kènaasjii	'I remember'
V, stem	[tàs.ɪe]	dààslhe	'I buy O'
V, prefix	[t <sup>h</sup> a.tè.ja]	taadèyaa	'he got lost'
V, prefix	[ha.jè.la]	haayèlaa	'he did it'
V, prefix	[na.t̄ʃ'ẽ]	naach'ẹ	'he dreams'
V, prefix	[ná.nΛ.tsΛt]	nàànadzat	'stand up!'

#### 2.4.2.1.1 Expected tone category: Group results

The H category mean for Doig as a whole was .24 ( $s = 0.1$ ), and L was  $-.24$  ( $s = 0.1$ ).

The H category mean for Halfway was .47 ( $s = 0.1$ ) and L was  $-.46$  ( $s = 0.1$ ). Below in

Figure 13 is a bar graph showing the H and L normalized means for both dialects.



**Figure 13** Bar graph showing group means for Tone category, both dialects. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

To determine if the difference between H and L is significant for Dane-zaa, I ran a one-factor repeated measure ANOVA. The dependent variable was each speaker's normalized pitch scores (z-scores for both H and L tone syllables) and the independent variable was Expected tone category, H or L. There was also one between-subject factor, Dialect, Doig or Halfway, since as discussed in Chapter 1, there may be differences between dialect areas.

As anticipated, Expected tone category had a significant effect on normalized pitch ( $F[1,12] = 308.926$ ,  $p < .0001$ ). There was also a significant interaction between tone category and dialect ( $F[1,12] = 32.148$ ,  $p = .0001$ ).

It is evident from the ANOVA results, confirmed visually in the graphic of Figure 13, that there is a distinction between expected H and L tone categories. There is also a difference in how each group manifest pitch on H and L tokens. Halfway speakers showed a wider span; the H targets were higher than those of Doig, the L targets were lower.

#### 2.4.2.1.2 Expected tone category: Individual results<sup>25</sup>

To determine how individual speakers distinguish H and L tone categories, a one-factor factorial ANOVA was used. In order to create individual results, one ANOVA was performed for each subject. Normalized pitch is the dependent variable. The independent variable is Expected tone category (H or L).

Results indicate that significance was not consistent across all speakers; subjects fell into two groups. The first group, consisting of ten speakers, had a significant difference between H and L. The second group, composed of the four remaining speakers, did not show a significant difference between H and L tone categories. Below

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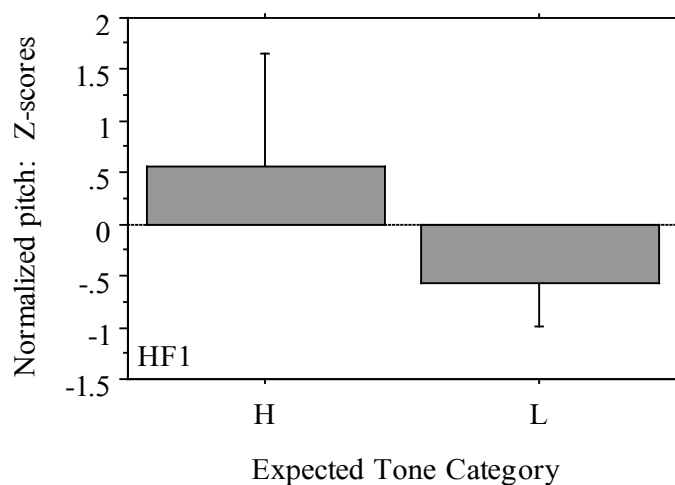
<sup>25</sup> Bar graphs of all individual means for Tone category can be found in Appendix 1.

are the individual results for the one-factor factorial ANOVA showing two groups based on significance results.

**Table 29 Individual significance results of one factor factorial ANOVA, independent variable: Tone category (H, L). Line indicating division of groups based on pattern of significance.**

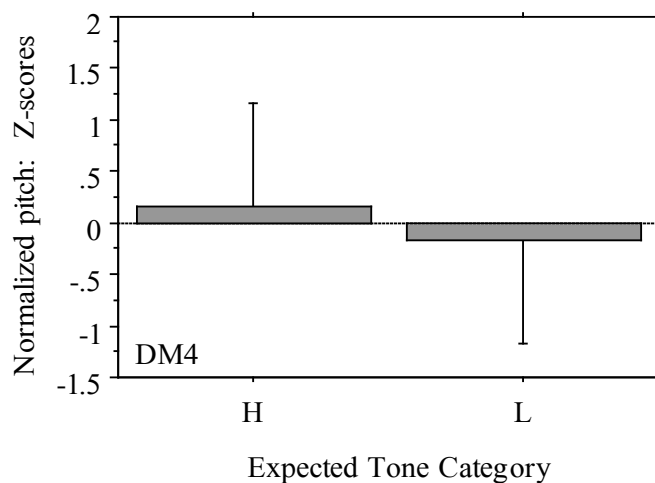
DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY
Doig	DF1	F [1,82] = 8.375, p = .0049
Doig	DF2	F [1,78] = 5.504, p = .0180
Doig	DM1	F [1,81] = 11.059, p = .0013
Doig	DM2	F [1,81] = 6.371, p = .0107
Halfway	HF1	F [1,81] = 39.521, p < .0001
Halfway	HF2	F [1,75] = 19.473, p < .0001
Halfway	HF3	F [1,89] = 18.676, p < .0001
Halfway	HF4	F [1,87] = 13.058, p = .0005
Halfway	HM1	F [1,83] = 23.435, p < .0001
Halfway	HM2	F [1,81] = 33.661, p < .0001
Doig	DF3	not significant
Doig	DF4	not significant
Doig	DM3	not significant
Doig	DM4	not significant

Speaker HF1 is representative of the first group, showing a significant difference between H and L tone categories,  $F [1,81] = 39.521, p < .0001$ . A Fisher's PLSD post hoc test confirms that HF1's H targets (.56,  $s = 1.1$ ) are significantly higher ( $p < .0001$ ) than her L targets (-.58,  $s = 0.4$ ). Below in Figure 14 is a bar graph illustrating these means. Error bars represent standard deviations.



**Figure 14** Bar graph showing individual means for Tone category, speaker HF1. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

DM4 is representative of the second group, demonstrating no significant difference between H and L tone categories. DM4's H tokens (.16,  $s = 1.0$ ) are not significantly higher than his L tokens (-.18,  $s = 1.1$ ). Note the large amount of variation, represented by the length of the error bars. Figure 15 offers a visual representation.



**Figure 15** Bar graph showing individual means for Tone category, speaker DM4. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

The table below summarizes the means and standard deviations for H and L tone categories. Ten of the fourteen speakers showed a significant difference between H and L targets; all of the Halfway speakers show this significance.

**Table 30 Summary of individual means and standard deviations for H vs. L tokens. Measures are normalized pitch: Z-scores.**

DIALECT	SPEAKER	H TOKENS	L TOKENS	SIGNIFICANCE
Doig	DF1	.29 (1.0)	-.32 (0.8)	<i>significant</i>
Doig	DF2	.28 (1.0)	-.24 (0.9)	<i>significant</i>
Doig	DF3	.15 (1.0)	-.16 (1.0)	n/s
Doig	DF4	.16 (1.1)	-.15 (0.9)	n/s
Doig	DM1	.34 (1.0)	-.35 (0.8)	<i>significant</i>
Doig	DM2	.28 (0.9)	-.29 (1.0)	<i>significant</i>
Doig	DM3	.23 (1.2)	-.25 (0.7)	n/s
Doig	DM4	.17 (1.0)	-.19 (1.0)	n/s
Halfway	HF1	.56 (1.1)	-.58 (0.4)	<i>significant</i>
Halfway	HF2	.46 (1.1)	-.45 (0.6)	<i>significant</i>
Halfway	HF3	.43 (0.9)	-.40 (0.9)	<i>significant</i>
Halfway	HF4	.36 (1.1)	-.36 (0.7)	<i>significant</i>
Halfway	HM1	.48 (1.1)	-.45 (0.6)	<i>significant</i>
Halfway	HM2	.55 (1.0)	-.53 (0.7)	<i>significant</i>

What should be noted, however, is the overall trend of H tone syllables demonstrating higher normalized pitch measures than L tone syllables. This is true of all speakers, supporting the premise of H tones manifesting a higher normalized pitch than L tones.

#### 2.4.2.1.3 Summary of expected tone category

The investigation into the tone categories yielded mixed results with respect to significance. For the group results, there was a significant effect of Expected tone category on normalized pitch across speakers. However, when the individual analyses

were performed, there was a significant effect for Tone category for only ten of the fourteen speakers. All speakers produced higher H tones than low tones, supporting my hypothesis.

#### 2.4.2.2 Effects of lexical category on normalized pitch

It has been noted in previous work on Dane-zaa tone (Miller, 2003) that verbs have significantly lower normalized pitch values than non-verbs. For this investigation, I will determine if the difference between verbs and non-verbs previously found in Doig and Blueberry dialects still holds for Doig and Halfway speakers when additional data are considered. The hypothesis for this experiment is repeated in (8).

- (8) **Hypothesis for lexical category:** There will be a significant main effect of lexical category on normalized pitch value: verbs will have a significantly lower normalized pitch value than non-verbs, for both the high-marked and low-marked dialects.

Word lists for this experiment are given below in Table 31 through Table 34.

Table 31 Marked tokens elicited from Doig speakers: LEXICAL CATEGORY X NORMALIZED PITCH

Categories	MARKED TOKENS		
	IPA	Dane-zaa	Gloss
Non-verb	[t <sup>h</sup> ás̩]	tás̩	'arrow'
Non-verb	[m <sup>é</sup> ɬ]	m <sup>é</sup> ɬh	'snare'
Non-verb	[ts <sup>h</sup> ááʔ]	tsááʔ	'beaver'
Non-verb	[t̪jú]	júú	'these'
Non-verb	[t <sup>h</sup> íʃ]	tíʃ	'crutch'
Non-verb	[jáʔ]	yááʔ	'louse'
Verb	[sʌ.k <sup>h</sup> éʔ.tʌ.tʃíh]	sakéʔ dajíih	'my foot hurts'
Verb	[tás̩.láʔ]	dááslááʔ	'I bought O'
Verb	[t <sup>h</sup> á.té.ʒa]	táádézhāa	'he went up'
Verb	[há.jé.la]	hááyélaa	'he gave us O'
	alt: [ná.nʌ.ʒʌt]	náánazat!	'stand up!'
Verb	[ná.t̪'ē]	náách'ẹ	'it's raining'
Verb	[k <sup>h</sup> á.ná.t̪ʃʌt]	káánáádzat	'he is hunting for O'

Table 32 Unmarked tokens elicited from Doig speakers: LEXICAL CATEGORY X NORMALIZED PITCH

Categories	UNMARKED TOKENS		
	IPA	Dane- <u>z</u> aa	Gloss
Non-verb	[xʌʂ]	has	'pus'
Non-verb	[tʂ <sup>h</sup> ɛ̄t]	tʂɛlh	'axe'
Non-verb	[sa]	saa	'month'
Non-verb	[t̄ju]	juu	'now'
Non-verb	[tʂ <sup>h</sup> itʂ]	tʂits	'duck'
Non-verb	[ja]	yaa	'sky'
Verb	[k <sup>h</sup> a.sú.tas.t̄ʂi]	kaasúúdaasjii	'I want'
	<i>alt:</i> [k <sup>h</sup> e.nas.t̄ʂi]	kénaasjii	'I remember'
Verb	[tás.t̄ɛh]	dááslheh	'I buy O'
Verb	[t <sup>h</sup> a.té.ʒa]	taadézhaa	'he got lost'
Verb	[ha.jé.la]	haayélaa	'he did it'
Verb	[na.t̄ʂ'ē]	naach'ɛ	'he dreams'
Verb	[ná.nʌ.t̄ʂʌt]	náánadzʌt	'stand up!'

Table 33 Marked tokens elicited from Halfway speakers: LEXICAL CATEGORY X NORMALIZED PITCH

Categories	MARKED TOKENS		
	IPA	Dane-zaa	Gloss
Non-verb	[t <sup>h</sup> às]	tàs	'arrow'
Non-verb	[m̩t̩]	m̩t̩	'snare'
Non-verb	[ts <sup>h</sup> àʔ]	tsàʔ	'beaver'
Non-verb	[t̩ʃù]	jùù	'these'
Non-verb	[t <sup>h</sup> ìs]	tìs	'crutch'
Non-verb	[jàʔ]	yààʔ	'louse'
Verb	[sʌ.k <sup>h</sup> èʔ.tʌ.t̩ʃi]	sakèʔ dajjì	'my foot hurts'
Verb	[tàs.làʔ]	dààslààʔ	'I bought O'
Verb	[t <sup>h</sup> à.tè.ja]	taàdèyaa	'he went up'
Verb	[hà.jè.la]	hààyèlaa	'he gave us O'
	alt: [nà.nʌ.zʌt]	naàànazat!	'stand up!'
Verb	[nà.t̩ʃ'ē]	nààch'ẹ	'it's raining'
Verb	[k <sup>h</sup> à.nà.tsʌt]	kàànààdzat	'he is hunting for O'

Table 34 Unmarked tokens elicited from Halfway speakers: LEXICAL CATEGORY X NORMALIZED PITCH

Categories	UNMARKED TOKENS		
	IPA	Dane-zaa	Gloss
Non-verb	[xʌs]	xʌs	'pus'
	<i>alt:</i> [sã̃s]	sʌs	'bear'
Non-verb	[ts <sup>h</sup> ɪ̃]	tsɪlh	'axe'
Non-verb	[sa]	saa	'month'
	<i>alt:</i> [ka]	gaa	'rabbit'
Non-verb	[t̃u]	juu	'now'
Non-verb	[ts <sup>h</sup> ɪ̃ts̃]	tsits	'duck'
Non-verb	[ja]	yaa	'sky'
Verb	[k <sup>h</sup> a.sù.tas.t̃ɪ̃]	kaasùdaasjii	'I want'
	<i>alt:</i> [k <sup>h</sup> è.nas.t̃ɪ̃]	kènaasjii	'I remember'
Verb	[tàs.ɬe]	dààslhe	'I buy O'
Verb	[t <sup>h</sup> a.tè.ja]	taadèyaa	'he got lost'
Verb	[ha.jè.la]	haayèlaa	'he did it'
Verb	[na.t̃ɪ̃'è̃]	naach'è	'he dreams'
Verb	[nà.nʌ.t̃sʌt]	nàànadzat	'stand up!'

## 2.4.2.2.1 Lexical category: Group results

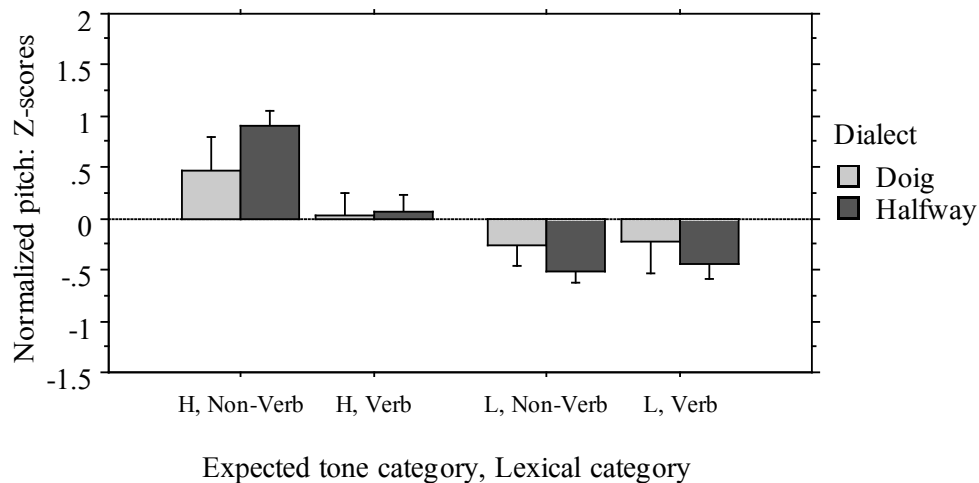
Descriptive statistics of the data separated by dialect shows that for Doig H tone non-verbs, the mean is .48, with a standard deviation of 0.3. Halfway H tone non-verbs have a mean of .90,  $s = 0.1$ . Doig H tone verbs show a mean of .03,  $s = 0.2$ , Halfway H verbs average .07,  $s = 0.2$ . Doig L tone non-verbs have a mean of -.30 and a standard deviation of 0.2. Halfway L tone non-verbs show an average of -.52,  $s = 0.1$ .

Conversely, Doig L verbs average -.23 with a standard deviation of 0.3 and Halfway L verbs have a mean of -.44,  $s = 0.1$ . I present these figures below in Table 35 for facilitated comparison of means.

**Table 35 Group means and standard deviations for H and L Non-verbs and Verbs. Measures are normalized pitch in z-scores**

DIALECT	H		L	
	NON-VERB	VERB	NON-VERB	VERB
Doig	.48 (0.3)	.03 (0.2)	-.30 (0.2)	-.23 (0.3)
Halfway	.90 (0.1)	.07 (0.2)	-.52 (0.1)	-.44 (0.1)

Across dialects, for the H tones, verbs show a lower mean than their non-verb counterparts; however, the L tones do not observe the expected pattern. The L non-verbs are lower than verbs for both Doig and Halfway dialects. Below in Figure 16 is a bar graph showing the graphical representation of Tone and Lexical category means for H and L tone targets.



**Figure 16** Bar graph showing group means for Tone category x Lexical category x Dialect. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

To explore if these differences in means are significant, I present results of the two-factor repeated measure ANOVA, Normalized pitch as the dependent variable. The independent variables, the two within-subject factors, were Expected tone category (H or L) and Lexical category (verb or non-verb). The between-subject factor is Dialect, Doig or Halfway.

Results indicate that there are main effects for Expected tone category of target syllable ( $F[1,12] = 244.469$ ,  $p < .0001$ ) and Lexical category of tone bearing syllable ( $F[1,12] = 8.476$ ,  $p = .0130$ ). There was not a significant main effect of Dialect group on normalized pitch. Regarding interactions between variables, there are significant interactions between Tone category and Dialect ( $F[1,12] = 21.375$ ,  $p = .0006$ ), indicating Doig speakers produce H and L tones differently from Halfway speakers.

There is also an interaction between Tone category and Lexical category, ( $F[1, 12] = 50.782, p < .0001$ ). This interaction points to how, for example, H tones manifest differently depending on whether they fall within a verb or a non-verb. There were no significant interactions between Lexical category and Dialect, or for the three-way interaction of Tone category x Lexical category x Dialect.

As was seen above in Figure 16, the verbs in the H tone category are considerably lower than the H non-verbs for both dialects. This is not the case for the L tone verbs. Unexpectedly, the L verbs are not lower than the L non-verbs. Although L tone is unmarked for Doig and marked for Halfway, the outcome is the same, non-verbs are lower than verbs.

#### 2.4.2.2.2 Lexical category: Individual results

It is the case that the overall trend of verbs manifesting lower pitch than the non-verbs held for seven speakers (4 from Doig, 3 from Halfway), regardless of tone category. Five speakers (2 from Doig, 3 from Halfway) had lower pitch on the H verbs, but not on the L verbs. Two speakers (from Doig) had higher pitch on both H and L verbs than on the non-verb tokens.

Individual means and standard deviations for each speaker are summarized below in Table 36. The expected trend of higher pitch on non-verbs than on verbs can

be seen throughout the table, each dialect offers a few exceptions; those are cited in bold font.

**Table 36 Individual means and standard deviations for H and L Verbs and Non-verbs. Exceptions to the expected pattern are highlighted. Measures are normalized pitch: Z-score.**

DIALECT	SPEAKER	H		L		
		NON-VERBS	VERBS	NON-VERBS	VERBS	
Doig	DF1	.79 (0.9)	-.12 (1.0)	-.17 (0.8)	-.58 (0.9)	<i>significant</i>
Doig	DF2	.55 (0.9)	.05 (1.0)	-.12 (0.8)	-.46 (1.1)	
Doig	DF3	<b>-.08 (1.0)</b>	<b>.33 (1.1)</b>	<b>-.70 (0.8)</b>	<b>.37 (0.8)</b>	<i>significant</i>
Doig	DF4	.78 (1.3)	-.42 (0.8)	-.10 (0.9)	-.14 (0.6)	<i>significant</i>
Doig	DM1	.63 (1.2)	.18 (0.9)	<b>-.43 (0.9)</b>	<b>-.35 (0.7)</b>	
Doig	DM2	.53 (0.7)	.06 (1.0)	-.18 (0.9)	-.46 (1.2)	
Doig	DM3	.50 (1.1)	-.07 (1.2)	<b>-.40 (0.8)</b>	<b>-.13 (0.3)</b>	
Doig	DM4	<b>.16 (1.0)</b>	<b>.24 (0.9)</b>	<b>-.32 (0.7)</b>	<b>-.13 (1.2)</b>	
Halfway	HF1	1.12 (1.1)	-.02 (0.7)	-.57 (0.3)	-.59 (0.4)	<i>significant</i>
Halfway	HF2	.67 (1.2)	.17 (1.1)	-.35 (0.6)	-.53 (0.6)	
Halfway	HF3	.86 (1.0)	.03 (0.8)	<b>-.58 (0.7)</b>	<b>-.25 (1.0)</b>	
Halfway	HF4	.95 (1.0)	-.21 (0.9)	<b>-.50 (0.5)</b>	<b>-.26 (0.9)</b>	<i>significant</i>
Halfway	HM1	.89 (1.2)	.22 (0.9)	-.52 (0.5)	-.53 (0.5)	
Halfway	HM2	.93 (0.8)	.21 (0.9)	<b>-.63 (0.4)</b>	<b>-.47 (0.9)</b>	

To determine whether or not verbs had significantly lower normalized pitch values than non-verbs at the individual level, I carried out a two-factor factorial ANOVA.

Normalized pitch was the dependent variable. The independent variables were Expected tone category (H or L) and Lexical category (Verb, Non-verb).

Four groups distinguished themselves for this experiment. For the most part, these groupings are based upon main effects involved in the analysis. The two-factor factorial ANOVA results, grouped by patterns of significance will be presented in the upcoming four tables. The first group is comprised of three speakers. Results are presented below in Table 37.

**Table 37 Group 1 of individual results of two-factor factorial ANOVA, independent variables: Tone category (H, L) and Lexical category (Verb, Non-verb).**

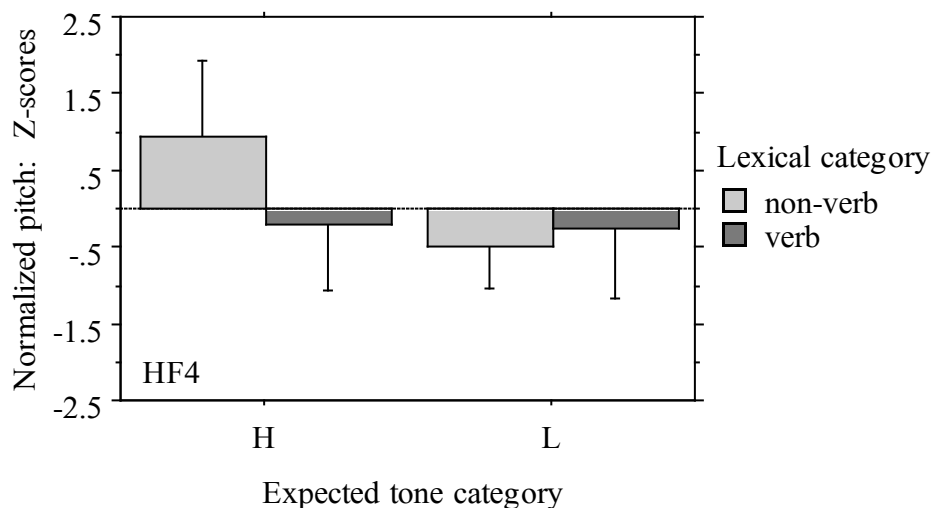
DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X LEXICAL CATEGORY	EXPLANATION OF GROUPINGS
Halfway	HF1	Tone: F [1,69] = 44.237, p < .0001 LexCat: F [1,69] = 11.417, p = .0012 Tone*LexCat: F [1,69] = 10.782, p = .0016	Significant main effect for both Tone and Lexical categories.
Halfway	HF4	Tone: F [1,71] = 14.857, p = .0003 LexCat: F [1,71] = 5.618, p = .0205 Tone*LexCat: F [1,71] = 12.842, p = .0006	
Doig	DF1	Tone: F [1,69] = 11.706, p = .0011 LexCat: F [1,69] = 10.174, p = .0021 Tone*LexCat: not significant	

For this group, there were main effects for both Tone category (H, L) and Lexical category (Verb, Non-verb). HF1 and HF2 showed a significant interaction between Tone and Lexical categories, DF1 did not.

To explore the specifics of these results, I'll use HF4 as the representative speaker for the group. HF4 yielded lower mean z-scores in her verbs than her non-verbs. For H non-verbs, she has a mean z-score of .95,  $s = 1.0$ , and for the H tone verbs, her mean is  $-.21$ , with a standard deviation of  $0.9$ . Conversely, the L tone non-verbs have a mean of  $-.50$ ,  $s = 0.5$  and L tone verbs have a mean of  $-.26$  and a standard deviation of  $0.9$ . A bar graph<sup>26</sup> of HF4's means for Lexical category can be seen below in Figure 17.

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<sup>26</sup> Bar graphs of all individual means for Tone category x Lexical Category can be found in Appendix 2.



**Figure 17** Bar graph showing individual means for Tone category x Lexical category, Speaker HF4. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

HF4 showed main effects for Expected tone category ( $F[1,71] = 14.857$ ,  $p = .0003$ ) as well as Lexical category ( $F [1,71] = 5.618$ ,  $p = .0205$ ). Fisher's PLSD post hoc tests indicate that the H targets for HF4 were significantly different from her L targets ( $p = .0002$ ) and that there was a significant difference in the pitch on her verbs versus her non-verbs ( $p = .0207$ ). Additionally, this speaker showed a significant interaction between Tone and Lexical categories ( $F[1,71] = 12.842$ ,  $p = .0006$ ).

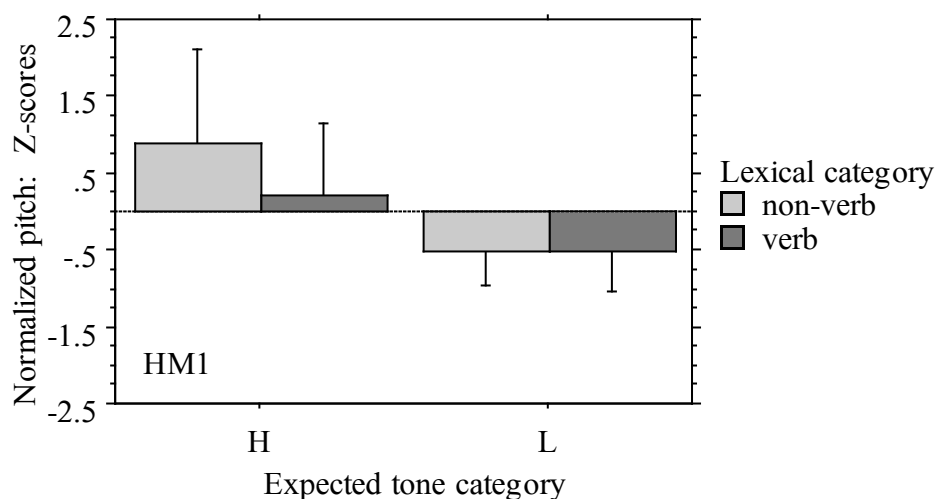
The second group, consisting of seven speakers, showed a significant main effect for Tone category, but not Lexical category. Results are presented below in Table 38.

**Table 38** Group 2 of individual results of two-factor factorial ANOVA, independent variables:  
Tone category (H, L) and Lexical category (Verb, Non-verb).

DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X LEXICAL CATEGORY	EXPLANATION OF GROUPINGS
Halfway	HM2	Tone: $F [1,67] = 34.141, p < .0001$ LexCat: not significant Tone*LexCat: $F [1,67] = 5.267, p = .0249$	Significant main effect of Tone but not Lexical category.
Halfway	HF3	Tone: $F [1,74] = 18.608, p < .0001$ LexCat: not significant Tone*LexCat: $F [1,74] = 8.532, p = .0046$	
Doig	DF2	Tone: $F [1,65] = 6.658, p = .0121$	
		LexCat: not significant	
		Tone*LexCat: not significant	
Halfway	HF2	Tone: $F [1,61] = 14.307, p = .0004$	
		LexCat: not significant	
		Tone*LexCat: not significant	
Doig	DM1	Tone: $F [1,66] = 12.757, p = .0007$	
		LexCat: not significant	
		Tone*LexCat: not significant	
Doig	DM2	Tone: $F [1,70] = 7.577, p = .0075$	
		LexCat: not significant	
		Tone*LexCat: not significant	
Halfway	HM1	Tone: $F [1,70] = 31.241, p < .0001$	
		LexCat: not significant	
		Tone*LexCat: not significant	

The representative for this group is HM1. For HM1, H non-verbs have a mean z-score of .88,  $s = 1.2$ , and his H tone verbs have a mean of .22, with a standard deviation

of 0.9. For the L non-verbs, HM1's mean is  $-0.52$ ,  $s = 0.5$  and his L tone verbs have a mean of  $-0.53$  and a standard deviation of  $0.5$ . A bar graph of his means for Lexical category can be found below in Figure 18.



**Figure 18** Bar graph showing individual means for Tone category x Lexical category, Speaker HM1. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

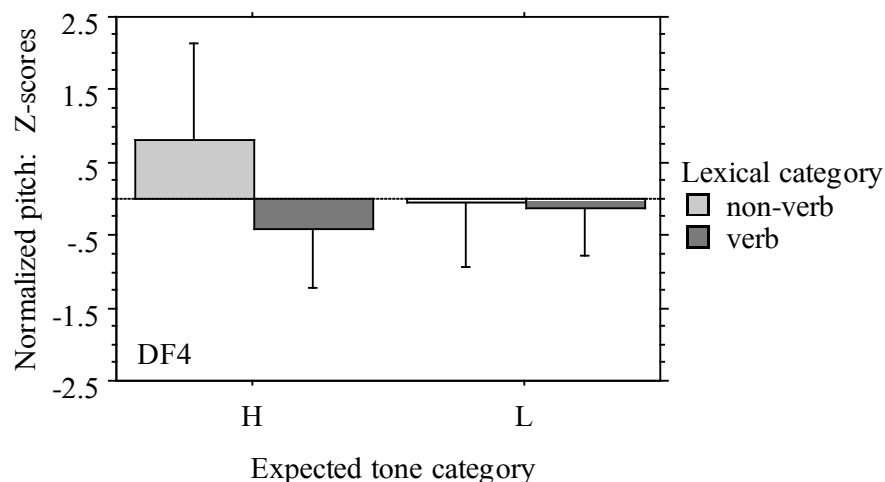
HM1 shows a main effect for Tone category, ( $F [1,70] = 31.241$ ,  $p < .0001$ ). For this speaker, there is a difference between H and L tone, but not between verb and non-verb. For both verb and non-verb, the means for the L tokens are nearly identical. As for the H tokens, there is a difference in means; however, this is accompanied by a relatively large amount of variation, as seen in the long error bars.

The third group is comprised of two speakers. This group shows a main effect for Lexical category and no significant effect for Tone category. Results are given below in Table 39.

**Table 39 Group 3 of individual results of two-factor factorial ANOVA, independent variables: Tone category (H, L) and Lexical category (Verb, Non-verb).**

DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X LEXICAL CATEGORY	EXPLANATION OF GROUPINGS
Doig	DF4	Tone: not significant LexCat: $F [1,60] = 7.138, p = .0097$ Tone*LexCat: $F [1,60] = 6.246, p = .0152$	Significant main effect of Lexical but not Tone category.
Doig	DF3	Tone: not significant LexCat: $F [1,69] = 11.786, p = .0010$ Tone*LexCat: not significant	

DF4 is the representative of this group. DF4's mean for H Non-verbs is .80 with a standard deviation of 1.3. Her H verbs average -.42,  $s = 0.8$ . Her L Non-verbs have a mean of -.06,  $s = 0.9$  and her L Verbs average -.14, having a standard deviation of 0.6. Her means for Lexical category are displayed in Figure 19.



**Figure 19** Bar graph showing individual means for Tone category x Lexical category, Speaker DF4. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

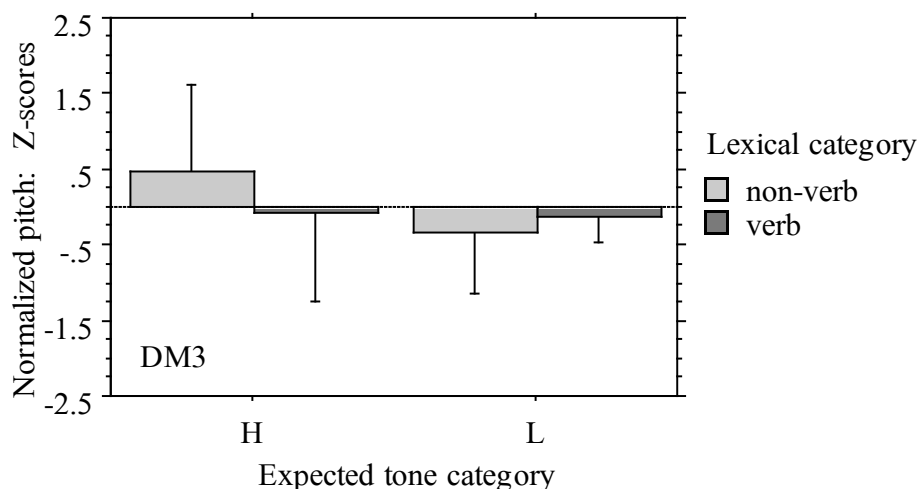
The only significant main effect is for Lexical category, ( $F [1,69] = 11.786$ ,  $p = .0010$ ). The Fisher's PLSD post hoc test indicates that for DF4, verbs are significantly different from non-verbs ( $p = .0159$ ). Speaker DF4 shows a distinct difference in Lexical category; her verbs are significantly lower than her non-verbs. Regarding Tone category, there is no significant difference between H and L tones, as is evident in her H verb tokens falling far below both L tone groups. This fact is consistent with the findings of the previous experiment on effects of Tone category, as DF4, as well as DF3, showed no main effect for Tone.

The final group consists of two speakers, DM3 and DM4. They show neither a main effect for Tone category nor for Lexical category. Table 40 provides the summary of significance for this final group.

**Table 40** Group 4 of individual results of two-factor factorial ANOVA, independent variables: Tone category (H, L) and Lexical category (Verb, Non-verb).

DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X LEXICAL CATEGORY	EXPLANATION OF GROUPINGS
Doig	DM3	Tone: not significant LexCat: not significant Tone*LexCat: not significant	No significant main effect for Tone or Lexical categories.
Doig	DM4	Tone: not significant LexCat: not significant Tone*LexCat: not significant	

Taking DM3 as the representative of this group, his mean for H Non-verbs is .48 with a standard deviation of 1.1. The H verbs average -.07,  $s = 1.2$ . His L Non-verbs have a mean of -.34,  $s = 0.8$  and his L Verbs average -.13, having a standard deviation of 0.3. I offer his means for Lexical category in the bar graph displayed in Figure 20.



**Figure 20** Bar graph showing individual means for Tone category x Lexical category, Speaker DM3. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

Speaker DM3 shows no significant difference between H and L tone or verb and non-verb. Regarding Tone category, his H verb tokens fall below the mean. Additionally, there is a great deal of variation, as noted in the error bars, preventing clear categorization of tone for this speaker. As for Lexical category, although non-verbs have both the highest and lowest means, and this is quite different from the verbs, the variation is too great to allow for clear categorization of verbs and non-verbs.

#### 2.4.2.2.3 Summary Lexical category

The investigation into effects of Lexical categories on pitch yielded mixed results with regard to significance. For the group results, there was a significant effect of Lexical category on normalized pitch across speakers. What is interesting to note is that across

dialects, the hypothesis that verbs would manifest lower tone than non-verbs only held for the H tokens. Also, it appears that verbs had a more compressed pitch range; lower H tones and higher L tones.

The means for the H verbs were lower for both dialect groups than the H non-verbs; however, the pitch of the L verb tokens was not lower than that of the L non-verbs. When the individual analysis was performed, there was a significant effect for Lexical category for only five of the fourteen speakers.

#### 2.4.2.3 Effects of Morphological category on normalized pitch

Previous studies on Athabaskan tone indicate that there is a significant difference between the pitch values of stems and those of prefixes. For Sekani (Hargus, In preparation), female speakers had significantly lower pitch on stems than on prefixes (for both H and L tone categories). In my previous studies of Dane-zaa (Miller, 2003, 2007a), results were mixed as to whether stem tones had higher or lower values than did prefix tones. This experiment will determine if there is a pattern for high-marked and low-marked languages with respect to effects of Morphological category. My hypothesis for this investigation is repeated in (9).

- (9) **Hypothesis for Morphological category:** There will be a significant main effect of Morphological category on normalized pitch value: the normalized pitch values for the stem tones will be lower than the values of the prefix tones, for both the high-marked and low-marked dialects, regardless of tone category.

Word lists for this experiment are provided below in Table 41 through Table 44.

**Table 41** Marked tokens elicited from Doig speakers: MORPHOLOGICAL CATEGORY X NORMALIZED PITCH

Categories	MARKED TOKENS		
	IPA	Dane-zaa	Gloss
Stem	[t <sup>h</sup> áʂ]	tás	'arrow'
Stem	[ts <sup>h</sup> áʔ]	tsááʔ	'beaver'
Stem	[sʌ.k <sup>h</sup> éʔ.tʌ.tʃíh]	sakéʔ dajíh	'my foot hurts'
Stem	[dás.láʔ]	dááslááʔ	'I bought O'
Prefix	[t <sup>h</sup> á.té.ʒa]	táádézhāa	'he went up'
Prefix	[há.jé.la]	hááyélaa	'he gave us O'
	[ná.nʌ.ʒʌt]	náánazat!	'stand up!'
Prefix	[ná.tʃ̃ẽ]	náách'ẹ	'it's raining'
Prefix	[k <sup>h</sup> á.ná.tʂʌt]	káánáádzat	'he is hunting for O'

**Table 42 Unmarked tokens elicited from Doig speakers: MORPHOLOGICAL CATEGORY X NORMALIZED PITCH**

Categories	UNMARKED TOKENS		
	IPA	Dane- <u>z</u> aa	Gloss
Stem	[xΛʂ]	has	'pus'
Stem	[sa]	saa	'month'
Stem	[k <sup>h</sup> a.sú.tas.tʃi]	kasúúdasjii	'I want'
	alt: [ke.nas.tʃi]	kénaasjii	'I remember'
Stem	[tás.ɬeh]	dááslheh	'I buy O'
Prefix	[t <sup>h</sup> a.té.ʒa]	taadézhaa	'he got lost'
Prefix	[ha.jé.la]	haayélaa	'he did it'
Prefix	[na.tj'ẽ]	naach'ẹ	'he dreams'
Prefix	[ná.nΛ.tʂat]	náánadz <sup>z</sup> at	'stand up!'

Table 43 Marked tokens elicited from Halfway speakers: MORPHOLOGICAL CATEGORY X NORMALIZED PITCH

Categories	MARKED TOKENS		
	IPA	Dane-zaa	Gloss
Stem	[t <sup>h</sup> às]	tàs	'arrow'
Stem	[ts <sup>h</sup> àʔ]	tsàʔ	'beaver'
Stem	[sʌ.k <sup>h</sup> èʔ.tʌ.tʃi]	sakèʔ dajìi	'my foot hurts'
Stem	[tàs.làʔ]	dààslààʔ	'I bought O'
Prefix	[t <sup>h</sup> à.tè.ja]	taàdèyaa	'he went up'
Prefix	[hà.jè.la]	hààyèlaa	'he gave us O'
	[nà.nʌ.zʌt]	naànazat!	'stand up!'
Prefix	[nà.tʃ'ě]	nàach'ẹ	'it's raining'
Prefix	[k <sup>h</sup> à.nà.tsʌt]	kàànàdzat	'he is hunting for O'

Table 44 Unmarked tokens elicited from Halfway speakers: MORPHOLOGICAL CATEGORY X  
NORMALIZED PITCH

Categories	UNMARKED TOKENS		
	IPA	Dane-zaa	Gloss
Stem	[xʌs]	xʌs	'pus'
	alt: [sʌ̃s]	sʌs	'bear'
Stem	[sa]	saa	'month'
	alt: [ka]	gaa	'rabbit'
Stem	[k <sup>h</sup> a.sù.tas.t̃ʃi]	kaasùùdaasjii	'I want'
	alt: [k <sup>h</sup> è.nas.t̃ʃi]	kènaasjii	'I remember'
Stem	[tàs.ɬeh]	dààslheh	'I buy O'
Prefix	[t <sup>h</sup> a.tè.ja]	taadèyaa	'he got lost'
Prefix	[hə.jè.la]	haayèlaa	'he did it'
Prefix	[nə.t̃ʃ'ɛ]	naach'ɛ	'he dreams'
Prefix	[nà.nə.t̃sət]	nàànadzat	'stand up!'

#### 2.4.2.3.1 Morphological category: Group results

Across the Dialect groups, Doig H tone prefixes yielded a mean z-score of .30,  $s = 0.2$ , Doig H stem tokens averaged .01,  $s = 0.2$ . The Halfway H tone prefixes showed a mean of .21,  $s = 0.2$  and for the H stems of Halfway, the mean was .62,  $s = 0.2$ . For Doig L tone prefixes, the mean was .07, with a standard deviation of 0.3 and the Doig L tone stems had a mean of -.40,  $s = 0.4$ . Halfway L tone prefixes averaged -.23 with a

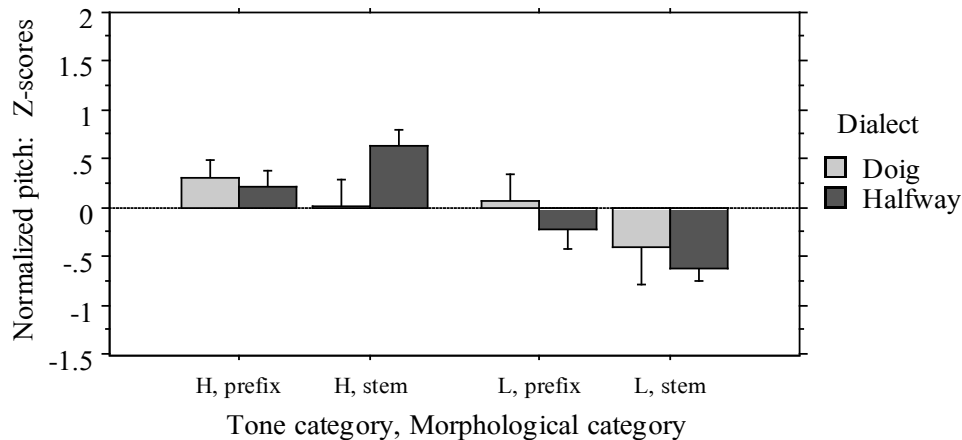
standard deviation of 0.2, and the Halfway L tone stems averaged  $-.62$ ,  $s = 0.1$ . I present these figures in Table 45 below for a facilitated comparison of means.

**Table 45 Group means and standard deviations for H and L Prefixes and Stems. Measures are normalized pitch in z-scores**

DIALECT	H		L	
	PREFIX	STEM	PREFIX	STEM
Doig	.30 (0.2)	.01 (0.2)	.07 (0.3)	-.40 (0.4)
Halfway	.21 (0.2)	.62 (0.2)	-.23 (0.2)	-.62 (0.1)

Again there are mixed results. Doig speakers average lower pitch in stems than in prefixes. For Halfway speakers, however, it is only the L tone stems which yield a lower normalized pitch than the prefixes, not so for the H tone group.

Below in Figure 21 is a bar graph showing the graphical representation of means for Tone and Morphological category, both H and L tone targets.



**Figure 21** Bar graph showing group means for tone category x Morphological category x dialect. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

In order to determine if these differences in tone category and Morphological category are significant I have run an inferential test, similar to the experiment in 2.4.2.2.1, a two-factor repeated measures ANOVA. The dependent variable is Normalized pitch. The independent variables, the two within-subject factors, are Tone category (H or L) and Morphological category (prefix or stem). The between-subject factor is Dialect (Doig or Halfway).

Results indicate that for this test, there is a significant main effect for Tone category of target syllable ( $F[1,12] = 85.762, p < .0001$ ). There is no significant result for Dialect ( $p = .9424$ ), nor for Morphological category, though the p-value is close to alpha ( $p = .0635$ ). There is significant interaction between for Tone category and Dialect ( $F[1,12] = 17.563, p = .0013$ ), but no interaction effect between Morphological

category and Dialect ( $p = .0506$ ). Other results also came close to not relying on chance alone, showing  $p$ -values that were slightly above the alpha level of .05. The interaction between Morphological category and Tone category had a  $p$ -value of .0506. The three-way interaction of Morphological category, Tone category and Dialect had a  $p$ -value of .0566.

The findings indicate that there is no significant difference between tones that fall on stems and those that fall on prefixes. Also, the two dialects do not behave significantly different with respect to marking stem or prefixes with a different pitch. The only significant main effect is for Tone category. H tokens have significantly higher normalized pitch than the L tokens. Also, the two dialect groups treat H and L tokens differently, as seen in the significant interaction results. Focusing on the stem tokens, it is apparent that the Halfway speakers show a wide pitch range. The Doig speakers do not exhibit a similarly wide range for their pitch results.

#### 2.4.2.3.2 Morphological category: Individual results

At the individual level, the pattern we saw in the group results of lower normalized pitch on stems than on prefixes held, though with some exceptions. I have included the means and standard deviations in Table 46, the exceptions are bolded and italicized. What is striking is that for all of the H tokens, both prefixes and stems, Halfway speakers yielded higher pitch measures on stems than on prefixes, counter to

my hypothesis. For their L tone tokens, stems have consistently lower pitch. The Doig group shows few exceptions to my expected trend; two occurrences on H tone tokens, one on L tone tokens.

**Table 46 Individual means and standard deviations for H and L Prefixes and Stems. Exceptions to the expected pattern are highlighted. Measures are normalized pitch in z-scores**

DIALECT	SPEAKER	H PREFIXES	H STEMS	L PREFIXES	L STEMS
Doig	DF1	.27 (1.3)	.28 (0.9)	.10 (0.7)	-.66 (0.8)
Doig	DF2	.50 (1.1)	.05 (0.6)	.13 (0.7)	-.58 (1.2)
Doig	DF3	.29 (1.0)	-.03 (1.0)	.50 (0.6)	-.72 (0.9)
Doig	DF4	.12 (0.8)	-.22 (1.5)	-.37 (0.6)	.34 (0.9)
Doig	DM1	.01 (0.8)	.52 (1.1)	-.19 (0.8)	-.28 (1.2)
Doig	DM2	.55 (0.7)	-.10 (1.0)	.28 (0.5)	-.82 (1.2)
Doig	DM3	.18 (1.5)	-.03 (1.0)	-.04 (0.5)	-.11 (0.7)
Doig	DM4	.47 (0.9)	-.35 (0.7)	.18 (1.0)	-.38 (1.2)
Halfway	HF1	.11 (1.2)	.96 (0.9)	-.36 (0.3)	-.81 (0.4)
Halfway	HF2	.37 (1.2)	.48 (1.2)	-.31 (0.7)	-.55 (0.4)
Halfway	HF3	.19 (0.9)	.51 (1.0)	.07 (1.1)	-.55 (0.6)
Halfway	HF4	-.06 (1.0)	.50 (1.0)	-.09 (1.1)	-.47 (0.5)
Halfway	HM1	.33 (1.5)	.66 (0.8)	-.40 (0.7)	-.70 (0.3)
Halfway	HM2	.33 (1.2)	.63 (0.6)	-.31 (1.1)	-.66 (0.3)

In order to investigate whether or not pitch differences in stems and prefixes were significant at the individual level, I performed a two-factor factorial ANOVA in

which Normalized pitch is the dependent variable and Expected tone category (H or L) and Morphological category (stem, prefix) are the independent variables.

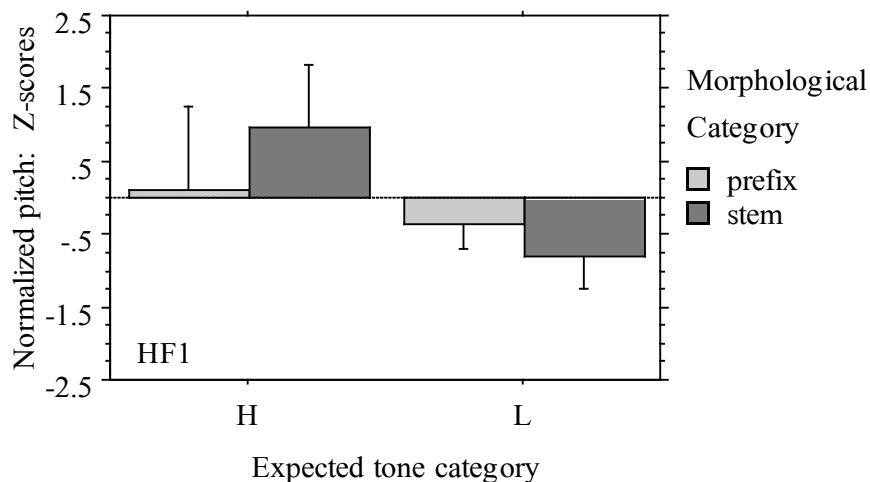
Three groups distinguished themselves for this experiment with respect to the significance findings. These groupings and significance results are outlined in the following tables. The first group contains five speakers showing a significant main effect for Tone. These results are presented in Table 47.

**Table 47 Group 1 of individual results of two-factor ANOVA, independent variables: Tone category (H, L) and Morphological category (Prefix, Stem).**

DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X MORPHOLOGICAL CATEGORY	EXPLANATION OF GROUPS
Halfway	HF1	Tone: F [1,45] = 25.371, p < .0001 MorphCat: not significant Tone*MorphCat: F [1,45] = 8.592, p = .0053	Significant main effect for Tone. No significant main effect for Morph. category.
Halfway	HF2	Tone: F [1,37] = 8.493, p = .0060 MorphCat: not significant Tone*MorphCat: not significant	
Halfway	HF3	Tone: F [1,48] = 5.349, p = .0251 MorphCat: not significant Tone*MorphCat: not significant	
Halfway	HM1	Tone: F [1,46] = 16.466, p = .0002 MorphCat: not significant Tone*MorphCat: not significant	
Halfway	HM2	Tone: F [1,44] = 14.251, p = .0005 MorphCat: not significant Tone*MorphCat: not significant	

As a means to explore details of the ANOVA results, I have chosen HF1 to represent the first group. H prefixes for HF1 have a mean of .11 and a standard deviation of 1.2. Her H stems average .96, s = 0.9. For the L prefixes, the mean is -.36, and the standard deviation is 0.3 and the L stems average -.81, s = 0.4. Her means and

standard deviations for Morphological category are presented in the bar graph<sup>27</sup> in Figure 22.



**Figure 22** Bar graph showing individual means for Tone category x Morphological category, Speaker HF1. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

There was a significant main effect for Tone ( $F [1,45] = 25.371, p < .0001$ ) but not for or Morphological category. There is a significant interaction between Tone and Morphological category ( $F[1,45] = 8.592, p = .0053$ ). That is to say, normalized pitch associated with H stem tones is significantly different than the normalized pitch of H prefixes.

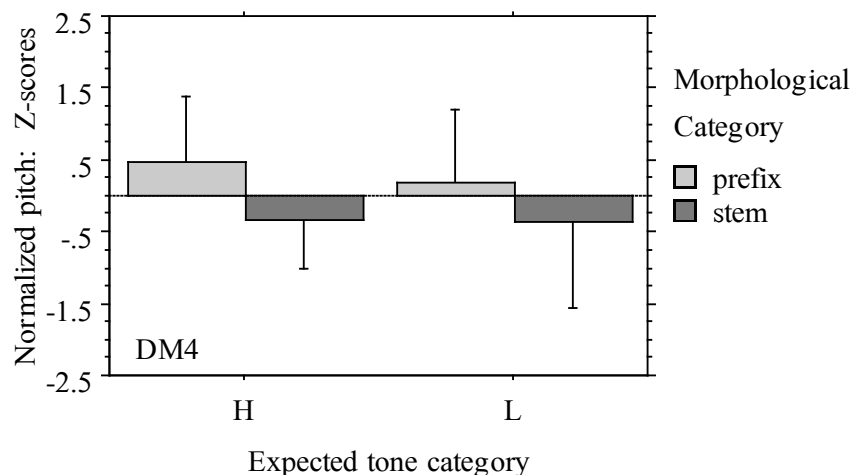
<sup>27</sup> Bar graphs of all individual means for Tone category x Morphological category can be found in Appendix 3.

The second group contains three speakers, who show significance for Morphological category. These speakers show no significance for either Tone category or interaction between Tone and Morphological categories. These results are presented in Table 48.

**Table 48 Group 2 of individual results of two-factor ANOVA, independent variables: Tone category (H, L) and Morphological category (Prefix, Stem).**

DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X MORPHOLOGICAL CATEGORY	EXPLANATION OF GROUPS
Doig	DF3	Tone: not significant MorphCat: F [1,46] = 8.764, p = .0048 Tone*MorphCat: not significant	Significant main effect for Morph. category. No significant main effect for Tone.
Doig	DM2	Tone: not significant (p = .0537) MorphCat: F [1,46] = 12.297, p = .0010 Tone*MorphCat: not significant	
Doig	DM4	Tone: not significant MorphCat: F [1,46] = 6.405, p = .0149 Tone*MorphCat: not significant	

This group is characterized by DM4. Results for DM4 indicate that his H prefixes have a mean z-score of .47, s = 0.9 and his H tone stems have a mean of -.35, with a standard deviation of 0.7. For his L prefixes, the mean is .18, s = 1.0, his L tone stems average -.38 with a standard deviation of 1.2. The bar graph in Figure 23 below shows his mean results for Morphological category.



**Figure 23** Bar graph showing individual means for Tone category x Morphological category, Speaker DM4. Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

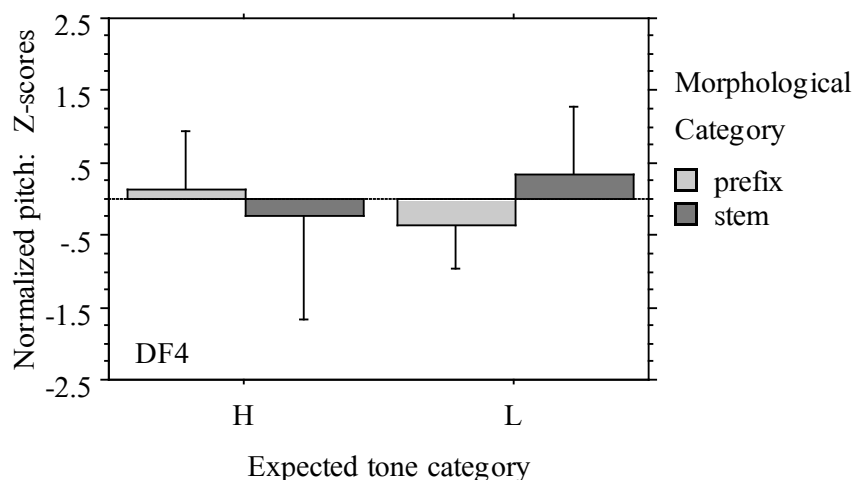
As for the ANOVA results, DM4 only shows a main effect for Morphological category, ( $F [1,46] = 6.405$ ,  $p = .0149$ ). A Fisher's PLSD post hoc test indicates that the normalized pitch on stems are significantly lower than those of the prefixes ( $p = .0133$ ). There was no main effect for Tone, nor was there a significant interaction between Tone and Morphological categories.

The final group consists of six speakers who show no significant main effects or interactions between the variables. These results are provided below in Table 49.

**Table 49 Group 3 of individual results of two-factor ANOVA, independent variables: Tone category (H, L) and Morphological category (Prefix, Stem).**

DIALECT	SPEAKER	FACTORIAL RESULTS: TONE CATEGORY X MORPHOLOGICAL CATEGORY	EXPLANATION OF GROUPS
Doig	DF1	Tone: not significant (p = .0503) MorphCat: not significant Tone*MorphCat: not significant	No significant main effects or interactions between categories.
Doig	DF2	Tone: not significant MorphCat: not significant (p = .0501) Tone*MorphCat: not significant	
Doig	DF4	Tone: not significant MorphCat: not significant Tone*MorphCat: not significant	
Doig	DM1	Tone: not significant MorphCat: not significant Tone*MorphCat: not significant	
Doig	DM3	Tone: not significant MorphCat: not significant Tone*MorphCat: not significant	
Halfway	HF4	Tone: not significant MorphCat: not significant Tone*MorphCat: not significant	

The representative speaker, DF4, shows an average H prefix of .12, having a standard deviation of 0.8, while her L prefixes average -.37, s = 0.6. The H stems have a mean of -.22, s = 1.5 and the L stems, .34, s = 0.9. Her means for Morphological category can be seen in the bar graph of Figure 24 below.



**Figure 24** Bar graph showing individual means for Tone category x Morphological category, Speaker EA (male). Measures are z-scores; error bars represent  $\pm 1$  standard deviation(s).

Speaker DF4 shows no clear categorization of the normalized pitch that falls on H and L tokens, as H stems measures average below the mean and L stems averages fall above the mean. Also, there is no significant distinction between the normalized pitch on stems and prefixes; stems fall both above and below the mean as do the prefixes.

Results for each speaker are summarized below in Figure 22. The overall trend of lower pitch on stems than on prefixes can be seen throughout the table, with the exceptions noted in bold font.

#### 2.4.2.3.3 Summary Morphological category

The investigation into the effects of Morphological category on pitch yielded expected mixed results. For the group, there was no effect for the within-speaker factor (Dialect) on Normalized pitch. Neither was there a main effect for Morphological category.

However, there was a significant effect of Tone category and significant interactions between Tone and Morphological categories and Tone and Dialect.

When exploring the individual results, I found that for these speakers, Morphological category was only significant for three of the fourteen. And of these three, Tone category did not have a significant effect on normalized pitch. The results for Tone category in this experiment turned up unexpected findings. In the first experiment for effects of Tone category ( $n = \text{approx. } 85$ ), summarized back in Table 29, differences between H and L tone were not significant for four speakers: DF3, DF4, DM3, DM4. In this experiment ( $n = \text{approx. } 45$ ), Tone category was not significant for six speakers: DF1, DF2, DF4, DM1, DM3 and HF4. I speculate that this is an artifact of the smaller data set used for this experiment.

#### *2.4.3 Summary of effects on normalized pitch*

Table 50 summarizes the results with respect to effects on normalized pitch for the overall group as well as the subgroups based on dialect. The cells display descriptive findings of whether the target tone measures follow the expected hypotheses, whereby one category within the factor presents higher tones than other.

**Table 50 Summary of group results for pitch relative to the investigated categories. Bolded, italicized font indicates a statistically significant main effect.**

DIALECT	TONE CATEGORY		LEXICAL CATEGORY		MORPHOLOGICAL CATEGORY	
	H	L	VERB	NON-VERB	PREFIX	STEM
Doig	<b>.24 (1.0)</b>	<b>-.24 (0.9)</b>	<b>-.09 (1.0)</b>	<b>.09 (1.0)</b>	.21 (0.9)	-.21 (1.1)
Halfway	<b>.47 (1.1)</b>	<b>-.46 (0.7)</b>	<b>-.19 (0.9)</b>	<b>.19 (1.1)</b>	-.01 (1.0)	.01 (0.9)

The overall group results indicate significance for two of the tests. For Tone Category x Normalized pitch, there was a significant main effect. As was expected, normalized pitch on H-marked tokens was significantly higher than that on the L-marked. For Lexical category x Normalized pitch, there was a significant main effect. The normalized pitch of verbs was significantly lower than that of non-verbs. And finally, for Morphological category x Normalized pitch, there was no clear pattern differentiating the pitch on stems from that on prefixes.

To illustrate the results of my hypotheses and to summarize the individual finding of the ANOVAs of this section, I have included Table 51 below. The cells indicate whether the normalized pitch was higher or lower for each specific category. The bolded, italicized font illustrates where the difference was significant.

**Table 51 Summary of individual results for pitch relative to the investigated categories. Bolded, italicized type indicates a significant effect. Outlined cells represent deviations from the expected patterns.**

DIALECT	SPEAKERS	TONE CATEGORY		LEXICAL CATEGORY		MORPHOLOGICAL CAT.	
		L	H	VERB	NON-VERB	PREFIX	STEM
Doig	DF1	<i>lower</i>	<i>higher</i>	<i>lower</i>	<i>higher</i>	higher	lower
Doig	DF2	<i>lower</i>	<i>higher</i>	lower	higher	higher	lower
Doig	DF3	lower	higher	<i>higher</i>	<i>lower</i>	<i>higher</i>	<i>lower</i>
Doig	DF4	lower	higher	<i>lower</i>	<i>higher</i>	lower	higher
Doig	DM1	<i>lower</i>	<i>higher</i>	lower	higher	lower	higher
Doig	DM2	<i>lower</i>	<i>higher</i>	lower	higher	<i>higher</i>	<i>lower</i>
Doig	DM3	lower	higher	lower	higher	higher	lower
Doig	DM4	lower	higher	<i>higher</i>	<i>lower</i>	<i>higher</i>	<i>lower</i>
Halfway	HF1	<i>lower</i>	<i>higher</i>	<i>lower</i>	<i>higher</i>	lower	higher
Halfway	HF2	<i>lower</i>	<i>higher</i>	lower	higher	higher	lower
Halfway	HF3	<i>lower</i>	<i>higher</i>	lower	higher	higher	lower
Halfway	HF4	<i>lower</i>	<i>higher</i>	<i>lower</i>	<i>higher</i>	lower	higher
Halfway	HM1	<i>lower</i>	<i>higher</i>	lower	higher	lower	higher
Halfway	HM2	<i>lower</i>	<i>higher</i>	lower	higher	higher	lower

For the category of Tone, each individual followed the expected trend of higher normalized pitch on H targets than on L ones. The difference between H and L was significant for ten of the fourteen speakers. For Lexical category, all but two of the speakers adhered to the expected pattern: lower normalized pitch on verbs than on non-verbs. The difference between Verb and Non-verb was significant for five of the

fourteen speakers, including one who did not have the expected pattern of lower normalized pitch on verbs. And finally, for the type of morpheme, nine of the fourteen speakers followed the expected pattern of lower normalized pitch on stems; however, the difference in tone on stems versus prefixes was only significant for three speakers.

### ***2.5 Chapter summary***

These experiments were designed to investigate acoustic properties of lexically marked and unmarked tone in Doig River and Halfway River Dane-zaa. My hypothesis that tone category would be a salient feature in both the H- and L-marked dialects was supported by the findings, but not exclusively. All speakers followed the trend that H tones would manifest higher pitch than L tones. What was surprising was that for half of the Doig speakers, there was no significant difference between H and L tones. This result was not reflected in the Halfway speakers. Tone was found to be statistically robust in Halfway, not so for Doig. This result may well be an early indication that the distinction between tonal categories in Doig is becoming less stable.

Regarding lexical category, the trend for both dialects was to produce lower pitch on verbs than non-verbs. Individual results showed a much more complex situation; half of the speakers produced higher pitch on the L verbs than the L non-verbs. Most of the exceptions to the expected pattern were in the L tone syllables.

Results for tones within prefixes versus stems were a bit less clear. I had predicted that stems would manifest lower pitch on both H and L syllables. There was no strong pattern except that the Halfway H stem tones had unexpectedly higher pitch than H prefix tones. The opposite pattern emerged for Doig speakers; Doig H stem tones averaged lower means than the H prefix tones. It is not likely that these variances in morphological categories arose from different stress patterns for Halfway and Doig. Athabaskan languages such as Navajo (McDonough, 1999), Tanacross (Holton, 2000), Ft. Ware Tsek'ene (Hargus, In preparation), Salcha and Minto dialects of Tanana (Tuttle, 1998), and Witsuwit'en, have been found to stress the stem or suffix/enclitic.<sup>28</sup> If it were the case that Halfway stressed stems, thus increasing pitch on the H tone stems, it would be likely that the L stems would be equally affected. This is not the case; Halfway L stems had lower pitch than L prefixes. As for Doig, the expected pattern obtained; both H and L stems were lower than their H and L prefix counterparts. It is unlikely that Doig prefixes are lower than stems due to a stress rule which stresses the prefix, thus raising the pitch of the prefixes. Clearly this topic

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<sup>28</sup> An example of a rare shift from historical stem stress to prefix stress can be found in the PA word for 'person' \**də.ne*. In a number of Athabaskan daughter languages (e.g. Navajo, Dena'ina, Deg Hitan, Ahtna, Gwich'in) the second syllable is stressed [də.'ne]. In Dane-zaa, as well as Northern and Southern Tutchone, Tagish, Tahltan, Sekani, Slave, and Witsuwit'en, the stress falls within what is considered to be the prefix ['də.ne] (Leer, 2005).

requires a much more refined study to investigate the interactions between morphology, tone, stress and intonation.

The goal of this nuts-and-bolts analysis was to add to what is known of tonal Athabaskan languages, but also to allow me to move on to more refined analyses of tone, with the confidence that the groundwork has been completed. The analyses in the remainder of this dissertation build upon these findings and progress toward a larger understanding of the acoustics of Dane-zaa tone.

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### **3 Tone and Voice Quality**

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#### ***3.1 Introduction***

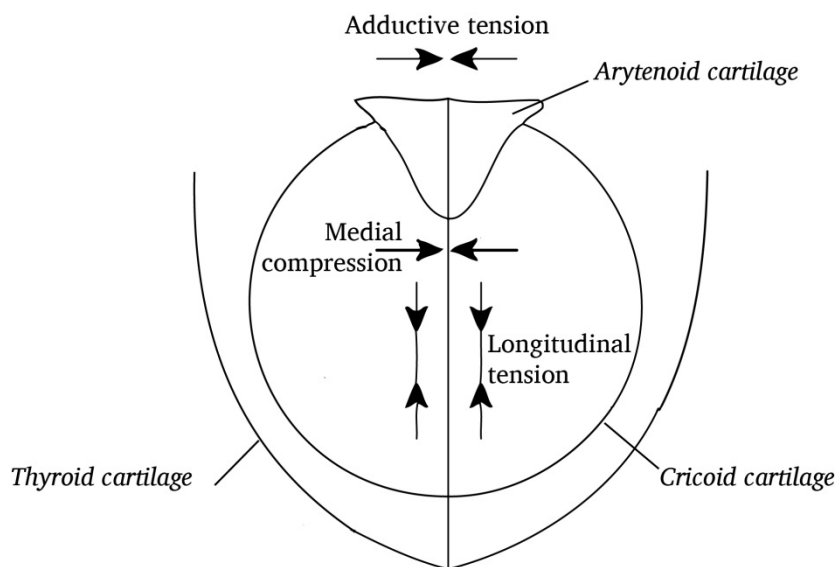
This chapter presents results from an investigation of voice quality in the Doig and Halfway dialects of Dane-zaa. Specifically, I explore effects of word-final glottal stops on the pitch, intensity, jitter and spectral tilt of the preceding vowel.

This chapter is organized in the following manner. As many descriptions of phonation types include anatomical terminology, I begin the chapter with an introduction of the physiology of the larynx in Section 3.2. This is followed by Section 3.3, offering descriptions of the various phonation types. Section 3.4 returns to the topic of Athabaskan tonogenesis, providing greater details of the role of voice quality in tonogenesis. My research questions are outlined in Section 3.5 and the methodology

used in this chapter is presented in Section 3.6. Results for the experiments of this chapter begin in Section 3.7. The chapter concludes with a summary and discussion offered in Section 3.8.

### **3.2 *Physiology of the larynx***

In differentiating phonation types, it is helpful to utilize not only acoustic characteristics, but also physiological descriptions of laryngeal muscular tension, such as adductive tension, medial compression and longitudinal tension. A schematic of the larynx, highlighting these muscular parameters is provided in Figure 25.

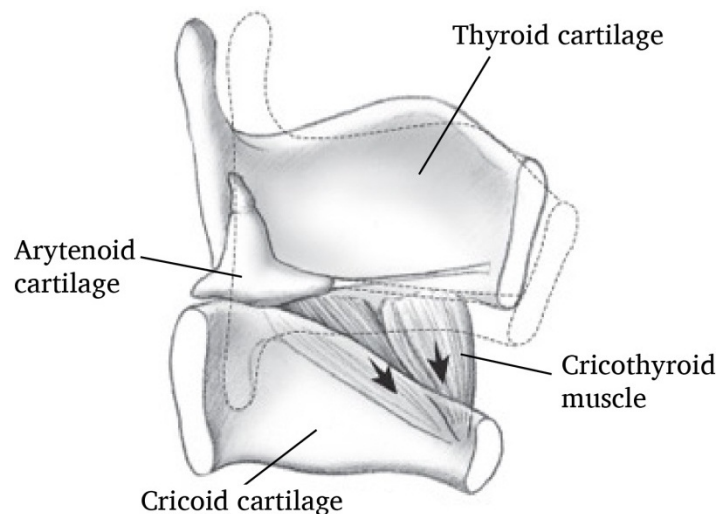


**Figure 25 Muscular tension in the larynx, based on Laver (1980). Superior view of larynx; front of larynx at the bottom of graphic.**

Adductive tension is used to bring together the arytenoid cartilages, closing the cartilaginous glottis, the posterior third of the vocal folds. Medial compression is the

force that closes the ligamental glottis, the anterior two-thirds of the vocal folds. Longitudinal tension is used to contract the vocal folds. Stretching the vocal folds increases the tension, resulting in higher F0; shortening them reduces tension, resulting in lower F0 (Laver, 1980).

The next images show some of the relevant cartilages and muscles of the larynx. Figure 26 shows the cricothyroid muscle as well as the thyroid, arytenoid and cricoid cartilages of the larynx.

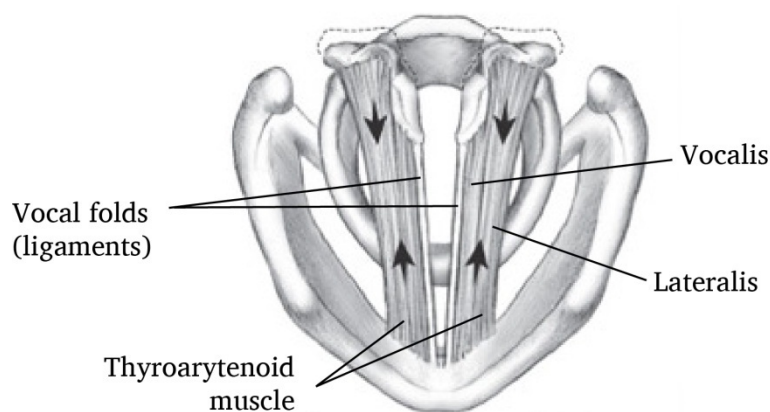


**Figure 26** Laryngeal cartilages and muscles: Cricothyroid (CT) muscle, based on NSDA (2013). The view is displaying the right side. The right of image is the front of the throat. Arrows indicate direction of muscle movement; resulting articulation is denoted by the dotted line.

The arrows in the above graphic indicate direction of contraction (longitudinal tension), in this case pulling the thyroid cartilage forward and down. Strong cricothyroid contraction alone brings the upper ends of the vocal folds into contact, lengthening and stiffening them, resulting in extreme F0 raising (falsetto voice quality).

Relaxing the cricothyroid muscle lessens the longitudinal tension and lowers F<sub>0</sub> (Laver, 1980).

Figure 27 presents the superior view of the larynx, highlighting the thyroarytenoid muscle and its two main component muscles, the vocalis and the lateralis.

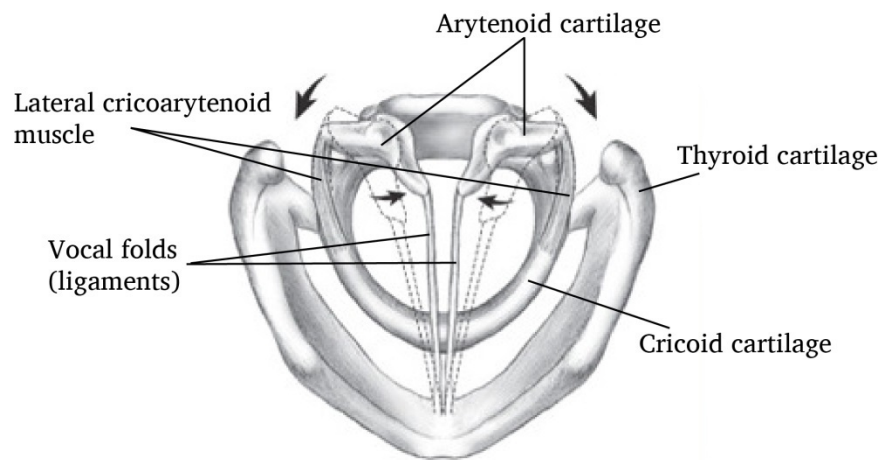


**Figure 27 Laryngeal cartilages and muscles: Superior view of thyroarytenoid (TA) and the component vocalis (V) and lateralis (L) muscles, based on NSDA (2013). Bottom of image is the front of the throat. Arrows indicate direction of muscle movement; resulting articulation is denoted by the dotted line.**

Strong thyroarytenoid constriction alone shortens and thickens the vocal folds, bringing both the upper and lower margins together. This action releases longitudinal tension and adds mass to the vocal folds. F<sub>0</sub> lowers considerably and phonation is creaky.

Medial compression can occur via contraction of the lateral cricothyroid, interarytenoid or lateralis adductor muscles (for location of lateralis muscle, refer to

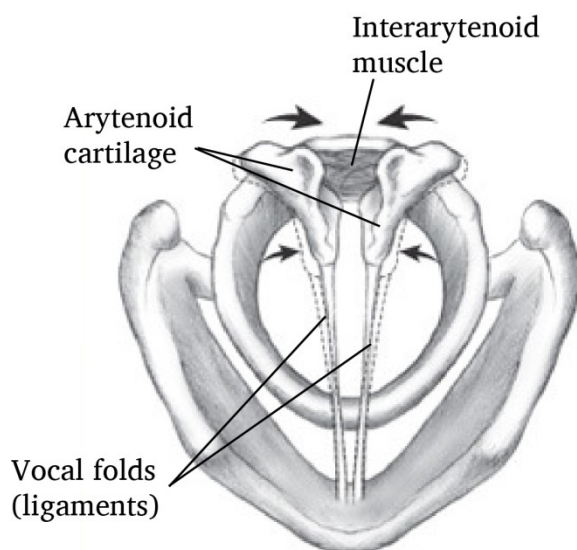
Figure 27). Superior view of the lateral cricoarytenoid muscle is presented below in Figure 28.



**Figure 28 Laryngeal cartilages and muscles: Superior view of actions of the lateral cricoarytenoid (LCA) muscle, based on NSDA (2013). Bottom of image is the front of the throat. Arrows indicate direction of muscle movement; resulting articulation is denoted by the dotted line.**

The lateral cricoarytenoid muscle contracts, pulling the arytenoid cartilage forward and bringing the vocal folds together medially.

The interarytenoid muscle is highlighted below in Figure 29. This adductor muscle is responsible for pulling the arytenoid cartilage together in the posterior region of the larynx. This movement also brings the vocal folds together medially.



**Figure 29 Laryngeal cartilages and muscles: Superior view of actions of the interarytenoid (IA) muscle, based on NSDA (2013). Bottom of image is the front of the throat. Arrows indicate direction of muscle movement; resulting articulation is denoted by the dotted line.**

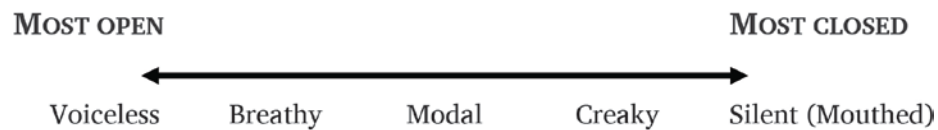
Although the level of detail necessary for understanding muscular tension involved in the different phonation types I have provided is adequate, the muscular adjustments involved in speech are in fact much more complex. For a more detailed discussion of timing, aerodynamic factors, and subtle muscular adjustments, I refer the reader to Gobl & Ní Chasaide (2010), Laver (1980), Kingston (2005), Stevens (1998).

### **3.3 Phonation types**

It is well understood that languages utilize phonation as a distinctive feature. Recent instrumental studies have explored voice quality in a variety of languages: Jalapa Mazatec (Garellek & Keating, 2011), White Hmong (Esposito, 2012), Yi (Keating et al.,

2010), Gujarati (Kahn, 2012), Green Mong (Andruski & Ratliff, 2000), Mpi (Blankenship, 2002), and !Xóõ (Esposito, 2006).

Phonation can be defined as variations in the manner of vocal fold vibration (Blankenship, 2002). Figure 30 contains the continuum of phonation types, as discussed in Gordon and Ladefoged (2001). The leftmost edge corresponds to the point at which the glottis is most open, the rightmost edge, full glottal closure (e.g. glottal stop).



**Figure 30** The continuum of phonation types, based on Gordon & Ladefoged (2001).

Breathy phonation occurs when the vocal folds are held apart allowing the glottis to fully close for only a very brief portion of the vibration cycle (Gobl & Ní Chasaide, 2010; Laver, 1980). Laryngeal muscle tension for breathy voicing involves minimal adductive tension, light medial compression and low longitudinal tension (Gobl & Ní Chasaide, 2010). Breathy phonation can be characterized by the following acoustic attributes: a lowered F<sub>0</sub>, turbulent energy appearing jagged in the waveform, and a decrease in the clarity of individual glottal pulses in the spectrogram. (Gordon & Ladefoged, 2001).

Modal phonation is considered to be the neutral phonation type (Gobl & Ní Chasaide, 2010; Laver, 1980). During modal phonation adductive tension, longitudinal tension and medial compression are moderate. Modal voicing has relatively clear formants in the spectrogram as well as distinct and evenly positioned glottal pulses. (Gobl & Ní Chasaide, 2010; Kirk et al., 1984; Laver, 1980)

Creaky phonation occurs when the vocal folds are loosely held together (Gobl & Ní Chasaide, 2010; Laver, 1980). For creaky voicing, there is high adductive tension, and medial compression, but very little longitudinal tension. Notable irregularity from one pitch point to the next, aperiodicity in the waveform, low F0 and more energy in the higher formants are some of the characteristics of creaky voicing (Gordon & Ladefoged, 2001).

A more detailed continuum comes from earlier work by Ladefoged (1971). This model has the same termini as the later version seen in Figure 30 (Gordon & Ladefoged, 2001), voiceless and silence (glottal stop); however, there are additional points along the continuum. Ladefoged mentions two important details concerning this continuum. First, no language uses more than three of these settings distinctively. Second, these categories are not discrete; they are understood to be relative to one another. Ladefoged's more comprehensive model is presented below in Figure 31.



**Figure 31** The continuum of glottal stricture, based on Ladefoged (1971). Additional terms in square brackets clarify Ladefoged’s original terms. ‘Slack’ and ‘Stiff’ were suggested in a footnote (Ladefoged, 1971), after Halle and Stevens (1971). ‘Modal’ and ‘Laryngealized’ were suggested as clarifications by Laver (1980).

The same broad, cross-linguistic phonation types from Figure 30 are included in this model: voiceless, breathy, modal, creaky, and silent. Descriptions of these phonations have already been provided above, so I only address the additional types here.

Murmured phonation (also known as whispery voicing), characterized by vocal folds that tend to be slightly less adducted than breathy phonation, with somewhat more longitudinal tension. Many studies, however, consider this phonation type to be synonymous with breathy phonation (Fischer-Jørgensen, 1967; Fulop & Golston, 2008).

According to Laver (1980), breathy, murmur and lax voicing are all different degrees of what he considers to be lax phonation.

On either side of modal voicing in the continuum are lax (slack) and tense (stiff) voicing; these phonation types are orientated more toward modal phonation than their more extreme counterparts: breathy and creaky. Lax phonation has slightly less adductive tension and medial compression, relative to modal phonation; tense phonation has higher adductive tension and medial compression relative to modal phonation (Gobl & Ní Chasaide, 2010). Lax and tense have acoustic properties which differentiate them. Tense voice has stronger energy in the higher harmonics than does lax voice. Articulatory features of tense differ from modal phonation in the following way. When producing an ejective, pressure builds up and an intense burst is produced. When the closure is released, there is a delay because the glottis remains tightly closed after the oral release. Once voicing starts, F<sub>0</sub> is high and the voice quality is modal. Voice quality is tense if the speaker continues to exert medial compression of the vocal folds (Kingston, 2005).

For creak [laryngealized phonation] the arytenoid cartilages in the larynx are drawn together, the glottis is constricted, save for a small portion in the anterior position, the vocal folds are compressed rather tightly, becoming relatively slack and compact (Ladefoged, 1971).

Many of the studies on phonation mentioned above investigated languages in which phonation type is contrastive. This chapter investigates non-contrastive voice qualities that arise from influences of the following glottalized segment. Creaky, lax (slack), modal, and tense (stiff) voicing are particularly pertinent to this chapter due to the possible tonogenetic effects of adjacent consonants on the phonation of the preceding vowel (Hombert, 1978; Kingston, 2005). Below in Table 52 I offer a summary of the relevant attributes of these phonation types.

**Table 52 Summary of key articulatory and acoustic characteristics of lax (slack), modal, tense (stiff) and creaky voicing. Shaded cells indicate non-applicable characteristic.**

	LAX 'SLACK'	MODAL	TENSE 'STIFF'	CREAKY
ADDUCTIVE TENSION	< moderate	moderate	> moderate	high
MEDIAL COMPRESSION	< moderate	moderate	> moderate	high
LONGITUDINAL TENSION		moderate		little
LARYNX HEIGHT	lowered	moderate	raised	lowered
F <sub>0</sub>	low	moderate	high	low
GLOTTAL PULSES	less periodic	regular	more periodic	irregular
ENERGY IN HARMONICS	< energy	moderate	> energy	> energy

The summary table above follows the conventions that phonation settings are not discrete categories and that modal voicing is considered the default setting. As a result, the descriptions of lax, tense and creaky phonation are relative to those of modal voicing. For example, lax phonation uses less adductive tension and medial compression than the moderate tension needed for modal phonation; tense phonation

uses greater adductive and medial tension. Creaky phonation requires high adductive and medial tension.

The experiments in this chapter will not only address whether or not there are effects of word-final glottal stops on preceding vowels, but also elucidate the classification of what those effects might be.

### **3.4 Athabaskan tonogenesis**

Tonogenesis is the development of phonemic tone in an environment where a contrast has been shifted from one set of segments to another. In situations when a language becomes tonal, the differences in pitch which were previously non-contrastive, take on a contrastive role (Matisoff, 1970; Yip, 2002).

Suprasegmentalization<sup>29</sup> of glottalization is a process posited by Leer (1979). The suprasegmentalization process occurred in the transition from Pre-Proto-Athabaskan (PPA) to Proto-Athabaskan (PA) (Leer, 1999). He describes it as the method by which the consonantal glottalization becomes the phonation type ‘constriction’ and then eventually evolves into the marked tone in the tonal daughter

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<sup>29</sup> Suprasegmentalization is a general expression that describes a number of occurrences (constriction, nasalization, ablaut) during this stage in PPA. Essentially, sequences of segments become simultaneously articulated features of both vowel and postvocalic segments. For a detailed description of these processes, see Leer (1979, 1999).

languages. Figure 32 breaks down into three steps the development of Athabaskan tone from PA glottalized consonants.<sup>30</sup>

**STEP 1: PRE-PROTO-ATHABASKAN  $\Rightarrow$  PROTO-ATHABASKAN**

<b><math>\text{VC}' \Rightarrow \text{VC}'</math></b>	Coarticulation of the vowel with the glottalic articulation of the consonant, resulting in a 'constricted' voice quality on the vowels preceding stem-final glottalic consonants. This constriction could be either tense or creaky phonation.
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**STEP 2: PROTO-ATHABASKAN  $\Rightarrow$  PROTO-ATHABASKAN (OR DAUGHTER LANGUAGE)**

<b><math>\text{VC}' \Rightarrow \text{VC}</math></b>	Stem-final consonant loses its glottalic articulation; contrast shifts to distinctive voice qualities on preceding vowels, still either tense or creaky.
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**STEP 3: PROTO-ATHABASKAN (OR DAUGHTER LANGUAGE)  $\Rightarrow$  DAUGHTER LANGUAGE**

<b><math>\text{VC} \Rightarrow \acute{\text{V}}\text{C} \text{ or } \grave{\text{V}}\text{C}</math></b>	Constricted voice quality is replaced by characteristic F0; contrast is now tonal. High tone develops from tense phonation, low tone, from creaky phonation.
---	--

**Figure 32 Three stages in the development of tone in the Athabaskan daughter languages from Pre-Proto-Athabaskan stem-final glottalization, from Kingston (2005).**

As a concrete illustration of the shift from Proto-Athabaskan glottalization into lexical tone in the H-marked Doig dialect of Dane-zaa, I provide the following example below in Table 53.

<sup>30</sup> This is an oversimplification of a more complicated process. Briefly, if the C' was a stop or affricate, the preceding vowel had to be reduced in order for the consonant constriction to become co-articulated with the vowel. This process did not occur on full vowels unless followed by a glottalized sonorant.

**Table 53** The process by which Proto-Athabaskan glottalization shifts to lexical H tone for Doig Dane-zaa.

PROTO-ATHABASKAN *ča' 'beaver'	INTERMEDIATE STAGE vC' → v̇C	DOIG DANE-ZAA [ts <sup>h</sup> áʔ] 'beaver'
glottalic element as ejective consonant ?	shift of glottalic element from consonant to preceding vowel (constriction)	glottalic element manifesting as tone on vowel á

The Proto-Athabaskan word \*ča' 'beaver' ends with a word-final glottal stop (PA reconstruction provided by Krauss (1979, 2005)). Recall that PA was not reconstructed as tonal. The next phase is the intermediate stage in which the glottalized element becomes suprasegmentalized and the constriction is co-articulated with the preceding vowel. In the final phase, the glottalic element manifests as tone in the daughter language.

Kingston (2005) proposes that Athabaskan languages differed in how speakers pronounced glottalized consonants of PA. Subsequently, these differences could have led to the development of creaky or tense phonation and eventually to the development of either low or high tone. He posits that there are two types of ejective consonants: stiff and slack. These descriptions denote the state of the vocal folds at the point of glottal constriction. Both tense and creaky phonations are produced with a closed or nearly closed glottis. Stiff ejectives in onset position tend to raise F<sub>0</sub> and produce

modal or tense phonation at the beginning of the following vowel. Alternatively, vowels following slack ejectives tend to have creaky phonation and a lowered F0. An important detail to note is that Kingston bases his theory of tonal development in Athabaskan on the idea that coda ejectives behave similarly to onset ejectives. The stiff ejectives in coda position will produce a raised F0 and tense voicing on the preceding vowel. Conversely, slack coda ejectives will lower F0 of preceding vowel and yield creakier phonation. Kingston explains the acoustic and articulatory differences between slack and stiff ejectives, summarized in Table 54.

**Table 54** Articulatory and acoustic effects of Kingston's 'stiff' and 'slack' pronunciation of glottal constriction on vowels.

'STIFF' PRONUNCIATION	'SLACK' PRONUNCIATION
<ul style="list-style-type: none"> <li>• glottis closed tightly to isolate oral cavity from subglottal cavity</li> </ul>	<ul style="list-style-type: none"> <li>• glottis is closed</li> </ul>
<ul style="list-style-type: none"> <li>• oral cavity maximally contracted to compress air inside it</li> </ul>	<ul style="list-style-type: none"> <li>• no extreme contraction of oral cavity</li> </ul>
<ul style="list-style-type: none"> <li>• compression produces intense burst after release</li> </ul>	<ul style="list-style-type: none"> <li>• burst is not dramatically intense</li> </ul>
<ul style="list-style-type: none"> <li>• glottis remains tightly closed for a long time after the release</li> </ul>	<ul style="list-style-type: none"> <li>• glottis does not remain tightly closed for a long time after the release</li> </ul>
<ul style="list-style-type: none"> <li>• voicing begins after a long delay</li> </ul>	<ul style="list-style-type: none"> <li>• voicing begins soon after the release</li> </ul>
<ul style="list-style-type: none"> <li>• F0 is high</li> </ul>	<ul style="list-style-type: none"> <li>• F0 is low</li> </ul>
<ul style="list-style-type: none"> <li>• voice quality is modal or tense</li> </ul>	<ul style="list-style-type: none"> <li>• voice quality is creaky</li> </ul>

Kingston postulates that stiff or slack constriction is controlled by two independent mechanisms within the larynx. One involves the contraction of the cricothyroid muscle (see Figure 26). The second mechanism of glottal stricture according to Kingston is the contraction of the thyroarytenoid muscle (see Figure 27).

When both the cricothyroid and thyroarytenoid are articulated simultaneously, the result is tense phonation and a raised F0. Referencing the microanatomy of the

vocal folds (Hirano, 1974), Kingston explains that they can be structurally divided into two parts: cover and body. These two parts can be stiffened independently, using the thyroarytenoid to stiffen the cover and the cricothyroid to stiffen the body.

To summarize, stiff ejectives are produced with glottal constriction involving longitudinal tension and medial compression of the vocal folds. Slack ejectives are produced with only medial compression. Kingston speculates that low tone in Athabaskan may have evolved from the pronunciation of PA glottalized consonants using a strong thyroarytenoid contraction (slack ejective). High tone may have evolved from tense phonation resulting from either a strong contraction of the cricothyroid muscle when producing glottalized consonants (stiff ejective), or from the simultaneous articulation of the thyroarytenoid and cricothyroid muscles. Kingston states that the second option is the more likely source for high tone in Athabaskan.

In a study of Witsuwit'en ejectives (Wright et al., 2002) the authors find that the binary model of stiff versus slack ejectives is inadequate in accounting for the variation extant in their results. Stiffness of the vocal folds alone cannot account for the necessary glottal closure for ejectives; it must be accompanied by medial compression of the vocal folds.

The stiff-slack model underestimates the complexity of the laryngeal system. The length, shape and tension of the vocal folds are variables that fall along a

continuum. Timing of the articulations is also variable, as the muscles act independently from one another.

In the Witsuwit'en study (Wright, et al., 2002) this complexity manifest in a wide range of variability in the results for the eleven speakers. To account for their data as well as results of cross-linguist studies, the authors posit a continuum model with the following three dimensions: larynx raising, medial compression and longitudinal tension. Using this model, they were able to map out the results of their speakers, in relation to canonical slack ejectives, stiff ejectives, fortis stops and post creaky stops (i.e. voiceless stop followed by creaky voicing in onset of following vowel).

### **3.5 Research questions**

Unlike the Witsuwit'en study (Wright, et al., 2002), I will not focus on typology of ejectives; rather I will focus on the effects of word-final glottal stops on the voice quality of preceding vowels, further exploring Kingston's hypothesis of Athabaskan tonogenesis. I will address the research questions listed below in (10).

**(10) Research questions for voice quality:**

- a) What are the effects of word-final glottal stop on voice quality at vowel offset? (Local effects)
- b) Does the presence of a word-final glottal stop affect a significant change in voice quality from vowel midpoint to endpoint? (Normalized, or perturbation effects)

Cross-linguistically, acoustic properties of glottal stops can vary in how they manifest. They may reach full glottal closure, as in Hawaiian. An acoustic correlate for this glottal stop is a period of silence visible in the waveform and spectrogram (Ladefoged & Maddieson, 1996). Glottal stops may also manifest as variation in phonation, as in Mazatec. In this case, the laryngealization is seen on the following vowel as creaky phonation (Kirk, et al., 1984). The glottal stop may have a less extreme realization, manifesting as stiff phonation (Ladefoged & Maddieson, 1996). In the Papuan language Gimi, the inter-vocalic glottal stop may be described as a creaky voiced glottal approximant. These glottal segments affect the formants of the flanking vowels, show irregularity in the glottal pulses as well as a decrease in energy in the pulses, indicating stiff phonation, but show no typical stop-like attributes (Ladefoged & Maddieson, 1996).

In both the Doig and Halfway dialects of Dane-zaa, acoustic properties of the word-final glottal stop are also variable. Specifically focusing on word-final glottal stops, in nearly all cases there is a clear period of silence. It is the case that some stops

do not have a delayed glottal release visible in the spectrogram. Some occurrences of word-final glottal stops have clear creaky phonation on the preceding vowel. Other times there is modal phonation throughout the vowel, followed by a clear period of silence.

I expect the voice quality of vowels preceding word-final glottal stops will be significantly different from that of vowels in open syllables. Both dialects will show evidence of constriction on the pre-glottal stop vowels. I hypothesize that for Doig speakers, H-marked vowels preceding glottal stops will show significantly greater tense phonation than vowels in open syllables. For the Halfway speakers, I would expect that these pre-glottal stop L-marked vowels will show significantly greater lax or creaky phonation than those in open syllables. Hypotheses specific to each voice quality measure will be introduced at the beginning of each subsection below.

### **3.6 Methodology**

#### *3.6.1 Speakers*

This experiment investigates both the Doig (H-marked) and Halfway (L-marked) dialects. Speakers recorded include 1 male and 1 female from Doig (DF3, DM4) and 1 male and 1 female from Halfway (HF2, HM1). These speakers all took part in the tone experiments of Chapter 2.

### 3.6.2 Word list

The word list was constructed to compare voice quality measures in vowels that precede glottal stops to those that occur in open syllables. All target vowels, located in the final (or only) syllable of each token, was the vowel [a]. In studies of voice quality requiring the generation of power spectra, it is essential to control for vowel quality, as the frequency of vowel formants affect amplitude levels (Gobl & Ní Chasaide, 2010). This will be further discussed in the section on spectral tilt, as the amplitude of the first formant was one of the measures collected.

Twenty tokens (2-3 repetitions) were randomized and recorded in isolation. The target syllables bearing the pre-glottal stop vowels had the following shapes: (-)C[á?] for the Doig speakers, (-)C[à?] for the Halfway speakers. The syllables bearing the plain vowels for both dialects had the shape (-)C[a]; the target plain vowel carried the unmarked tone, which is low for Doig and high for Halfway. Word lists for both dialects are presented below in Table 55.

**Table 55** Glottal (marked) and plain (unmarked) tokens elicited from Doig speakers (top) and Halfway speakers (bottom). Target syllables are word-final.

## DOIG DIALECT (H-MARKED)

GLOTTAL	GLOSS	PLAIN	GLOSS
jáʔ	'louse'	ja; alt: sa	'sky'; alt: 'month'
ts <sup>h</sup> áʔ	'beaver'	sa	'sun'
e.ɣa.táʔ; alt: k <sup>h</sup> a.nu.t <sup>h</sup> áʔ	'you (pl.) ate O'; (alt: 'he'll look for O')	ʌs.pa	'mountain goat'
mɛs.k <sup>h</sup> áʔ	'his son'	ʌs.k <sup>h</sup> a	'boy'
u.sáʔ	'bucket'	xʌ.ta	'moose'
sɿ.láʔ	'my hand'	ɛ.pa	'weasel'
ʌ.tʃáʔ	'he became'	té.ʒa	'he is going'
mʌ.(tse).ɣáʔ;	'its hide'	t <sup>h</sup> a.t <sup>h</sup> é.ʒa	'he got lost'
ʔa.ʔɛ.láʔ	'he made it'	t <sup>h</sup> á.t <sup>h</sup> é.ʒa	'he went up'
(mʌ).tas.láʔ; alt: ɔ.láʔ	'I bought (O)'; (alt: 'he made O')	(ni).ni.ja	'I came'

## HALFWAY DIALECT (L-MARKED)

Glottal	gloss	Plain	gloss
jàʔ	'louse'	ja (alt: sa, amaa)	'sky' (alt: 'month', 'mother')
ts <sup>h</sup> àʔ	'beaver'	sa	'sun'
e.ɣa.tàʔ	'you (pl.) ate O'	ʌs.pa	'mountain goat'
mɛs.k <sup>h</sup> àʔ	'his son'	ʌs.k <sup>h</sup> a	'boy'
u.sàʔ	'bucket'	xʌ.ta	'moose'
ʌ.tʃàʔ	'he became'	ɛ.pa	'weasel'
sɿ.làʔ	'my hand'	tè.ʒa	'he is going'
mʌ.wàʔ	'its hide'	t <sup>h</sup> a.t <sup>h</sup> è.ja	'he got lost'
ʔa.ʔɛ.làʔ	'he made it'	t <sup>h</sup> à.t <sup>h</sup> è.ja	'he went up'
(mʌ).tas.làʔ	'I bought (O)'	(ni).ni.ja	'I came'

For this study, I was not able to control for tone; in Dane-zaa, stem syllables having the shape (-)C[á] / (-)C[à] do not occur. Neither are there vowels, unmarked for tone, followed by final glottal stops: (-)C[aʔ].

### *3.6.3 Audio recording and processing*

All recordings were made with the Marantz CDR300 portable CD recorder, using the AKG C 520 unidirectional (cardioid polar pattern) head-mounted microphone. The microphone was set approximately one inch from the corner of the speaker's mouth. These recording sessions were carried out immediately following the tone word list sessions described in Chapter 2. All recordings for this experiment were collected at a sampling rate of 48,000 Hz, and then down-sampled during the segmentation process to 11 kHz.

### *3.6.4 Measurement and analysis methodologies*

#### *3.6.4.1 Measurement methods*

Measurements collected for this chapter, including pitch, intensity, jitter and spectral tilt, are known to characterize distinct phonation types cross-linguistically (Gobl & Ní Chasaide, 2010; Gordon & Ladefoged, 2001; Laver, 1980). The methodology used here is similar to two previous studies carried out by Hargus, investigating effects of voice

quality of word-final glottal stops in the non-tonal Athabaskan languages, Witsuwit'en (2007) and Deg Xinag (In progress). Like Hargus, I explore changes in voice quality from midpoint to endpoint (perturbation effects); however, I do not investigate persistent effects of glottal stop at vowel midpoint. As Dane-zaa is a tonal language, any analyses on non-normalized measurements from the vowel midpoint may be influenced by correlates of lexical tone.

Using Kay Elemetrics Multi-Speech software,<sup>31</sup> each measurement was taken from two locations within the target syllable, vowel offset and vowel midpoint. Prior to measuring, I opened each audio file in Multi-Speech and inserted tags for location of midpoint, endpoint and glottal stop. Tagging the location of glottal stops enabled me to visibly confirm their presence, having already done so auditorily. The following criteria were checked to confirm the presence of glottal stops where expected:

- auditory confirmation
- pulse seen on waveform
- abrupt edge seen in spectrogram
- irregular pulses seen in spectrogram

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<sup>31</sup> All graphics included in this chapter, unless stated otherwise, were created using Praat; Multi-Speech image export options are very limited.

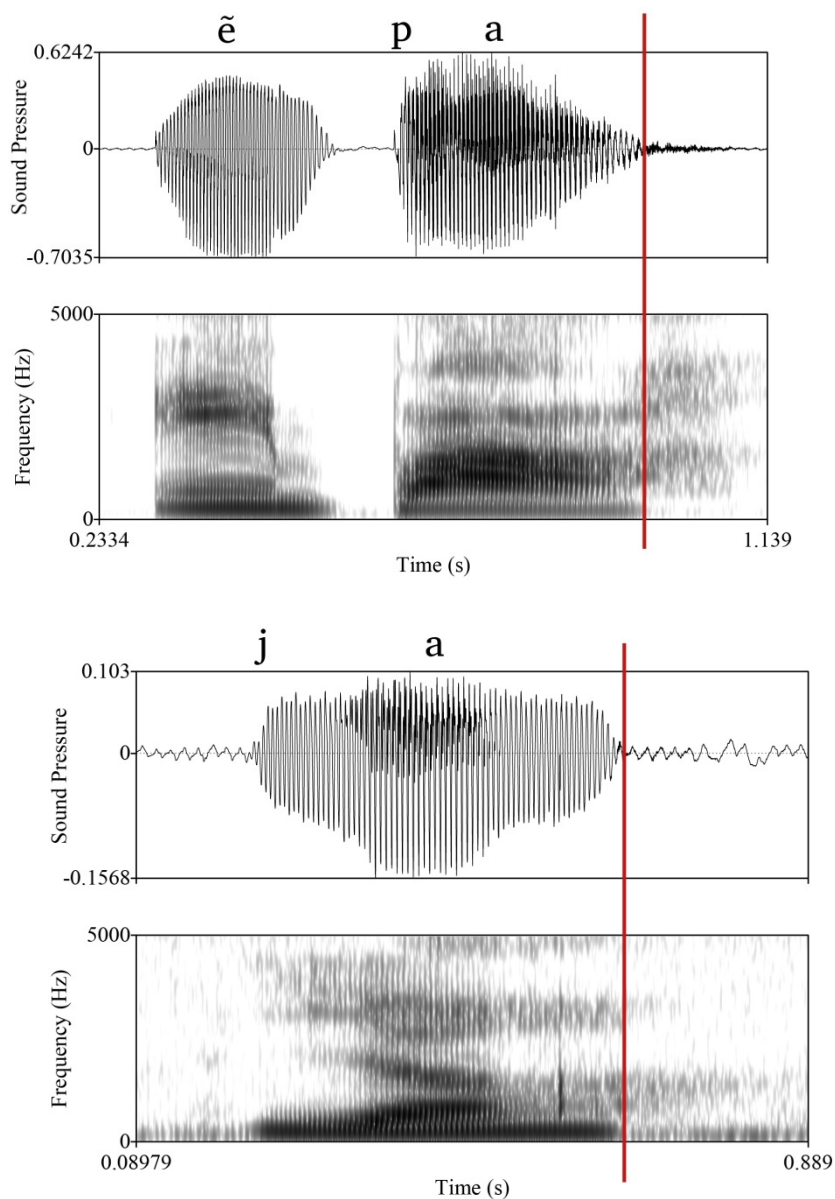
If a token did not meet the above criteria, then it was excluded. Exclusions were due to reasons other than a lack of glottal stop;<sup>32</sup> speakers were consistent in the production of expected glottal stops.

Once all of the files were tagged, the measuring phase began. At this point, I took a second look at each file, and I evaluated tag placement for consistency, based on knowledge gained from having already looked through all of the files.

The first location for measurement was at the vowel endpoint. For open syllables, vowel formants had a tendency to gradually fade to silence, rendering it difficult to locate an offset. The endpoint was taken to be where F2 lost intensity and voicing stopped. Figure 33 offers two examples of measurement locations within open syllables. The top image is from speaker DF3, token [ɛpa] ‘weasel’, the bottom from HF2, token [ja] ‘sky’.

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<sup>32</sup> One repetition of a token was excluded each for speakers DM4 and HF2, attributable to complete devoicing of the vowel in final syllable, thus no pitch track or voice points could be generated. HM1 had twelve tokens with only two repetitions (rather than three) due to speaker’s time constraints, not due to missing criteria.

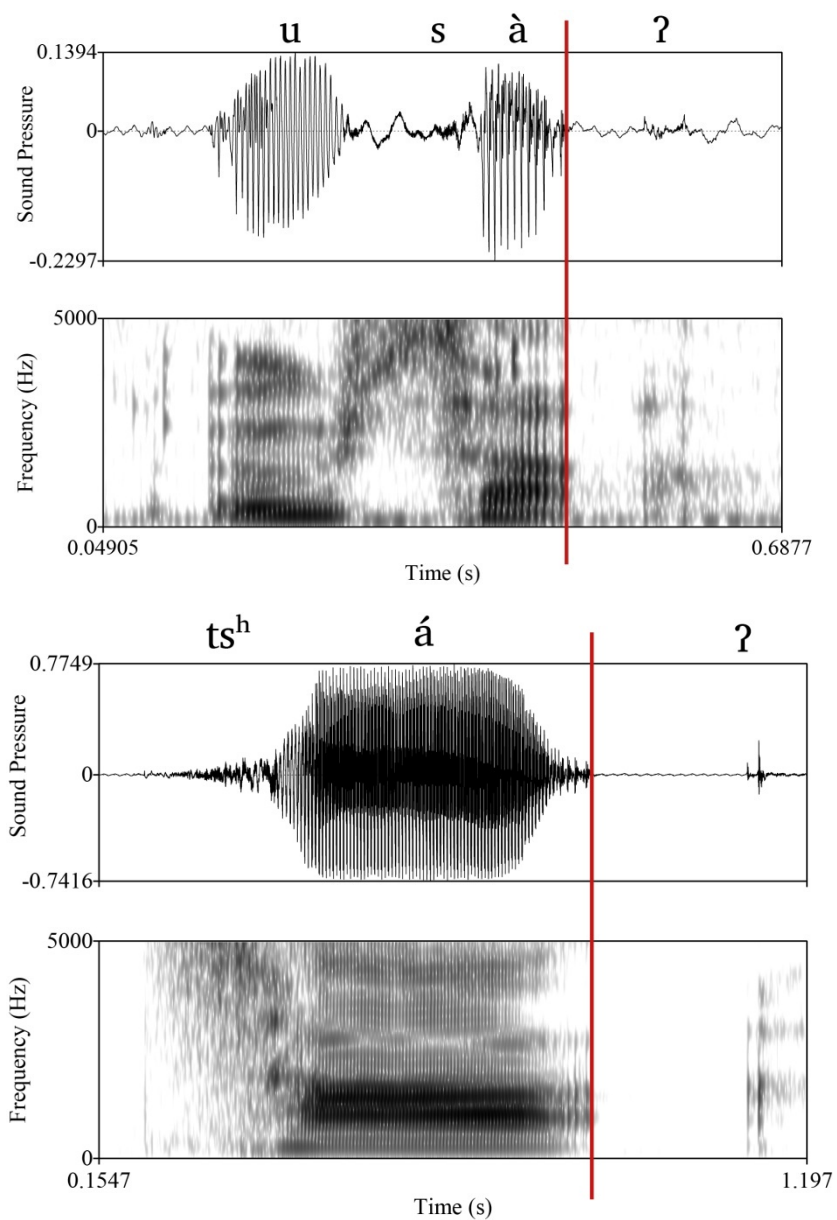


**Figure 33** Waveforms and spectrograms of open syllables in tokens [ɛpa] ‘weasel’, speaker DF3 (top), and [ja] ‘sky’, speaker HF2 (bottom). Bold vertical line indicates location of vowel offset. Measurements taken over 30ms from that point, leftward.

Looking at the top image for speaker DF3, aspiration, or aperiodicity, in the waveform at vowel offset is typical for the majority of open syllable tokens for all four

speakers. In the spectrogram, this aspiration manifests as noise seen in the higher frequencies, with some intensity in the formant regions of the preceding vowel. In the bottom graphic, speaker HF2 produces an offset that is easier to locate, as there is less of a gradual fade-out at the end of the vowel.

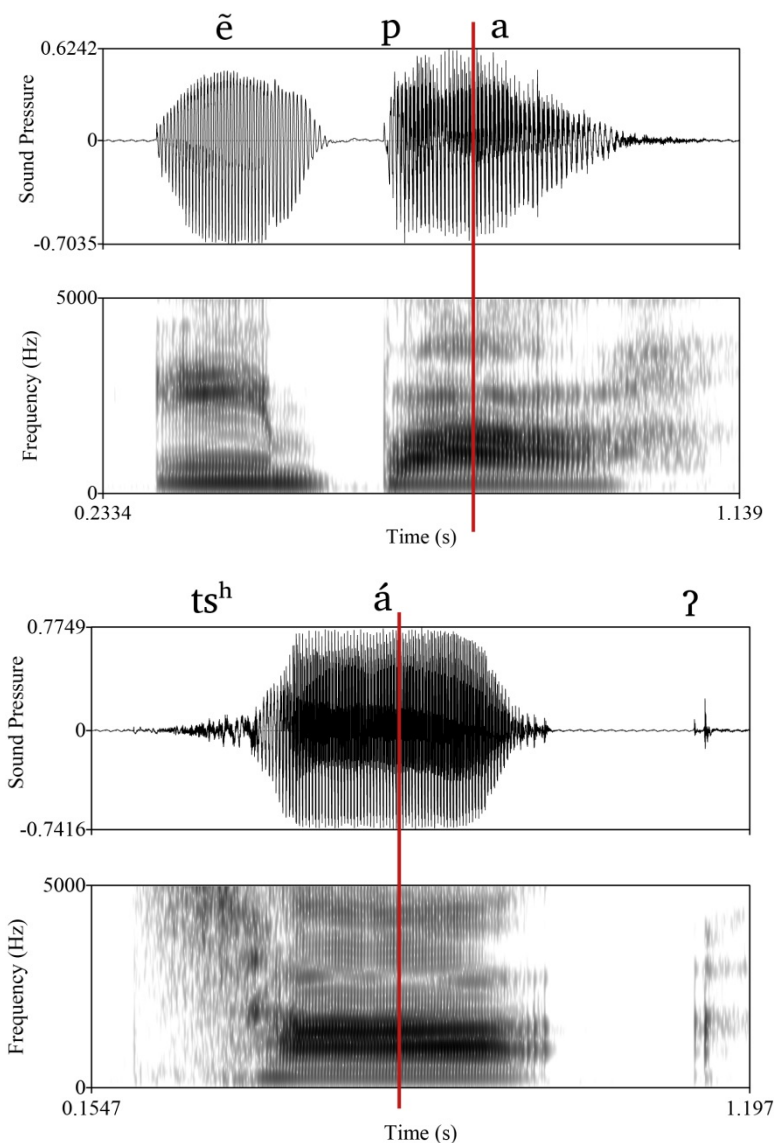
For syllables closed with a glottal stop, the location of vowel offset was not difficult to consistently locate. This point was taken to be the start of the silent period between the vowel and the glottal stop. Figure 34 provides two examples of vowel offset locations in syllables closed with a glottal stop. The top image is taken from speaker HF2, token [usàʔ] ‘bucket’; the bottom graphic is from speaker DF3, token [ts<sup>h</sup>áʔ] ‘beaver’.



**Figure 34** Waveforms and spectrograms of syllables closed with glottal stops in tokens [usàʔ] ‘bucket’, speaker HF2 (top), and [ts<sup>h</sup>áʔ] ‘beaver’, speaker DF3 (bottom). Bold vertical line indicates location of vowel offset. Measurements taken over 30ms from that point, leftward.

Vowel offset is unambiguous in HF2's graphic (top) despite the presence of noise around the release. DF3's graphic (bottom) shows a clear, prolonged period of silence at vowel offset.

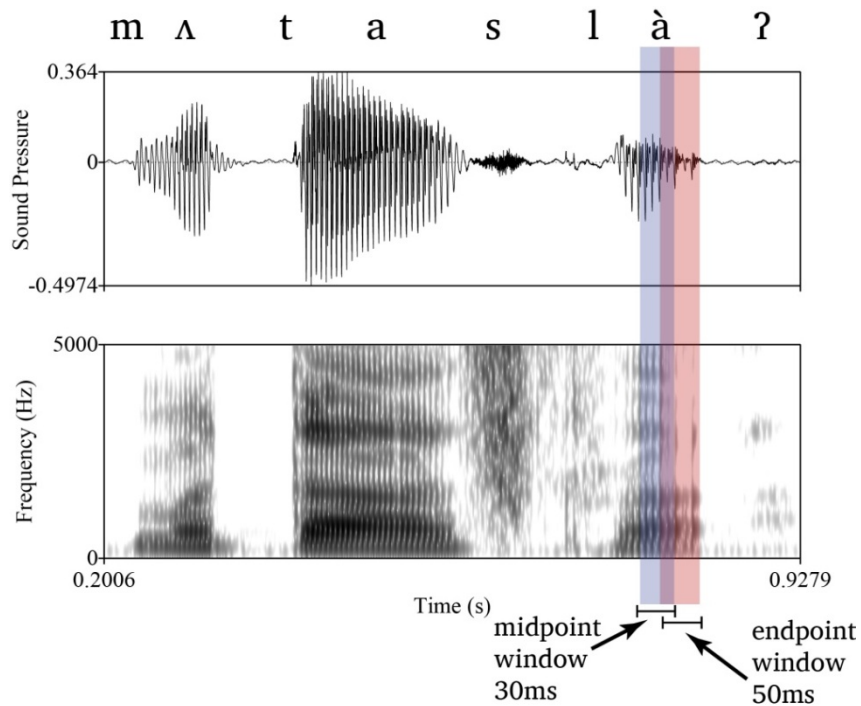
The second location for measurement was at the formant steady-state of the vowel. As some of the target lexical items had onsets such as [j], I decided upon a measuring location where there was no obvious effect on the formants from the preceding segment. This location was not always halfway through the vowel; it was where the formants were steady. Figure 35 offers images of vowel midpoint locations. The top waveform and spectrograph is from speaker DF3, token [ɛpa] 'weasel'. The bottom image is speaker DF3's token [ts<sup>h</sup>áʔ] 'beaver'.



**Figure 35** Waveforms and spectrograms highlighting midpoint locations (bold, vertical line) of vowel in open syllable [ɛpa] ‘weasel’, speaker DF3 (top), and in syllable closed with glottal stop [ts<sup>h</sup>áʔ] ‘beaver’, speaker DF3 (bottom). Measurements taken over 30ms from that point, leftward.

On rare occasions, the vowel was very short, and there was a slight amount of overlap in the analysis windows for midpoint and endpoint. This usually occurred in

short, creaky vowels in which the endpoint analysis window needed to be expanded to include enough voice period points for a jitter measure. An example of this is HF2's token [mʌtaslɑ̃ʔ] 'I bought it', seen in the graphic in Figure 36. The endpoint analysis window was expanded to 50ms to include enough voice points for analysis. The midpoint window was 30ms.



**Figure 36** Waveform and spectrogram showing overlap of midpoint and endpoint analysis windows in vowel with short duration, token [mʌtaslɑ̃ʔ] 'I bought it', speaker HF2.

I made the decision to not move the midpoint window any closer to the onset to avoid any unwanted influence from onset segments; this resulted in a scenario in which two

voice period points were shared by both measurements. The combination of irregular glottal pulses within a vowel of such short duration was uncommon.

Additional procedures pertaining to each voice quality measure will be introduced at the beginning of each sub-section in the qualitative results Section 3.7. Although all measures were collected using the same software and collected from the same analysis window, each measure has different auditory and spectral characteristics that are best discussed in detail on their own.

#### 3.6.4.2 Analysis methods

The analyses for this chapter were carried out using endpoint and perturbation values for all four of the voice quality measures. Endpoint values were collected to investigate local effects. Perturbation values were collected to explore changes from vowel midpoint to vowel endpoint.

Perturbation, a type of normalization, is calculated by subtracting the midpoint values from those of the endpoint. Formulas for each voice quality measure are presented in Table 56 below.

**Table 56 Formulas for creating normalized values of voice quality measures to explore local effects of glottalization**

PERTURBATION FORMULAS	
Pitch <sub>perturbation</sub>	= [pitch @ endpoint] – [pitch @ midpoint]
Jitter <sub>perturbation</sub>	= [jitter @ endpoint] – [jitter @ midpoint]
Spectral tilt <sub>perturbation</sub>	= [spectral tilt @ endpoint] – [spectral tilt @ midpoint]
Intensity <sub>perturbation</sub>	= [intensity @ endpoint] – [intensity @ midpoint]

All inferential statistical analyses were performed using factorial ANOVAs. Voice quality measures were the dependent variables, for example, Jitter at endpoint, or Spectral tilt perturbation. The independent variable was the categorization of the target vowel, as described by its syllable shape, Glottal or Plain. Use of the term ‘glottal’ or ‘glottalized’ in the analyses of this chapter, specifically in the graphics, is not to assume any laryngealization of the vowel, rather it is a short-cut for describing the vowel that precedes a glottal stop, as opposed to the ‘plain’ vowel, or the vowel that occurs in the open syllables.

### **3.7 Results for voice quality**

Results for this section are drawn from factorial ANOVAs and are presented for individual speakers. An informal, qualitative assessment of the dialect groups will follow individual results. (There are only two speakers (1 male, 1 female) representing each dialect, not enough for quantitative group results).

The results section is structured in the following way. Findings for pitch, intensity, jitter and spectral tilt will be presented separately. Each section will include an introduction to the hypothesis pertaining to that measure as well as specific methodologies and explanation of the measurements. This is followed by a presentation of the individual endpoint results (local effects of glottalization) then the individual perturbation results (normalized local effects of glottalization). Each section includes a summary of results for each voice quality measure. Section 3.8 will summarize all of the findings in a concise manner as well as offer a discussion of each voice quality result, returning to the specific research questions. This discussion will also tie in the larger picture of tonogenesis in Athabaskan.

### *3.7.1 Pitch*

Different phonation types interact with fundamental frequency in various ways. In a study of phonation and tone interactions in Jalapa Mazatec (Garellek & Keating, 2011), a language with three tones (high, mid, low) and three distinct phonation types (breathy, modal, laryngealized), tone categories significantly differed in voice quality. Within a given tone category, phonation types were not equally salient. The different phonation types were best distinguished on low tone. Mid tone was found to be the most modal of the three tone categories. Breathy and modal phonation types were least distinguishable on high tones. Overall, tonal distinctions were less salient at

vowel midpoint except during breathy phonation; tonal distinctions were clearer near the vowel endpoint. Phonation differences were more salient at the midpoint. Results pooled across tone category at all three locations in the vowel (first third, second third and final third) showed that pitch was lowest in breathy phonation, highest in laryngealized phonation. Modal phonation fell between the two. However, in a study of the Wakashan language Kwakw'ala (Gordon & Ladefoged, 2001), both breathy and creaky sonorants in onset and coda positions were found to have a lowering effect on the fundamental frequency of the tautosyllabic vowel compared to modal phonation.

This lowering effect of non-modal phonation can be found in other languages, but it is not universal. Diachronic evidence for tonogenesis in Athabaskan languages (Kingston, 2005; Krauss, 1979, 2005; Leer, 1979) offers the proposal that tense or creaky phonation due to word-final glottalized segments can trigger both pitch lowering and pitch raising.

Confirmation of this hypothesis was discovered by Hargus in her investigations of the non-tonal Athabaskan languages, Witsuwit'en and Deg Xinag (Hargus, 2007, In progress). In both studies results indicated that when producing vowels before glottal stops some speakers were "pitch raisers" while others were "pitch lowerers".

Pitch perturbation findings in Witsuwit'en (Hargus, 2007) showed that five of the ten speakers lowered their pitch before word-final glottal stops, two speakers raised

their pitch and three showed little pitch change from midpoint to endpoint. Pitch measures at vowel midpoint indicated that for three speakers, pitch was significantly higher in the vowels followed by a glottal stop than in the open syllable vowels. For the remaining seven speakers, there was no significant effect.

In the study of Deg Xinag (Hargus, In progress), perturbation findings showed that three of the seven speakers produced significantly lower pitch in vowels preceding glottal stops than those in open syllables. Only one speaker had significant pitch raising from vowel midpoint to offset. For the midpoint pitch, four speakers had significantly higher pitch in vowels followed by a glottal stop than those in open syllables. The remaining three speakers had no significant difference in pitch between the two syllable shapes.

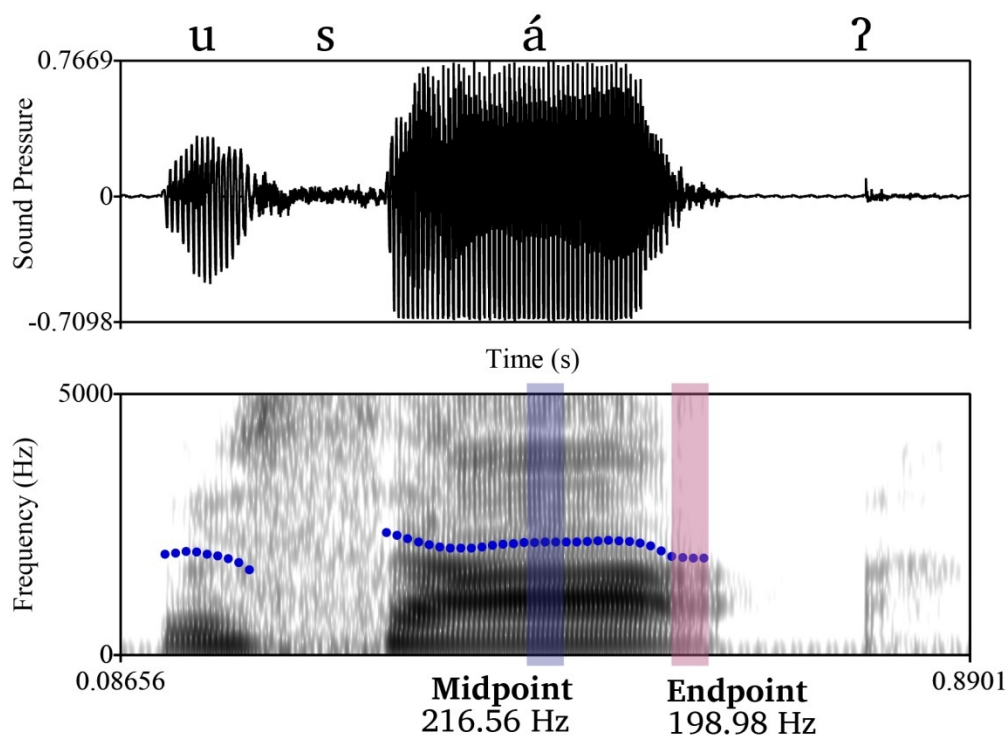
Due to the intrinsic relationship between tone marking and word-final glottal stops for Dane-zaa, it is not possible to determine any subtle persistent effects of glottal stop on pitch at vowel midpoint. Doig pre-glottal stop vowels are all marked with H tone; Doig plain vowels carry the unmarked L tone. Conversely, the Halfway vowels preceding glottal stops are L-marked and the plain vowels have the H unmarked tone. For this section I will restrict my investigation to effects of word-final glottal stops on pitch at vowel endpoint (local effects) and perturbation values (normalized effects) based on changes from vowel midpoint to endpoint. I present the research question for this section below in (11).

(11) **Research question for effect of word-final glottal stop on pitch:**

- a) What are the effects of word-final glottal stop on pitch at vowel offset? (Local effects)
- b) Does the presence of a word-final glottal stop affect a significant change in pitch from vowel midpoint to endpoint? (Normalized, or perturbation effects)

Based on findings from Hargus (2007, In progress) of the related languages of Witsuwit'en and Deg Xinag, I would expect to find similar cross-dialectal results for effects on pitch, especially due to the mirror-image tone marking of the H-marked and L-marked dialects of Dane-zaa. I hypothesize that the H-marked Doig speakers will show pitch raising before glottal stops; Halfway speakers will show pitch lowering.

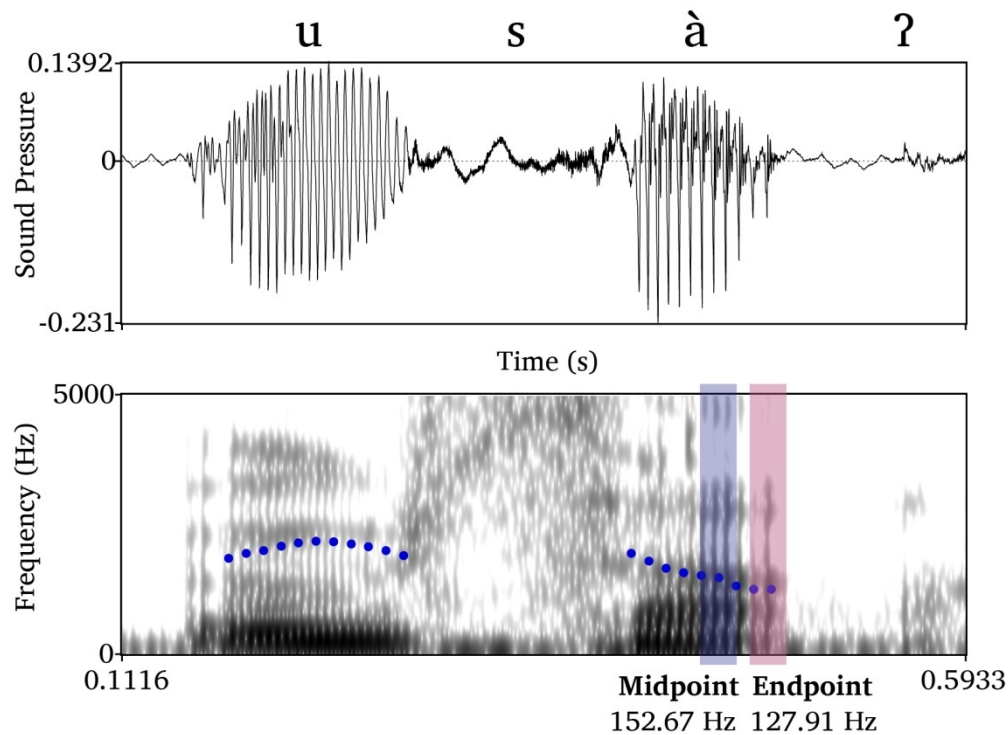
Figure 37 provides an example of where measurements for pitch midpoint and endpoint were taken. The waveform and spectrogram represent the token [usáʔ] 'bucket' for speaker DM3. The locations for measurement are highlighted and the pitch values are provided at the bottom of the graphic.



**Figure 37** Waveform and spectrogram of [usá?] 'bucket', speaker DF3. Vowel midpoint and endpoint analysis windows (30ms) highlighted. Pitch track is represented by the blue dotted line; values are in Hz.

Vowel midpoint is located at the steady-state, mid-way through the vowel. Vowel offset is located at the point where voicing ends and the formant structures fade out. DF3's high-marked vowel [á] shows a midpoint pitch of 216.56 Hz and an endpoint pitch of 198.98 Hz. The pitch perturbation for this token is -17.58 Hz. The negative value for DM3 indicates a slight drop in pitch at vowel endpoint from vowel midpoint.

The next graphic in Figure 38 shows the waveform and spectrogram of the low-marked counterpart to the previous token, [usà?] 'bucket', spoken by the Halfway speaker HF2.



**Figure 38** Waveform and spectrogram of [usà?] 'bucket', speaker HF2. Vowel midpoint and endpoint analysis windows (30ms) highlighted. Pitch track is represented by the blue dotted line; values are in Hz.

The midpoint and endpoint locations for this token are equally unambiguous. The pitch value at vowel midpoint of HF2's L-marked [à] is 152.67 Hz. At the end of the vowel, though the voicing bar at the bottom of the spectrogram shows some noise continuing beyond the selection, the higher formants abruptly stop, signifying vowel offset. HF2 produced an endpoint pitch of 127.91 Hz. The pitch perturbation value for HH2 is -24.76 Hz. Both speakers show a pattern of pitch lowering from vowel midpoint to vowel offset, seen in the negative perturbation values.

Having explained the methods by which I collected vowel midpoint and endpoint pitch measures and calculated pitch perturbation, I now move on to the presentation of results for effects of glottalization on pitch, starting with endpoint and then continuing onto the perturbation results.

#### 3.7.1.1 Pitch at vowel endpoint

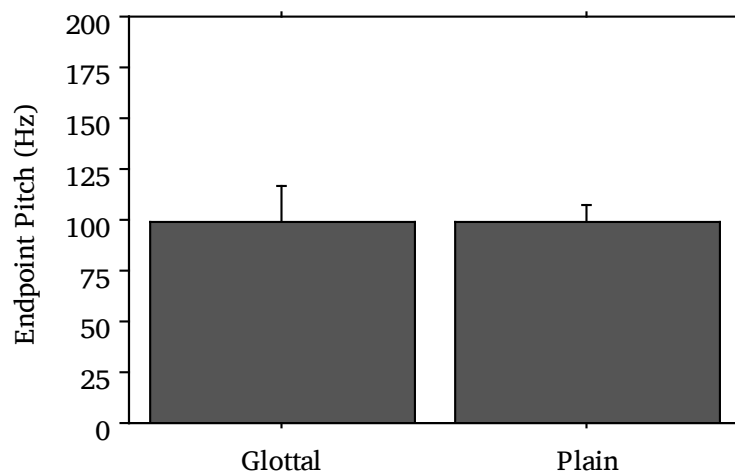
This section presents results for effects on pitch at vowel endpoint due to the presence of a word-final glottal stop. I ran a one-factor ANOVA for each speaker. The dependent variable was Endpoint pitch; the independent variable was Glottalization (Glottal, Plain).

Pitch was significantly lower in vowels preceding glottal stops than in plain vowels for speakers HF2 and HM1. For the two Doig speakers, there was no significant effect. Table 57 contains the individual means and significance results for effects at vowel endpoint.

**Table 57 Pitch means at vowel endpoint, standard deviations, and significance results for individual speakers. Measures are (Hz).**

SPEAKER	GLOTTAL (MARKED TONE)			PLAIN (UNMARKED TONE)			SIGNIFICANCE
		MEAN	ST DEV		MEAN	ST DEV	
DF3	[áʔ]	122.27	(34.7)	[à]	135.88	(27.2)	not significant
DM4	[áʔ]	99.47	(17.6)	[à]	98.88	(8.1)	not significant
HF2	[àʔ]	114.54	(21.5)	[á]	148.03	(20.2)	F[1,55] = 36.608, p < .0001
HM1	[àʔ]	126.43	(41.2)	[á]	153.44	(25.8)	F[1,38] = 5.845, p = .0205

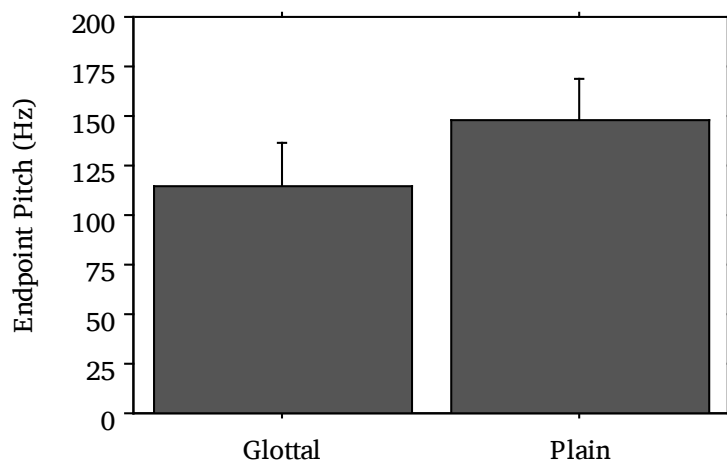
As an example of a non-significant result, DM4 shows similar pitch means for both types of vowels; his pre-glottal stop vowels have a mean of 99.47Hz,  $s = 17.6$  and his plain vowels, 98.88,  $s = 8.1$ . Figure 39 provides the bar graph of his pitch means.



**Figure 39 Bar graph showing means for endpoint pitch, speaker DM4. Error bars represent  $\pm 1$  standard deviation(s). Measures are (Hz).**

Speaker HF2 is representative of the speakers who show a significant difference in pitch. Her pre-glottal stop vowels (114.54 Hz,  $s = 21.5$ ) are significantly lower than

her plain vowels (148.03 Hz,  $s = 20.2$ ). The bar graph for HF2's means is below in Figure 40.



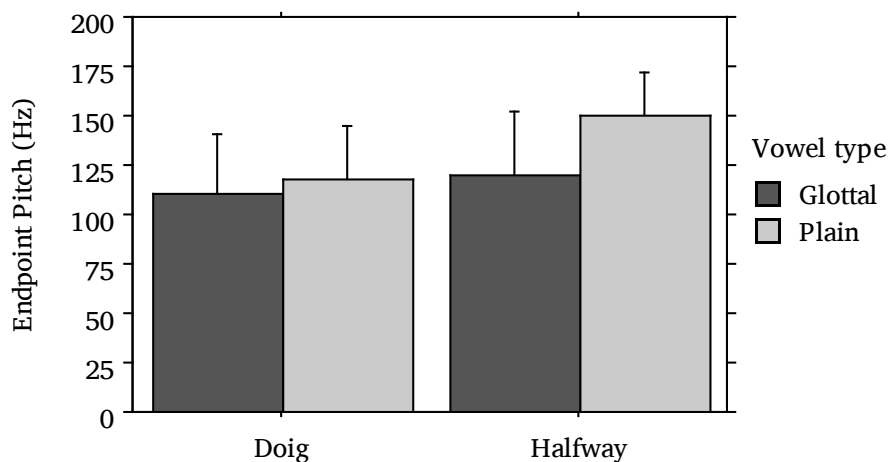
**Figure 40** Bar graph showing means for endpoint pitch, speaker HF2. Error bars represent  $\pm 1$  standard deviation(s). Measures are (Hz).

Looking at possible patterns based on dialect, it is tempting to say that the results are meaningful. However, as there are only two speakers representing each dialect, I will refrain from exploring anything beyond an informal discussion (i.e. no inferential statistics will be presented for group data). Means for each dialect is offered in Table 58.

**Table 58** Endpoint pitch means and standard deviations for the two dialect groups. Measures are (Hz). Syllable rhyme transcription provided to clarify dialectal mirror-image tone categories for each set of vowels.

DIALECT	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)	
	MEAN	ST DEV	MEAN	ST DEV
Doig [áʔ]	110.66 Hz	(29.5)	[à] 117.71 Hz	(27.4)
Halfway [àʔ]	119.99 Hz	(32.2)	[á] 150.02 Hz	(22.3)

Looking at the dialect results based on tone category, the Doig L-unmarked vowels in open syllables, 117.71 Hz ( $s = 27.4$ ) were similar to Halfway's L-marked, pre-glottal stop vowels, 119.99 Hz ( $s = 32.2$ ). The H vowels, on the other hand were very different. For the Doig H-marked, pre-glottal stop vowels, the pitch mean was 110.66 Hz ( $s = 29.5$ ). The Halfway H-unmarked plain vowels averaged 150.02 Hz ( $s = 22.3$ ). The glottal stop had a lowering effect for both dialects. To see the means represented in a bar graph, I have included Figure 41 below.

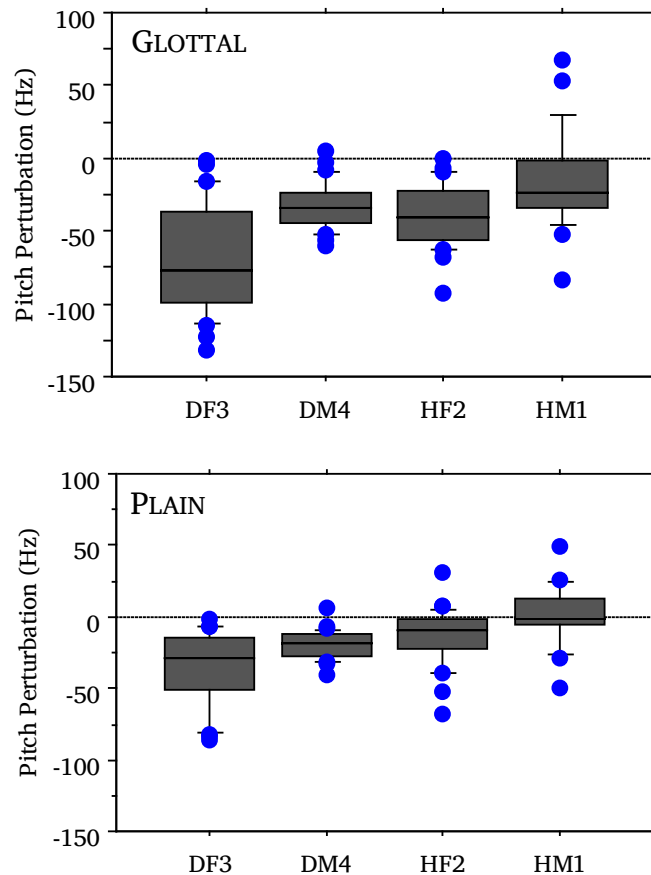


**Figure 41** Bar graph showing group means for endpoint pitch, measured in (Hz). Error bars represent  $\pm 1$  standard deviation(s).

The Halfway speakers show greater pitch lowering in the vowels that precede glottal stops than the Doig speakers.

### 3.7.1.2 Pitch perturbation

Recall that pitch perturbation is a means to normalize results; this measure calculates the difference in pitch from vowel midpoint to vowel offset. For every speaker in both dialects, the mean pitch at vowel offset was lower than the mean pitch at vowel midpoint, preceding a glottal stop. Pitch was also lower for the open syllables for all but HM1. I provide a boxplot in Figure 42 to display the clear pattern across speakers of pitch lowering before glottal stops as well as in open syllables.



**Figure 42** Boxplots of effect on perturbation values by vowels preceding glottal stops (top) or vowels in open syllables (bottom). Speakers are listed across the bottom.

Means of vowels before glottal stops displayed in the top graphic indicate that three of the speakers lower their pitch at the vowel offset nearly 100% of the time; HM1 does so 75% of the time. Means of plain vowels presented in the bottom graphic show that for Doig speakers, nearly 100% of their pitch measures were lower in the plain vowels. For HF2, this was the case for 75% of her tokens. HM1, on the other hand, had raised his pitch at vowel offset nearly 75% of the time.

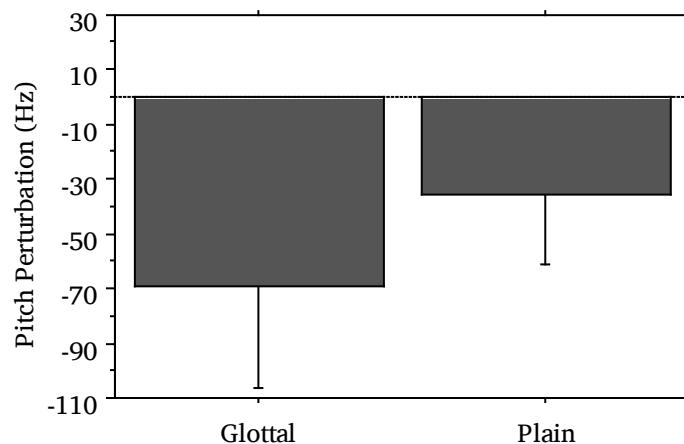
The inferential analysis was carried out using a one- factor ANOVA, with Pitch perturbation as the dependent variable, and the presence or lack of syllable-final glottal stop was the independent variable (Glottal, Plain). Individual results show a significant difference between the two syllable shapes for three of the four speakers. I present numeric results for each speaker below in Table 57.

**Table 59 Pitch perturbation means, standard deviations, and significance results for individual speakers. Measures are (Hz).**

SPEAKER	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV	MEAN	ST DEV	
DF3	[áʔ] -69.25	(37.2)	[à] -31.36	(33.7)	F[1,53] = 15.609, p = .0002
DM4	[áʔ] -32.23	(15.9)	[à] -19.26	(10.0)	F[1,53] = 12.995, p = .0007
HF2	[àʔ] -39.10	(22.7)	[á] -13.75	(19.4)	F[1,55] = 20.636, p < .0001
HM1	[àʔ] -15.75	(33.0)	[á] 0.34	(21.9)	not significant

The negative perturbation values indicate that for all four speakers there is a pattern of pitch lowering in vowels followed by a glottal stop, as well as vowels in open syllables, with the exception of HM1's open syllable vowels. This general tendency toward falling intonation is not unexpected; Müller discusses the L% tone intonation found in declarative sentences in the Alberta dialect of Dane-zaa. For HM1, his plain vowels have a pitch value at vowel offset that is near the pitch value taken at vowel midpoint, 0.34Hz (s = 21.9). For the remaining three speakers, the difference in pitch between these two syllable shapes is significant.

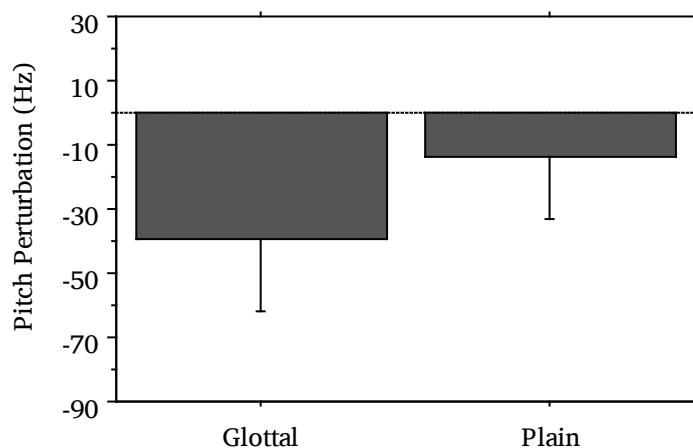
Speaker DF3, representing the Doig dialect, shows significant differences in pitch perturbation values for vowels followed by glottal stop and vowels in open syllables. Her data indicate significant pitch lowering, -69.25 ( $s = 37.2$ ) in the pre-glottal stop vowels, as compared to her plain vowels, -35.70 ( $s = 25.3$ ). DF3's means are presented below in the bar graph of Figure 43.



**Figure 43** Bar graph showing means for pitch perturbation, speaker DF3. Error bars represent  $\pm 1$  standard deviation(s). Measures are (Hz).

There is clear lowering in both vowel types; however, the lowering that occurs before a glottal stop is significantly greater than the lowering that occurs in plain vowels. It is important to remember that the tones on the vowels preceding glottal stops are H-marked for Doig speakers. The pitch at vowel midpoint will be greater in those syllables than the plain vowel syllables.

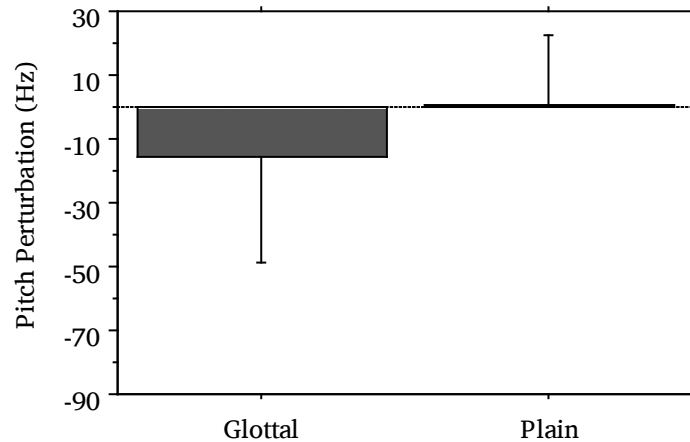
An example of a significant result for a Halfway female, comes from speaker HF2. HF2's L-marked vowels before glottal stops carried a mean pitch perturbation of -39.10 ( $s = 22.7$ ). This figure is significantly lower than that of her H-unmarked plain vowels, -13.75 ( $s = 19.4$ ). Figure 44 offers a graphical representation of her means.



**Figure 44** Bar graph showing means for pitch perturbation, speaker HF2. Error bars represent  $\pm 1$  standard deviation(s). Measures are (Hz).

HF2 shows clear lowering for both types of vowels. Despite the L tone of the vowels preceding glottal stops, there exists a notable lower drop in pitch for her plain vowels.

The remaining Halfway speaker, HM1, did not show a significant difference in perturbation due to glottalization. His means are displayed in the bar graph in Figure 45.



**Figure 45** Bar graph showing means for pitch perturbation, speaker HM1. Error bars represent  $\pm 1$  standard deviation(s). Measures are (Hz).

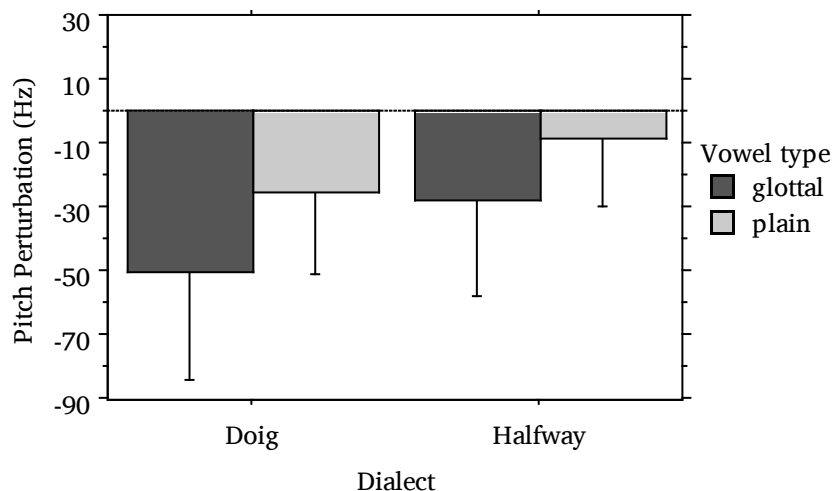
HM1 was the only individual to show the lack of intonational declarative pattern of final lowering; in this case the positive perturbation mean was seen in his H-unmarked plain vowels. The difference between the perturbation of his vowels before glottal stops and plain vowels was not great and the non-significant result is likely due to the relatively high amount of variation in both vowel categories, as seen in the long error bars in Figure 45.

The main difference between the two dialects can be seen in the H tone categories. For Doig, the H-marked vowels preceding glottal stops show a perturbation mean of -50.40. Halfway H-unmarked tones, on the other hand, show a perturbation value of -08.58. Perturbation means for the Doig L-unmarked and Halfway L-marked tones are relatively similar. Dialect means are presented below in Table 60.

**Table 60** Pitch perturbation means and standard deviations for the two dialect groups. Measures are (Hz). Syllable rhyme transcription provided to clarify dialectal mirror-image tone categories for each set of vowels.

		GLOTTAL	PLAIN
Doig	[áʔ]	-50.40 (33.8)	[à] -27.48 (20.8)
Halfway	[àʔ]	-28.40 (30.0)	[á] -08.58 (21.3)

For both groups, there is more variation in the perturbation of vowels that precede glottal stops than those in open syllables. For a final view, I have included a bar graph of perturbation means for both vowel types, separated by dialect, Figure 46.



**Figure 46** Bar graph showing group means for pitch perturbation, measured in Hz. Error bars represent  $\pm 1$  standard deviation(s).

To summarize, for three of the four speakers, there was a significant local effect of glottal stop on the pitch of the preceding vowel; this effect was to lower the pitch. The fourth speaker followed the trend of pitch lowering before glottal stop; however,

the difference in perturbation values between the two vowel types was not significant for him.

### 3.7.1.3 Pitch summary

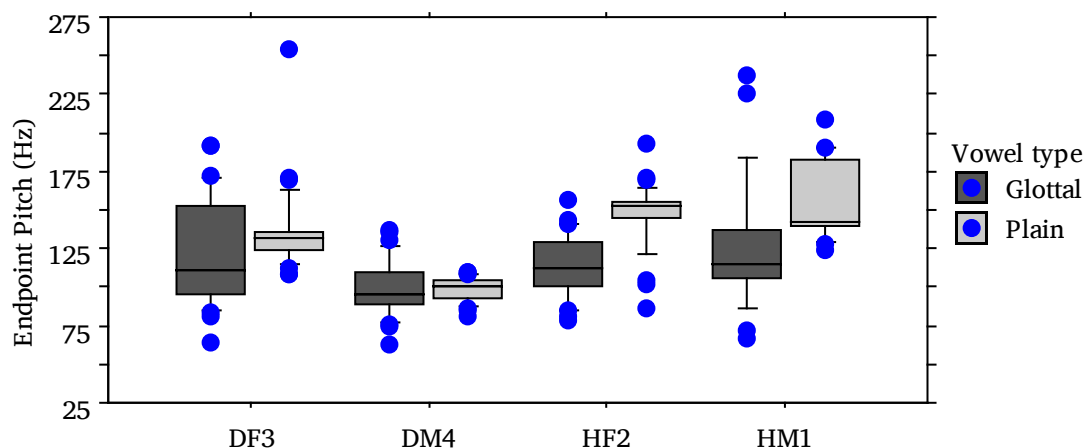
This section set out to investigate local effects of word-final glottal stops on the pitch preceding vowels. My hypothesis was that the Doig speakers would exhibit pitch raising in vowels preceding glottal stops; Halfway would exhibit pitch lowering. Of the Doig speakers, DF3 lowered her pitch, DM4 did not have a noteworthy difference between the two sets of vowels; neither result was significant. The significant effects were found in the results for the Halfway speakers. Both yielded significantly lower pitch in their vowels preceding glottal stops than in their plain vowels. I offer a summary of these findings in Table 61.

**Table 61** Local effect (vowel endpoint) and normalized effect (perturbation) of glottalization on pitch. **Bolded, italicized text indicates statistical significance.**

DIALECT	SPEAKER	PITCH AT ENDPOINT	PITCH PERTURBATION
Doig	DF3	lower pitch before ?	<b><i>lower pitch before ?</i></b>
	DM4	higher pitch before ?	<b><i>lower pitch before ?</i></b>
Halfway	HF2	<b><i>lower pitch before ?</i></b>	<b><i>lower pitch before ?</i></b>
	HM1	<b><i>lower pitch before ?</i></b>	lower pitch before ?

DF3 does show lower pitch before glottal stops than in her plain vowels; it is interesting to note that she lowers pitch more at the endpoint of H-marked vowels

preceding glottal stops, than she does her plain vowel L tones, offering good evidence that glottal stops have a lowering effect for her. This can be seen in the box plot of means taken at vowel offset for each speaker in Figure 47.



**Figure 47** Boxplot showing individual means for pitch at endpoint for both glottal and plain vowels. Dots indicate outliers in the top 90th and bottom 10 percentiles. Error bars represent  $\pm 1$  standard deviation(s). Measures are (Hz).

As previously mentioned, the confounding issue pertaining to effects of final glottal stop on pitch was that marked tone is intrinsically tied to the glottal stop in these tokens. For Dane-zaa stems, occurrences of an open syllable vowel carrying a marked tone do not exist. Word-final glottal stops preceded by vowel unmarked for tone are also not found in Dane-zaa.

### *3.7.2 Intensity*

Both non-modal phonation types, breathy and creaky, have been characterized by decreased energy (Gordon, 1998; Gordon & Ladefoged, 2001). In qualitative inspections of Deg Xinag spectrograms, Hargus found a large drop in energy in vowels preceding glottal stops, motivating a quantitative investigation into effects of final glottal stops on energy in the non-tonal Witsuwit'en and Deg Xinag languages.

In her study of effects of glottal stops on energy perturbation in Witsuwit'en, Hargus found that for all speakers, the drop in intensity in vowels preceding glottal stops was significantly greater than that found in the plain vowels. She did not report energy at vowel midpoint.

In her investigation of energy perturbation in Deg Xinag, Hargus found that there was a significant decrease in energy for three of the seven speakers in vowels preceding glottal stops. At vowel midpoint, there was only one speaker who showed a significant difference in the energy of pre-glottal stop vowels compared to her vowels in open syllables.

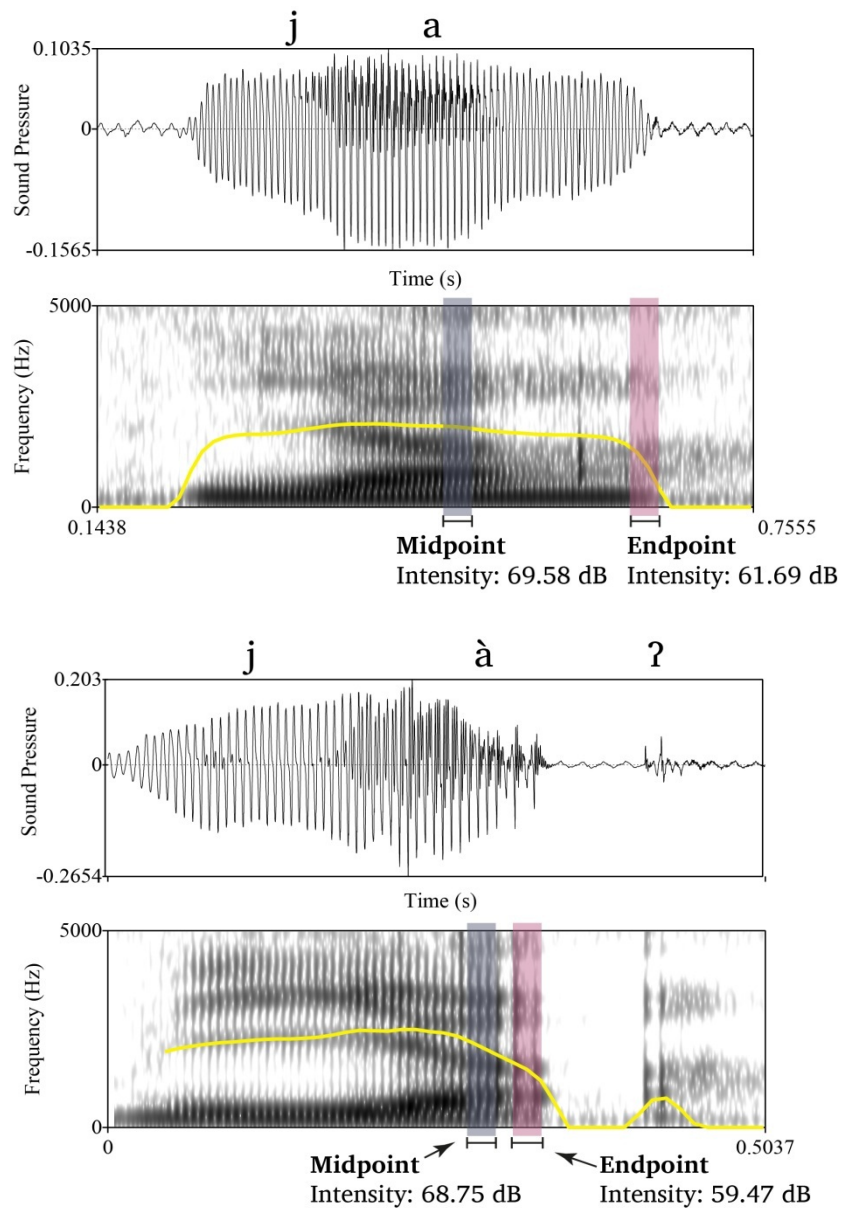
In this section I present findings of my investigation into effects of word-final glottal stops on the intensity of preceding vowels. My research questions for this experiment are presented in (12).

**(12) Research question for effect of word-final glottal stop on intensity:**

- a) What are the effects of word-final glottal stop on intensity at vowel offset? (Local effects)
- b) Does the presence of a word-final glottal stop affect a significant change in intensity from vowel midpoint to endpoint? (Normalized, or perturbation effects)

Based on the findings summarized above, I would expect similar results for local effects of glottalization: lower energy at the endpoint of vowels preceding glottal stops. I would also expect that the effect on normalized intensity will manifest as a decrease in energy from vowel midpoint to endpoint for all speakers.

As mentioned in the methodology section of 3.6.4, intensity perturbation is defined as the intensity taken at vowel endpoint, less the intensity at vowel midpoint. A negative value indicates a fall in energy from midpoint to endpoint. Figure 48 provides examples of where measurements for midpoint and endpoint intensity were taken. The waveforms and spectrograms of speaker HF2 are from the H-unmarked token [ja] ‘sky’ and, and L-marked [jàʔ] ‘louse’, highlighting the intensity track as well as the measurement locations.



**Figure 48** Waveforms and spectrograms of [ja] 'sky' (top) and [jà?] 'louse' (bottom), speaker HF2. Vowel midpoint and endpoint analysis windows (30ms) highlighted. Intensity track is represented by the yellow line; values are in dB.

In the above graphics, the yellow line indicates the intensity for that vowel. The midpoint is highlighted by the blue 30ms selection, the endpoint, by the red 30ms

selection. Midpoint intensity in the plain vowel of HF2's top token [ja] 'sky' is 69.58 dB, the endpoint value is 61.69 dB. As you recall, the perturbation value is calculated by subtracting the midpoint value from that of the endpoint. In this case, the perturbation value is -7.89 dB. For the vowel in the token [jàʔ] 'louse', which precedes the glottal stop, the endpoint intensity value is 59.47 dB; the midpoint value is 68.75 dB. The perturbation value for this token is -9.28 dB. Both tokens show negative perturbation scores, indicating a decrease in intensity from vowel midpoint to endpoint.

The next two sections explore the possible effects on intensity due to this word-final glottal stop. Endpoint results will be presented first, followed by the perturbation results.

### 3.7.2.1 Intensity at vowel endpoint

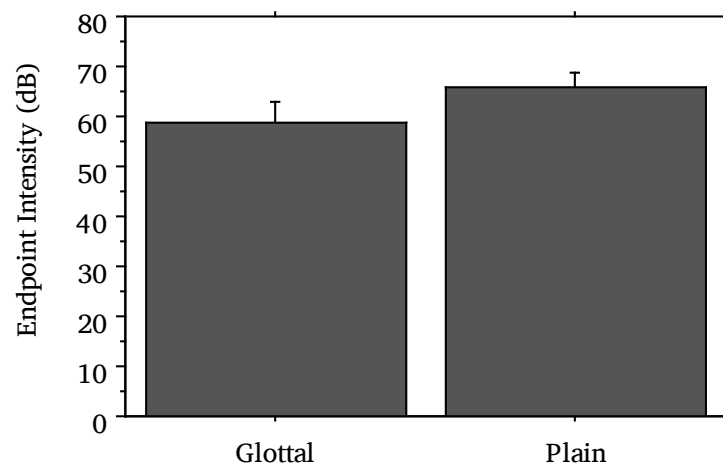
This section presents results from the investigation of effects of word-final glottal stops on preceding vowels. A factorial ANOVA was utilized; the dependent variable was Endpoint intensity, the independent variable was Glottalization (Glottal, Plain).

All speakers showed a significant local effect of word-final glottal stop. This effect was to lower intensity in the preceding vowels. Individual means and significance results can be seen below in Table 62.

**Table 62 Endpoint intensity means, standard deviations, and significance results for individual speakers. Measures are (dB).**

SPEAKER	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV	MEAN	ST DEV	
DF3	[á?] 58.77	(4.2)	[à] 65.93	(3.0)	F[1,53] = 53.103, p < .0001
DM4	[á?] 56.81	(3.2)	[à] 60.44	(2.7)	F[1,53] = 20.624, p < .0001
HF2	[à?] 57.77	(3.1)	[á] 61.97	(3.1)	F[1,55] = 25.525, p < .0001
HM1	[à?] 56.46	(3.1)	[á] 60.12	(2.4)	F[1,38] = 16.784, p = .0002

Means for vowels preceding glottal stops and vowels in open syllables were similar across speakers. There was very little variation, as seen in the small standard deviation values. As an exemplar, I offer the bar graph of means for speaker DF3 in Figure 49.



**Figure 49 Bar graph showing means for endpoint intensity, speaker DF3. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB).**

For speaker DF3, vowels preceding glottal stops had a mean of 58.77 dB,  $s = 4.2$ ; plain vowels averaged 65.93 dB,  $s = 3.0$ . Energy in her pre-glottal stop vowels was significantly lower than that found in her open syllable vowels.

Results based on dialects are not noteworthy; there was no discernible difference between speakers of the two dialects.

### 3.7.2.2 Intensity perturbation

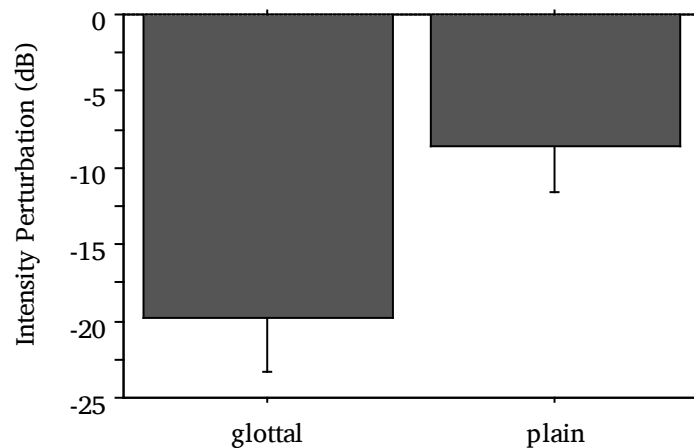
For this analysis, a one-factor factorial ANOVA was run with Intensity Perturbation values as the dependent variable. As in the previous investigation of pitch, the independent variable was Glottalization (Glottal, Plain). Individual results show a significant difference in intensity perturbation between vowels before glottal stops and plain vowels for every speaker.

Speaker DF3 shows the greatest difference in intensity from vowel midpoint to offset, for both vowels preceding glottal stops and those in open syllables. For her, vowels that are followed by glottal stops have a mean perturbation of  $-19.79$ ,  $s = 3.5$ , which is significantly lower than the perturbation of her vowels in open syllables,  $-8.60$ ,  $s = 3.0$ . Table 63 provides the individual means, standard deviations and significance results for all speakers.

**Table 63 Intensity perturbation means, standard deviations, and significance results for individual speakers. Measures are (dB).**

SPEAKER	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV	MEAN	ST DEV	
DF3	[áʔ] -19.79	(3.5)	[à] -8.60	(3.0)	F[1,53] = 164.687, p < .0001
DM4	[áʔ] -8.41	(3.3)	[à] -4.56	(1.8)	F[1,53] = 28.859, p < .0001
HF2	[àʔ] -8.81	(5.2)	[á] -3.98	(3.1)	F[1,55] = 19.935, p < .0001
HM1	[àʔ] -7.08	(3.0)	[á] -3.59	(1.6)	F[1,38] = 19.749, p < .0001

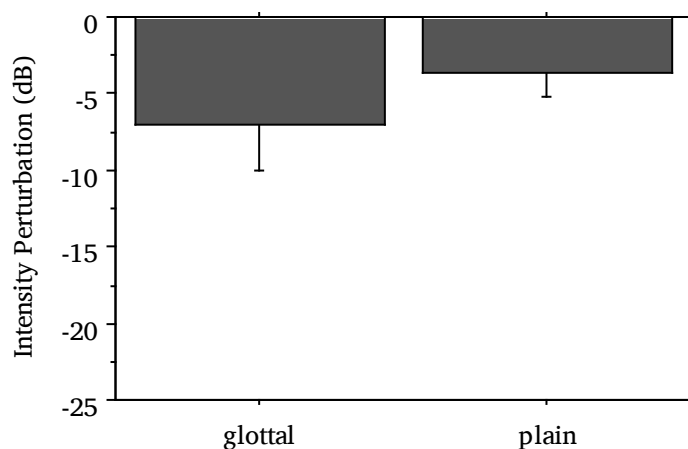
The negative perturbation values for vowels preceding glottal stops are indicative of a drop in energy before glottal stops. DM3's means are graphically rendered in the bar graph of Figure 50 below.



**Figure 50 Bar graph showing means for intensity perturbation, speaker DF3. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB).**

Speaker HM1, on the other hand, is representative of the rest of the speakers. The difference in means for intensity perturbation is not as extreme between glottal

and plain vowels, though this difference remains significant. HM1's mean for vowels preceding glottal stops (-7.08,  $s = 3.0$ ) is significantly lower than his plain vowel means (-3.59,  $s = 1.6$ ). HM1's means are displayed in the bar graph in Figure 51 below.



**Figure 51** Bar graph showing means for intensity perturbation, speaker HM1. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB).

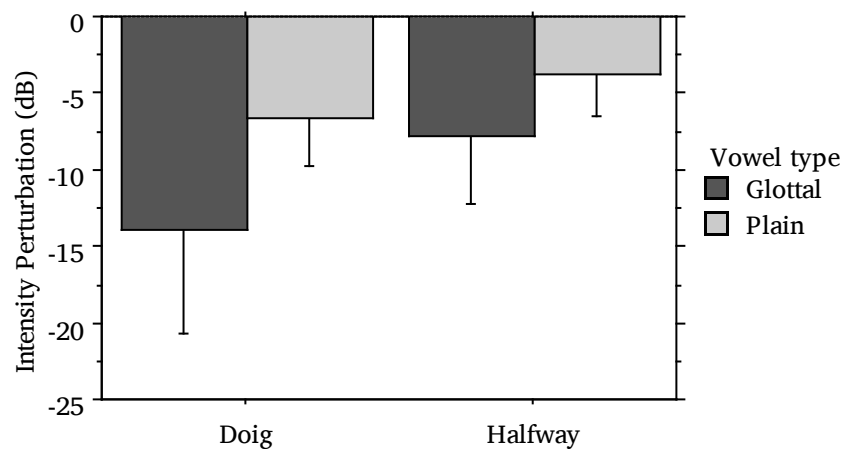
For all speakers, the drop in energy that occurs from vowel midpoint to endpoint is statistically greater in vowels before glottal stops than vowels in open syllables.

Looking informally at group results based on dialect, within vowel type, Doig speakers show a greater decrease in intensity for vowels that precede glottal stops and those in open syllables. I offer the means below in Table 64.

**Table 64 Intensity perturbation means and standard deviations for the two dialect groups.**  
**Measures are (dB).**

DIALECT	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)	
	MEAN	ST DEV	MEAN	ST DEV
Doig [áʔ]	-14.00 dB	(6.6)	[à] -6.62 dB	(3.2)
Halfway [àʔ]	-7.83 dB	(4.4)	[á] -3.84 dB	(2.7)

The above means are presented below in a bar graph for facilitated visual comparison below in Figure 52.



**Figure 52 Bar graph showing group means for intensity perturbation, measured in (dB). Error bars represent  $\pm 1$  standard deviation(s).**

Having determined that there is a significant local effect of the presence of word-final glottal stop on energy for all four speakers, the next section investigates effects of the glottal stop on intensity perturbation.

## 3.7.2.3 Intensity summary

Both the open vowels and those followed by a glottal stop experienced intensity lowering from midpoint to endpoint. This lowering was significantly greater for the pre-glottal stop vowels. These findings support my hypotheses that there would be significantly lower of energy at vowel offset for the pre-glottal stop vowels and that there would be significant lowering of energy from vowel midpoint to endpoint for these same vowels. I offer the boxplots of measurements from midpoint and endpoint locations for all speakers, below in Figure 53.

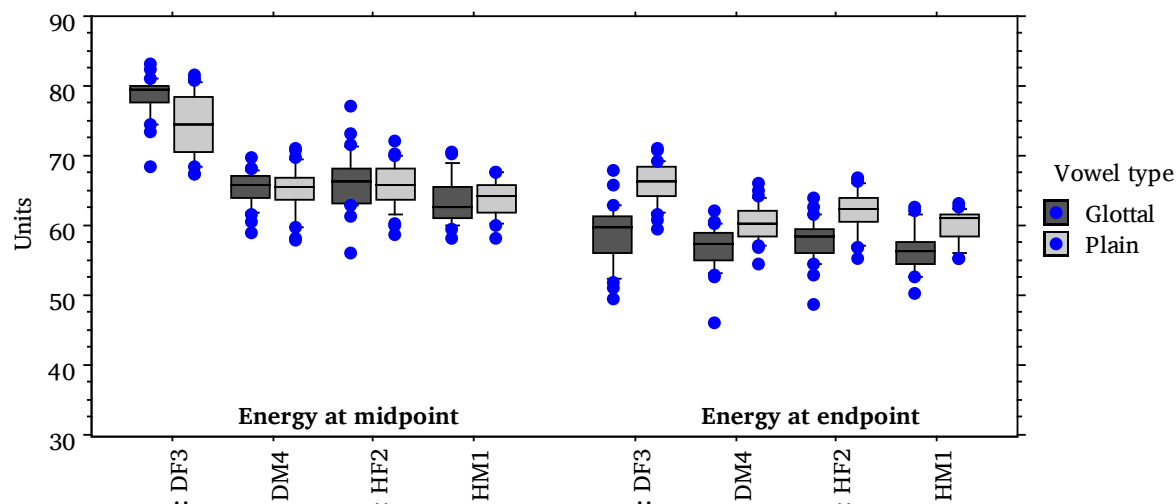


Figure 53 Boxplot showing individual means for intensity at midpoint and endpoint for both glottal and plain vowels. Dots indicate outliers in the top 90<sup>th</sup> and bottom 10 percentiles. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB).

Table 65 summarizes my hypotheses for both local and normalized effects.

**Table 65** Local (vowel endpoint) versus normalized (perturbation) effects of glottalization on intensity. **Bolded, italicized text indicates statistical significance.**

DIALECT	SPEAKER	INTENSITY AT ENDPOINT	INTENSITY PERTURBATION
Doig	DF3	<b><i>lower intensity before ?</i></b>	<b><i>intensity decreases before ?</i></b>
	DM4	<b><i>lower intensity before ?</i></b>	<b><i>intensity decreases before ?</i></b>
Halfway	HF2	<b><i>lower intensity before ?</i></b>	<b><i>intensity decreases before ?</i></b>
	HM1	<b><i>lower intensity before ?</i></b>	<b><i>intensity decreases before ?</i></b>

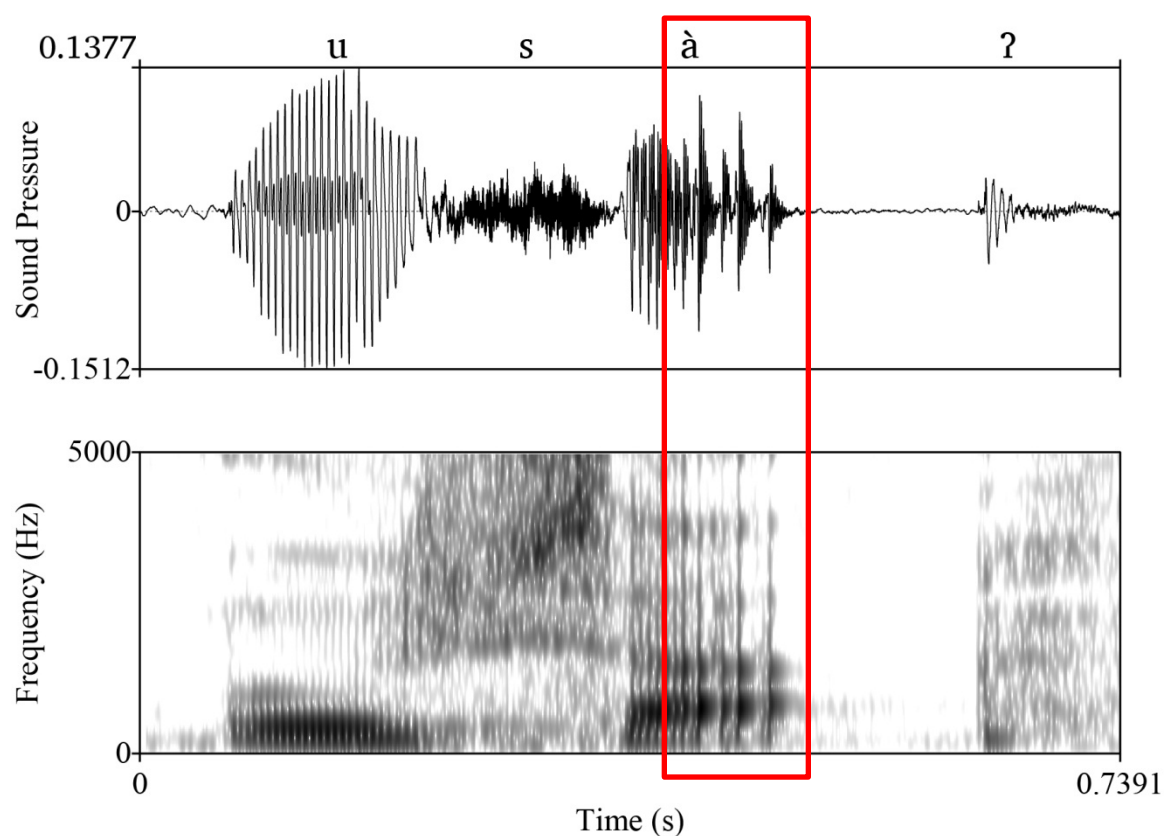
As I anticipated, intensity was significantly affected by word-final glottal stop. Local effects show lower energy in vowels preceding glottal stops than in vowels of open syllables. Normalized effects, as seen in the perturbation results, indicate that there was a significantly greater amount of energy lowering in the pre-glottal stop vowels, than in the plain vowels.

### 3.7.3 Jitter

Jitter is a measure of the variability in glottalic cycles. There exist multiple jitter measurements; the chosen jitter measure for this study is based on the Relative Average Perturbation of Koike (1973), as this is the jitter analysis used by the Multi-Speech software. Boersma and Weenink (Boersma & Weenink, 2012) summarize this particular jitter measure as “the average absolute difference between an interval and the average of it and its two neighbors, divided by the average interval”. The unit of measurement is therefore a percentage. The greater the jitter measure, the greater the

variability in the length of the glottalic cycle. The jitter values are higher in creaky phonation than in modal or breathy

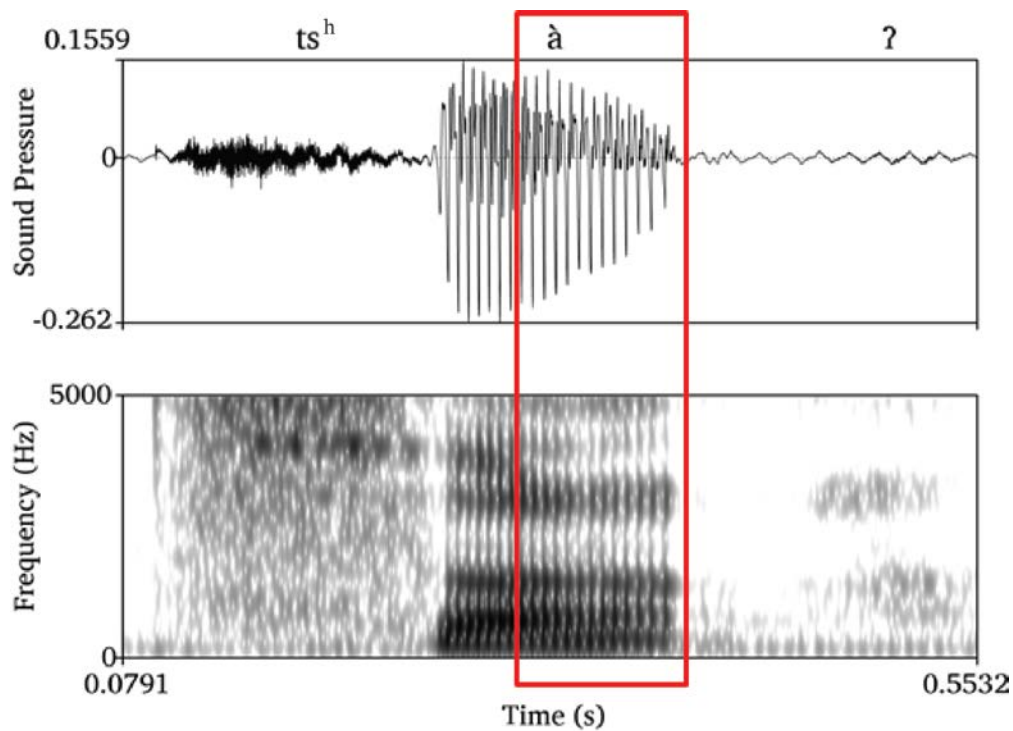
Figure 54 below is a graphic created using Praat. The red box highlights the irregular glottal pulses in the token [usàʔ] ‘bucket’ for the male Halfway speaker HM1.



**Figure 54** Praat graphic of waveform and spectrogram for speaker HM1, token [usàʔ] ‘bucket’. Note the irregular glottal pulses for the second vowel [à]. Jitter measure for endpoint of this vowel: 26.79%

The irregularly spaced glottal pulses are acoustic correlates to what is perceived auditorily as creaky voicing. In addition to the irregularity of glottal cycles, another

characteristic to creaky voicing are long glottal cycles, relative to modal voicing (Gordon, 2001). For comparison, Figure 55 offers an example of modal phonation.



**Figure 55** Praat graphic of waveform and spectrogram for speaker HF2, token [ts<sup>h</sup>àʔ] ‘beaver’. Note the regularity of glottal pulses for vowel [à]. Jitter measure for endpoint of this vowel: 0.44%

The glottal cycles above are regularly spaced and relatively closer together than what was seen in Figure 54. This token was produced with more modal phonation.

In Witsuwit’en, Hargus (2007) investigated effects of word-final glottal stop on jitter. She found that for vowels preceding glottal stops, there was a dramatic increase

in jitter from vowel midpoint to endpoint. This increase was significantly different from the jitter of plain vowels for all ten speakers in the study.

In her investigation of effects of word-final glottal stops on jitter in Deg Xinag (In progress), Hargus found that from vowel midpoint to endpoint, jitter increased in vowels preceding glottal stops for all speakers. This increase was significantly different from the plain vowels for five of the seven speakers. For jitter at vowel midpoint, six of the seven speakers had higher jitter values in vowels preceding glottal stops than in open syllables; this difference was significant for two of the seven.

For this section, my investigation explores effects of word-final glottal stops on the jitter values of the preceding vowels. My research questions are offered below in (13).

**(13) Research question for effect of word-final glottal stop on jitter:**

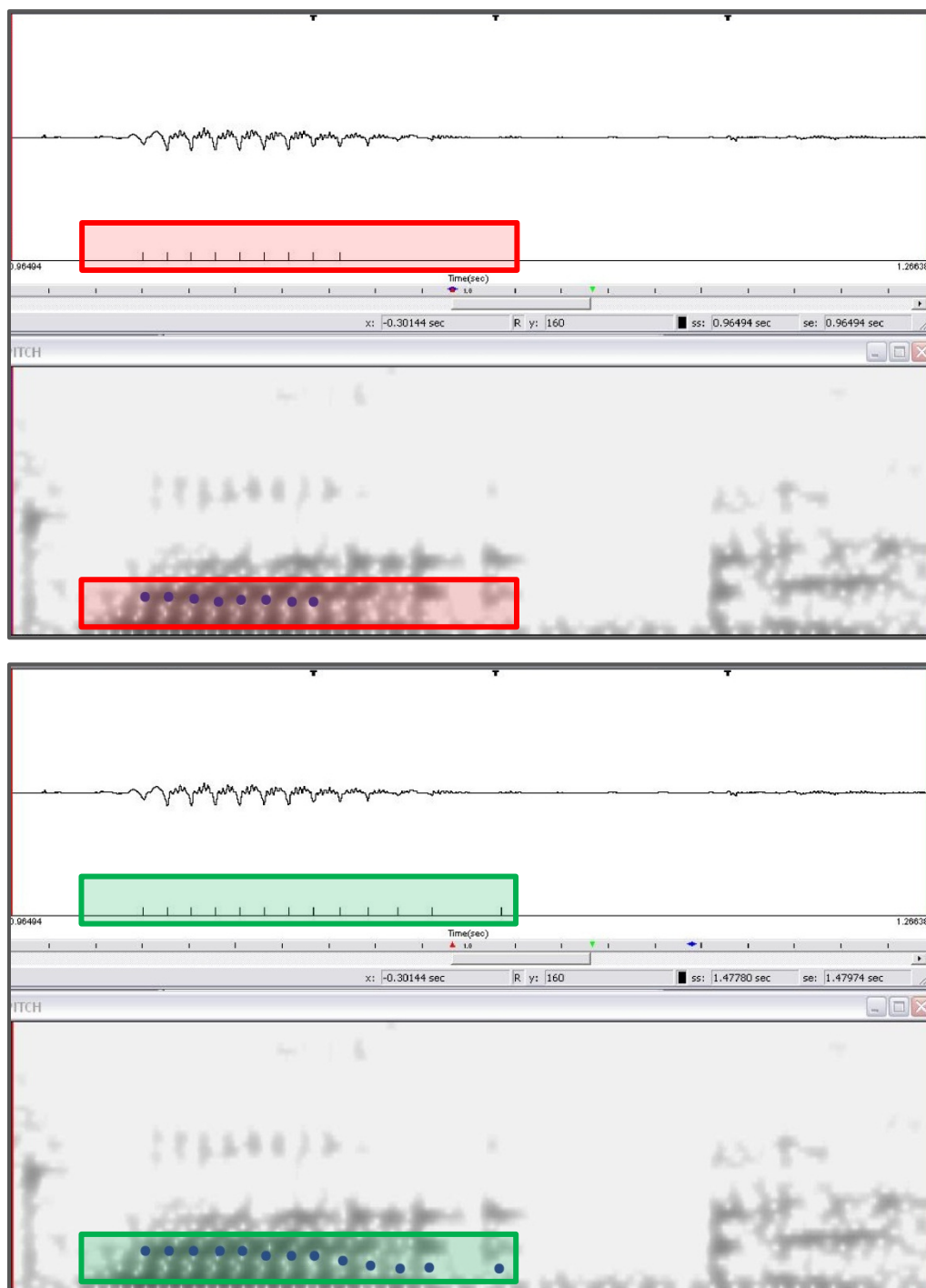
- a) What are the effects of word-final glottal stop on jitter at vowel offset? (Local effects)
- b) Does the presence of a word-final glottal stop affect a significant change in jitter from vowel midpoint to endpoint? (Normalized, or perturbation effects)

Based on the findings of the non-tonal Athabaskan languages mentioned above, I hypothesize that there will be significant local effects of word-final glottal stops on jitter perturbation. Jitter will be significantly higher in vowels before glottal stops than in vowels of open syllables. Additionally, I expect that there will be significantly

increased jitter from midpoint to offset in vowels preceding glottal stops than in plain vowels.

The collection of jitter measurements was done using Multi-Speech, as with the previous two measurements of voice quality, pitch and intensity. The main motivation for using Multi-Speech over Praat for this dissertation was due to the ease of correcting spurious voiced period points in Multi-Speech. When the voicing points were generated in Praat and Multi-Speech, many occurrences of improper placement transpired. As this study focuses on jitter, and specifically jitter at the endpoint of the vowel, I needed to employ an efficient way to correct the obvious errors. Praat does have a way to measure jitter using corrected voicing points, however it is very time consuming.

In the following graphics, I provide a step-by-step method describing how I corrected absent voicing points in Multi-Speech. In Figure 56, the top image highlights the location of absent voicing points and the subsequent missing pitch track. The bottom graphic shows the hand corrected voicing points, based on the extant pattern of correctly placed points in the waveform, in this case of marking the trough with the voicing points. A new pitch track was then generated. The rectangles outline the pertinent locations. The pitch track can be found in the spectrograms, denoted by the blue dotted line.

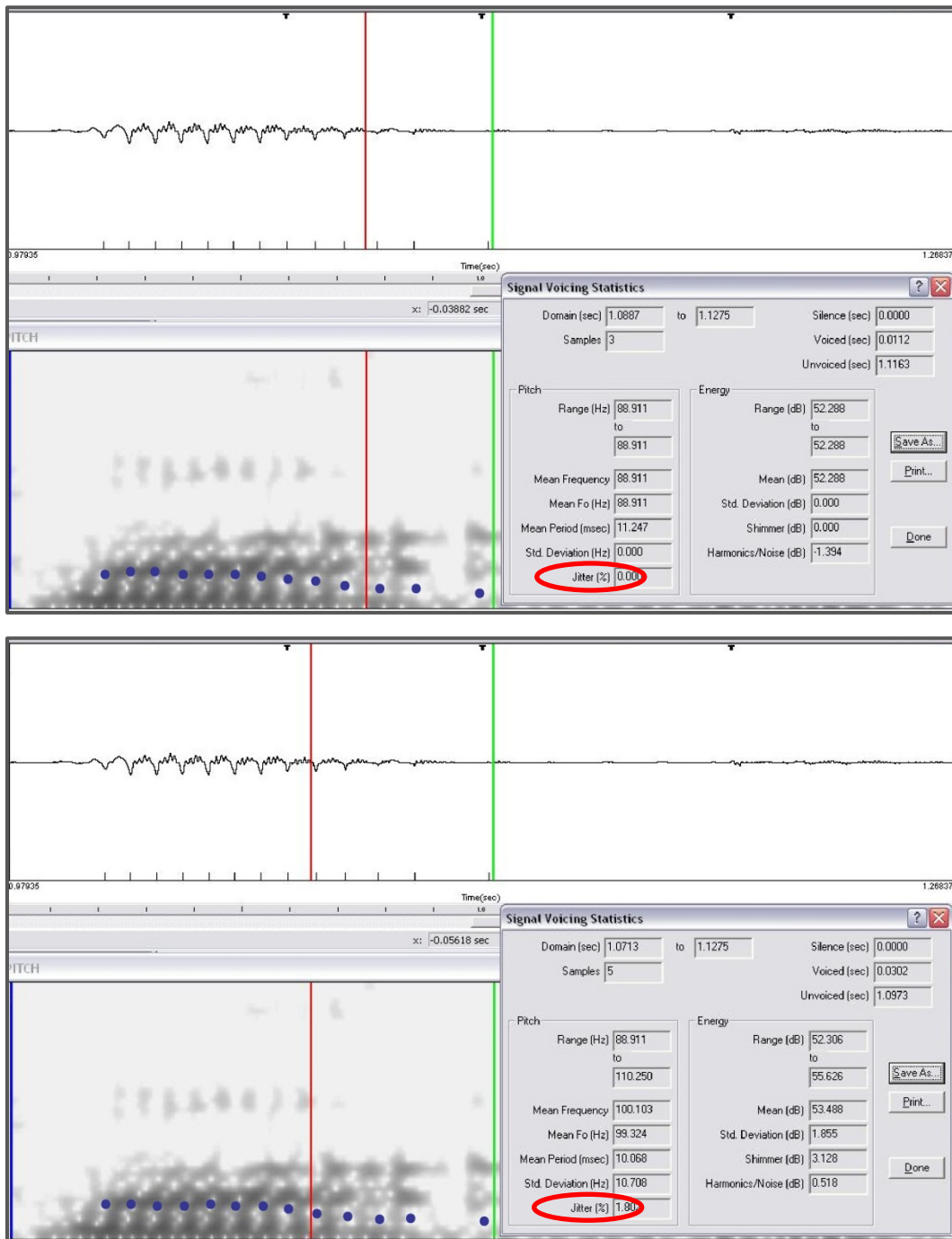


**Figure 56** Screenshot of waveform and spectrogram from Multi-Speech, for speaker DM4, token [taslà?] ‘I bought’, last syllable. Rectangle highlighting location of missing voicing points and pitch track (top), subsequent hand-correction of voicing points (below).

A minimum window size of 30ms was used for the analyses in this chapter. On occasion the selection window needed to be expanded to include enough voice period points to make an analysis.<sup>33</sup> The need for an expanded selection was limited to tokens with widely spaced glottal pulses. In the images of Figure 57 below, the waveforms and spectrograms feature red and green cursors. Between these lines falls the region for analysis. The top image shows the original 30ms window, with too few voicing points to complete a jitter analysis. The voicing report window is superimposed, with a red circle around the jitter result. The bottom image shows the expanded analysis window which includes the minimum number of points necessary to generate a jitter report for this endpoint measure. On rare occasions, three points were not enough for an analysis; in this case five points were needed.

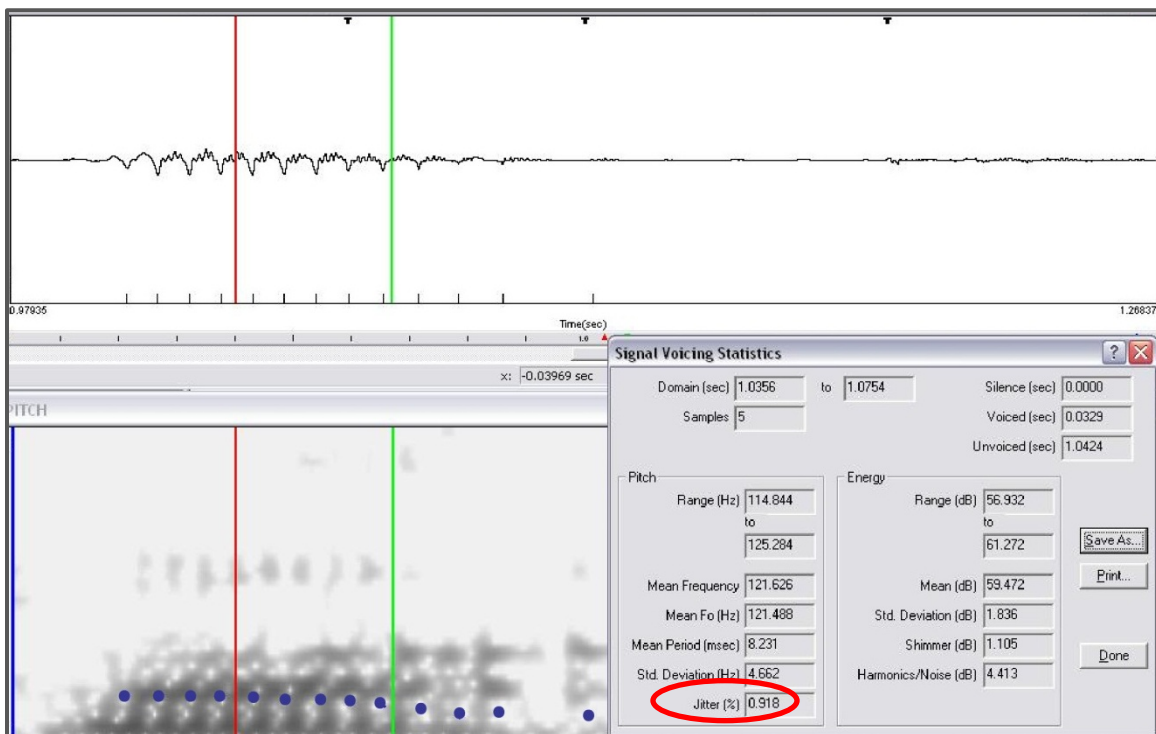
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<sup>33</sup> According to Koike (1973), the number of glottal pulses necessary to calculate RAP jitter (Relative Average Perturbation) is three.



**Figure 57** Screenshot of waveform and spectrogram from Multi-Speech, for speaker DM4, token [taslà?] 'I bought', last syllable. Top image shows jitter result (0.0%) when too few voicing points are selected for analysis (30ms selection window is between the red and green cursors). Bottom image shows acceptable jitter result due to expanded analysis window.

The next image in Figure 58 shows the location of the midpoint measurement, the 30ms selection between the red and green cursors. In this case, there was an overlap of one voicing point with the endpoint analysis due to the relatively short duration of the target vowel. Typically, there was no overlap of analysis windows.



**Figure 58** Screenshot of waveform and spectrogram from Multi-Speech, for speaker DM4, token [taslà?] 'I bought', last syllable. Image shows location of midpoint measurement. Window includes overlap of one voicing point from endpoint analysis window. Jitter result circled.

Figure 59 below offers Praat-generated waveforms and spectrograms highlighting the locations of jitter midpoint and endpoint measurements. Jitter values are given below each selection window. The top image is the token [ts<sup>h</sup>áʔ] ‘beaver’ from speaker Doig DM4. The bottom image is the word [usàʔ] ‘bucket’ from Halfway speaker HM1. The long vertical lines seen in the waveforms are voice period points.

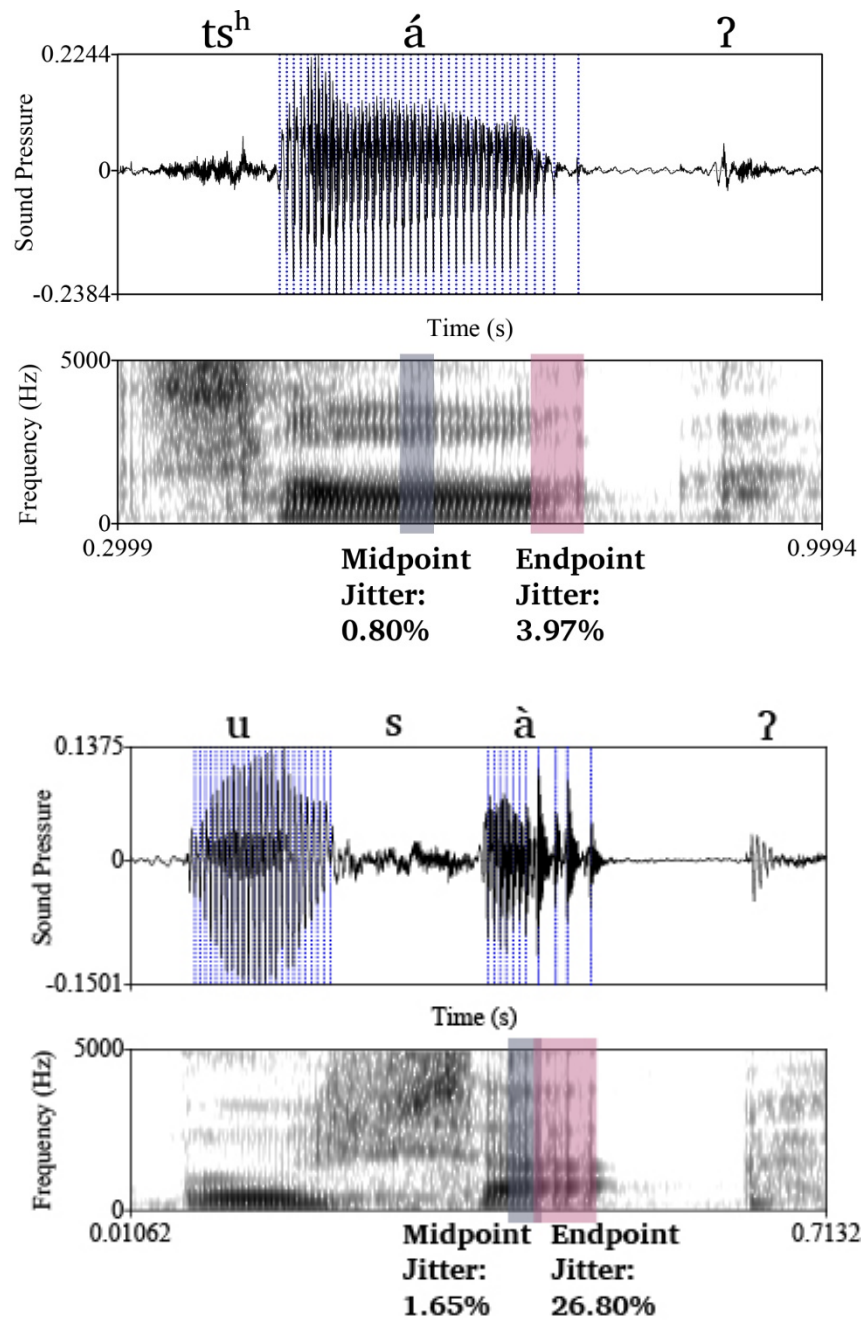


Figure 59 Waveforms and spectrograms of [ts<sup>h</sup>áʔ] 'beaver', speaker DM4 (top) and [usàʔ] 'bucket' (bottom), speaker HM1. Blue vertical lines indicate voicing points. Vowel midpoint and endpoint analysis windows (30ms) highlighted. Jitter values are percentages.

For DM4, the endpoint jitter value is 3.97%, the midpoint is 0.80%. These measures create a positive jitter perturbation value of 3.17%, indicating a rise in jitter from vowel midpoint to endpoint. HM1, on the other hand, has a comparatively high jitter endpoint value of 26.80% and a jitter midpoint value of 1.65%, yielding a perturbation score of 25.15%. HM1 has a higher increase toward creakier phonation in this pair of examples. The midpoint jitter is relatively low for both speakers.

### 3.7.3.1 Jitter at vowel endpoint

This section presents results from the investigation of effects of word-final glottal stop on jitter. In the factorial ANOVA, the dependent variable was Endpoint jitter; the independent variable was Glottalization (Glottal, Plain). I have included individual means and significance results below in Table 66.

**Table 66 Endpoint jitter means, standard deviations, and significance results for individual speakers.**

SPEAKER	GLOTTAL (MARKED TONE)			PLAIN (UNMARKED TONE)			SIGNIFICANCE
		MEAN	ST DEV		MEAN	ST DEV	
DF3	[áʔ]	10.46	(6.6)	[à]	2.21	(1.7)	F[1,53] = 41.024, p < .0001
DM4	[áʔ]	5.83	(3.8)	[à]	3.14	(2.1)	F[1,53] = 10.462, p = .0021
HF2	[àʔ]	8.25	(6.3)	[á]	2.32	(2.7)	F[1,55] = 22.719, p < .0001
HM1	[àʔ]	12.02	(10.0)	[á]	2.03	(1.7)	F[1,38] = 17.639, p = .0002

For all four speakers, there was significantly greater jitter in the vowels preceding glottal stops than in the plain vowels. Results from DF3 are representative of

the other speakers. For DF3’s endpoint jitter, vowels preceding glottal stops averaged 10.46%,  $s = 6.6$  and 2.21,  $s = 1.7$  for her plain vowels. Figure 60 shows a bar graph of these means.

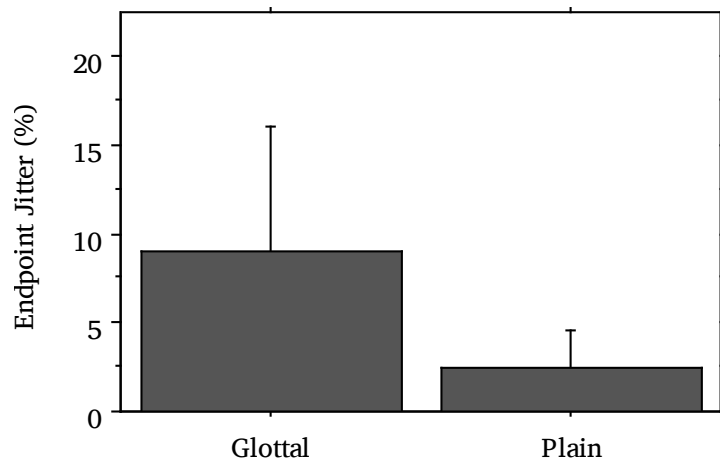


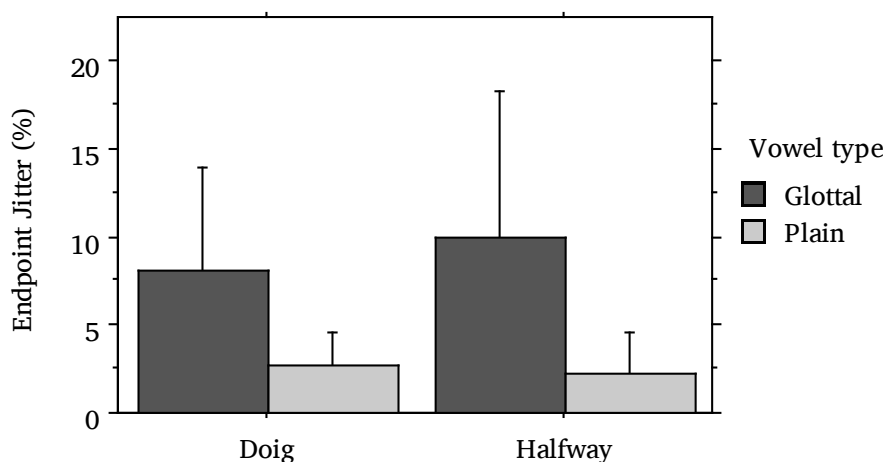
Figure 60 Bar graph showing means for endpoint jitter, speaker DF3. Error bars represent  $\pm 1$  standard deviation(s).

To informally explore patterns based on dialect, I have present endpoint jitter means for the Doig and Halfway dialects in Table 67.

Table 67 Endpoint jitter means and standard deviations for the two dialect groups. Measures are (%).

DIALECT	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)	
	MEAN	ST DEV	MEAN	ST DEV
Doig	[á?] 8.10%	(5.8)	[à] 2.67%	(1.2)
Halfway	[à?] 10.0%	(8.3)	[á] 2.21%	(2.4)

Results for the two dialects are similar. Both average increased jitter in pre-glottal stop vowels. What is interesting is the amount of variation produced in the pre-glottal stop vowels by speakers of both dialects. This variation is clearly evident in the long error bars in the bar graph of Figure 61 below.



**Figure 61** Bar graph showing dialect means for endpoint jitter. Error bars represent  $\pm 1$  standard deviation(s).

### 3.7.3.2 Jitter perturbation

As explained above, jitter perturbation is a normalized jitter figure which consists of the measure of jitter at vowel endpoint less the measure of jitter at vowel midpoint. A positive jitter perturbation result indicates jitter is greater at the vowel endpoint.

To investigate the effects of word-final glottal stops on jitter perturbation, a one-factor ANOVA was utilized, with Jitter perturbation as the dependent variable, and Glottalization was the independent variable (Glottal, Plain). Results indicate that there

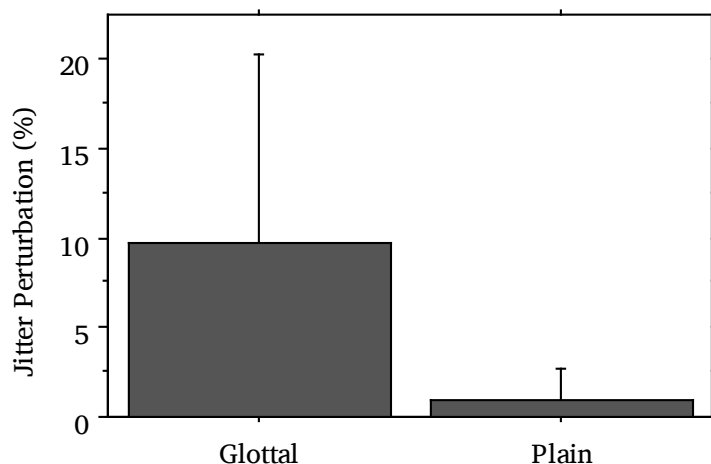
was a significant effect of final glottal stops on jitter perturbation for every speaker. Jitter perturbation values were positive, indicating a rise in jitter from vowel midpoint to offset. Even though all vowels yielded positive jitter perturbation results, the means for vowels before glottal stops were significantly greater than the means of vowels in open syllable. Numeric results are given in Table 68 below.

**Table 68** Jitter perturbation means, standard deviations, and significance results for individual speakers.

SPEAKER	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV	MEAN	ST DEV	
DF3	[áʔ]	7.16 (4.0)	[à]	1.12 (1.7)	F[1,53] = 53.205, p < .0001
DM4	[áʔ]	4.75 (3.8)	[à]	2.20 (2.0)	F[1,53] = 9.799, p = .0028
HF2	[àʔ]	6.50 (5.9)	[á]	0.89 (2.8)	F[1,55] = 22.136, p < .0001
HM1	[àʔ]	9.74 (10.5)	[á]	0.97 (1.7)	F[1,38] = 12.295, p = .0012

What is also notable in the table above is the high variation for each speaker, specifically for the set of vowels preceding glottal stops, as was found to be the case for jitter at vowel endpoint.

HM1 shows the highest jitter perturbation score for his pre-glottal stop vowels (9.47%,  $s = 10.5$ ). This is significantly higher than his plain vowels (0.97%,  $s = 1.7$ ). Means for HM1 are graphically presented in the bar graph of Figure 62.



**Figure 62** Bar graph showing means for Jitter perturbation, speaker HM1. Error bars represent  $\pm 1$  standard deviation(s).

The long error bar for the glottal measures represents the high standard deviation (10.5) for this speaker. The jitter figure at vowel offset for HM1's plain vowels is quite small in comparison to his vowels preceding glottal stops, indicating more regularity in the glottalic cycles of his plain vowels. Additionally, the jitter perturbation values for his plain vowels show considerably less variation.

Word-final glottal stops also had a significant effect on jitter perturbation for speaker DM4; however, DM4 shows noticeably less variation in his vowels preceding glottal stops. He shows a significant difference between mean jitter at the endpoint of vowels that precede glottal stops (4.75%, 3.8) and the vowels in open syllables (2.20%,  $s = 2.0$ ). Figure 63 offers a bar graph of his results.

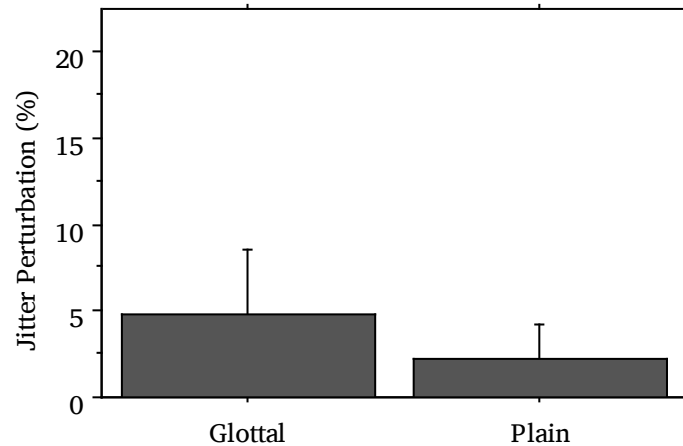


Figure 63 Bar graph showing means for jitter perturbation, speaker DM4. Error bars represent  $\pm 1$  standard deviation(s).

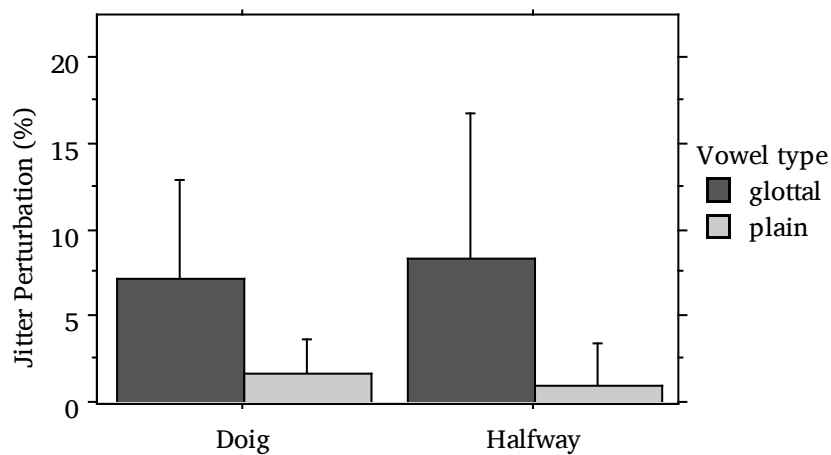
Means for DM4 do not diverge as greatly as those of HM1; however, they are significantly different.

For each speaker, there was significantly increased irregularity in glottal pulses from vowel midpoint to vowel endpoint. To determine the possibility of a pattern based on the tone of the target vowel, I offer the means grouped by dialect in Table 69.

Table 69 Jitter perturbation means and standard deviations for the two dialect groups. Measures are (%).

DIALECT	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)	
	MEAN	ST DEV	MEAN	ST DEV
Doig	[áʔ] 5.93%	(4.0)	[à] 1.65%	(1.9)
Halfway	[àʔ] 8.00%	(8.4)	[á] 0.91%	(2.4)

Halfway speakers in this study produced increased jitter in vowels preceding glottal stops than did the Doig speakers. Note the high level of variation, indicated by the large error bars in Figure 64, especially in the glottal set.



**Figure 64** Bar graph showing dialect means for Jitter perturbation. Error bars represent  $\pm 1$  standard deviation(s).

The effect of word-final glottal stops on jitter perturbation manifest in the following way: all speakers showed significant increases in irregularity of glottal pulses from vowel midpoint to endpoint in vowels preceding glottal stops.

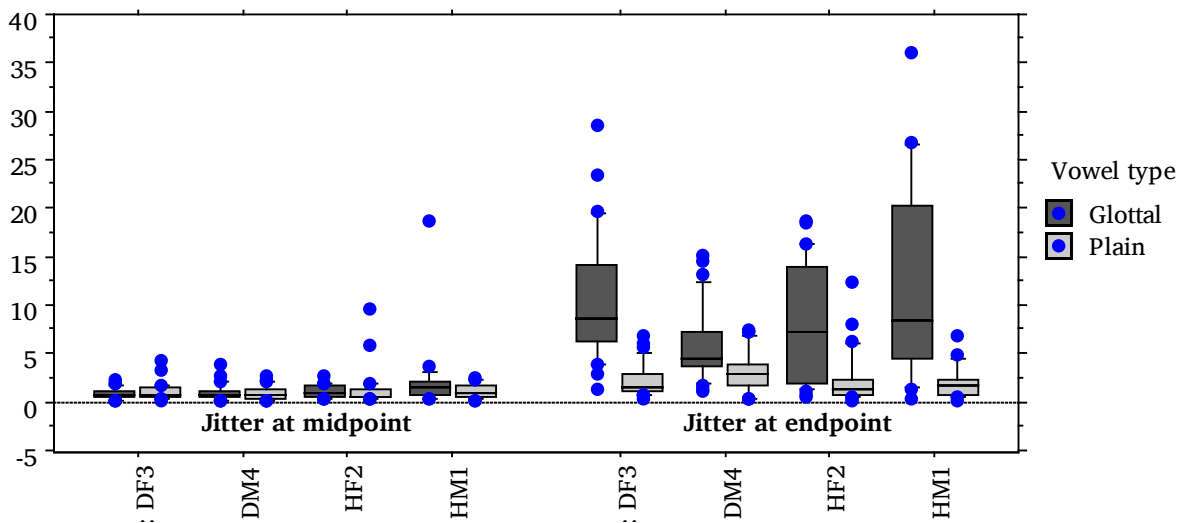
### 3.7.3.3 Jitter summary

Local effect of word-final glottal stop on jitter was significantly different for vowels preceding glottal stops than for plain vowels. This effect was higher jitter for all four speakers. The irregularity of glottal pulses significantly increased from vowel midpoint to endpoint. Table 70 provides the summary for local and normalized effects.

**Table 70 Local (vowel endpoint) and normalized (perturbation) effects of glottalization on jitter.**  
**Bolded, italicized text indicates statistical significance.**

DIALECT	SPEAKER	JITTER ENDPOINT	JITTER PERTURBATION
Doig	DF3	<i><b>jitter higher before ?</b></i>	<i><b>jitter increases before ?</b></i>
	DM4	<i><b>jitter higher before ?</b></i>	<i><b>jitter increases before ?</b></i>
Halfway	HF2	<i><b>jitter higher before ?</b></i>	<i><b>jitter increases before ?</b></i>
	HM1	<i><b>jitter higher before ?</b></i>	<i><b>jitter increases before ?</b></i>

To summarize, jitter at vowel offset and jitter perturbation were significantly greater in vowels preceding glottal stops than in vowels of open syllables. The box plot in Figure 65 offers a look at the jitter means at midpoint and endpoint for comparison across all speakers.



**Figure 65 Boxplot showing individual means for jitter at midpoint and endpoint for vowels preceding glottal stops and plain vowels. Dots indicate outliers in the top 90<sup>th</sup> and bottom 10 percentiles. Error bars represent  $\pm 1$  standard deviation(s). Measures are (%).**

Jitter values at vowel midpoint, regardless of the presence of a word-final glottal stop, were very low, indicating regularly spaced glottal pulses and very low jitter values, resulting in significant increases in jitter from vowel midpoint to offset. The significant jitter perturbation results for all speakers show a clear effect of word-final glottal stop on preceding vowels. Jitter at vowel endpoint, on the other hand, showed higher jitter, thus greater irregularity in the glottal pulses, particularly in vowels preceding glottal stops, confirming a significant local effect on jitter.

#### *3.7.4 Spectral tilt*

Spectral tilt is a measurement which allows for the characterization of voice quality by calculating differences in amplitude between the higher harmonics of a speech signal from the lower harmonics. Formulas for calculating spectral tilt include calculating the difference between the second and first harmonic ( $H2-H1$ ), the first formant and the first harmonic ( $F1-H1$ ), and the second formant and the first harmonic ( $F2-H1$ ).

It is expected that for each of the spectral tilt measurements the spectral tilt values will be greater for creaky or tense voicing than for modal voicing, as laryngealization is known to “tilt the spectrum up”. For creaky and tense voicing, the higher harmonics will have greater amplitude than the lower harmonics. If the difference in amplitude between the two harmonics were close to zero, it would indicate modal voicing. If the lower harmonics had greater amplitude than the higher

harmonics, the voicing would be more breathy (Gordon & Ladefoged, 2001; Jackson et al., 1985; Kirk, et al., 1984; Maddieson & Ladefoged, 1985). Additionally, for vowels produced with tense phonation, F1 tends to be higher than in lax vowels (Kuang & Keating, 2012).

In his investigation of phonation in Tanacross, Holton (2000) found that in the case of the H-marked syllables, there was generally greater energy in the higher harmonics than the lower. For these syllables (F1-H1) values were positive. The unmarked syllables showed less energy in the higher harmonics manifesting in a negative, or close to zero (F1-H1) value. These differences were significant.

In her investigation of effects of word-final glottal stops on spectral tilt in the non-tonal Athabaskan language Witsuwit'en, Hargus (2007) found that for nine of the ten speakers, there was a significant difference in the spectral tilt of vowels preceding glottal stops than that of the plain vowels. Using the formula  $(H1-H2)$ , Hargus found that of those nine speakers, six showed a negative spectral tilt value, signifying greater energy in the higher harmonics at vowel endpoint than at vowel midpoint, indicating creaky voicing. Three speakers yielded positive spectral tilt values. These positive values were due to lower energy in the higher harmonics at vowel endpoint than at vowel midpoint, signifying more breathiness. At vowel midpoint, spectral tilt values were significantly different preceding a glottal stop for two of the nine speakers. In

both cases, there was significantly more energy in the higher harmonics, demonstrating increased creakiness.

In her study of Deg Xinag, (Hargus, In progress), results for spectral tilt perturbation showed that for four of the seven speakers, there was significantly greater spectral tilt perturbation for vowels preceding glottal stops than for plain vowels. These negative spectral tilt values indicate an increase in creaky voicing before the glottal stops. For two of the seven speakers, there was a positive spectral tilt, indicating a decrease in creakiness from midpoint to endpoint of vowels before glottal stops. This decrease was significant for both speakers.

In this section, I explore effects of word-final glottal stops on two measures of spectral tilt (H2-H1) and (F1-H1). The specific research questions are provided below in (14).

**(14) Research question for effect of word-final glottal stop on spectral tilt, both (H2-H1) and (F1-H1):**

- a) What are the effects of word-final glottal stop on the spectral tilt, at vowel offset? (Local effects)
- b) Does the presence of a word-final glottal stop affect a significant change in spectral tilt from vowel midpoint to endpoint? (Normalized, or perturbation effects)

Based on Holton's (2000) findings, I would predict that at the vowel endpoint the H-marked vowels preceding glottal stops for Doig would yield positive spectral tilt

values, signifying tense voicing, essentially phonation indicating more glottal stricture than modal voicing, but with a higher F0 than creaky phonation. The L-unmarked vowels in open syllables would show negative or close to zero spectral tilt values. As for the L-marked Halfway pre-glottal stop vowels, I would also expect there to be non-modal phonation. In this case, the outcome would be creaky voicing, as it is more common for creaky voicing to be associated with low F0 (Gobl & Ní Chasaide, 2010; Gordon, 2001; Laver, 1980). Halfway H unmarked open syllable vowels would yield similar spectral tilt results as Doig's L unmarked vowels.

The results Hargus uncovered for pitch lowering and pitch raising before glottal stops in the non-tonal Witsuwit'en and Deg Xinag languages lend credence to the theory that word-final glottal stops can influence F0 in any direction, particularly at vowel offset. I could take this one step further and hypothesize that the tone category of the preceding vowel in an Athabaskan tonal language does not dictate whether there is creaky voicing, rather creaky phonation may, or may not, occur on any vowel followed by a glottal stop.

In order to collect measurements of spectral tilt, a Fast Fourier Transform (FFT) and Linear Predictive Coding (LPC) were generated using Multi-Speech for each vowel midpoint and endpoint target locations. Each spectral slice was generated from a

selection measuring a minimum of 30 ms.<sup>34</sup> As mentioned in Section 3.6.3, the audio files used in this analysis had a sampling rate of 11kHz, thus the Nyquist frequency was 5,500. As a result, the LPC smoothing was set to 5 peaks, approximately 1 per 1,000 Hz. For this investigation, I focused on two spectral tilt measures, (H2-H1) and (F1-H1) for a comparison of their ability to capture the audible creakiness which was heard.

Measurements of H1, H2 and F1 were taken by hand from the analysis window containing the FFT and LPC. Within this window, the y-axis displayed the amplitude in dB, the x-axis displayed the frequency in Hz. As the first harmonic (H1) denotes the fundamental frequency, its location in the spectrum was confirmed by matching the frequency displayed in the FFT window to that of the pitch track within the spectrogram window. H2 is approximately twice the frequency of H1, which guided where I measured the amplitude for H2. The LPC aided in locating F1, as this formant typically correlates to the first free-standing peak in the LPC.

To begin, I present the waveform and spectrogram in Figure 66 for the token [já?] ‘louse’ for speaker DF3, a female speaker of the Doig dialect. Recall that the

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<sup>34</sup> Recall that all measurements for this chapter were taken simultaneously, using the same analysis window. As noted in the section on jitter, the analysis window was set at 30ms, unless there were not enough voice period points (typically three) to calculate jitter. In these situations, the analysis window was increased until 3 points could be analyzed.

target vowel carries a marked H tone. In the spectrogram, note the regularly spaced glottal pulses up to the very end of the vowel, at which point the pulses become wider spaced. The higher formants are somewhat fuzzy and relatively lighter, indicating less intensity.

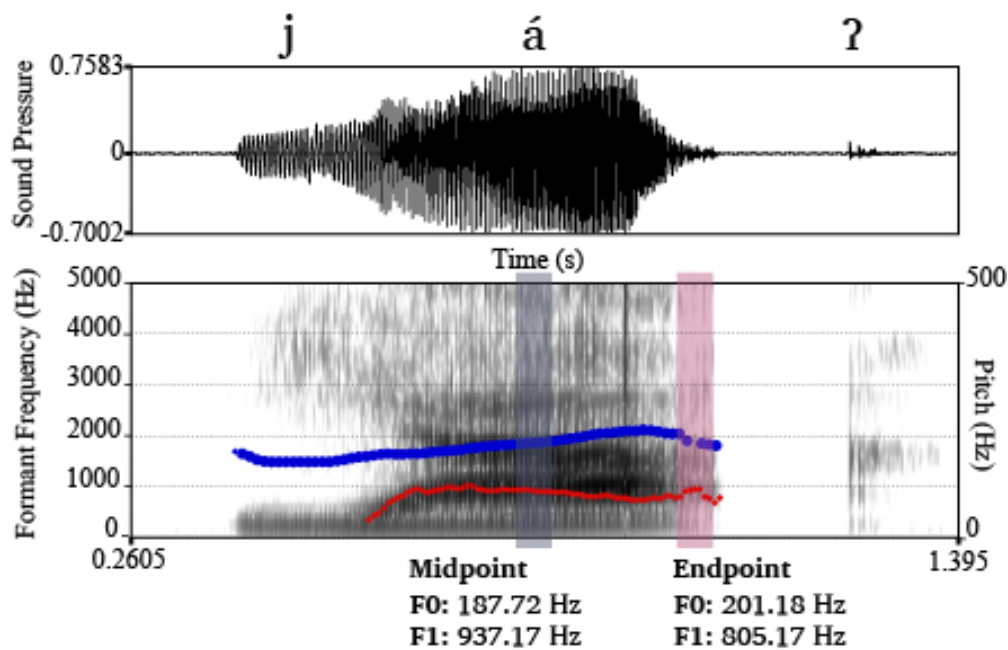


Figure 66 Waveform and spectrogram of token [já?] ‘louse’, 2nd repetition, speaker DF3. Pitch track denoted by blue dotted line; first formant represented by red dotted line.

This token shows modal phonation up to the point at which the higher formants lose intensity, voicing fades out, and the glottal pulses become irregular. In the waveform there is evidence of slight frication.

In Figure 67, I provide the spectra for the endpoint and midpoint locations of the above token for speaker DF3. H1, H2 and F1 are highlighted and the associated

measurements are provided for both the x- and y-axes. The amplitude measured along the y-axis is the target value for determining spectral tilt.

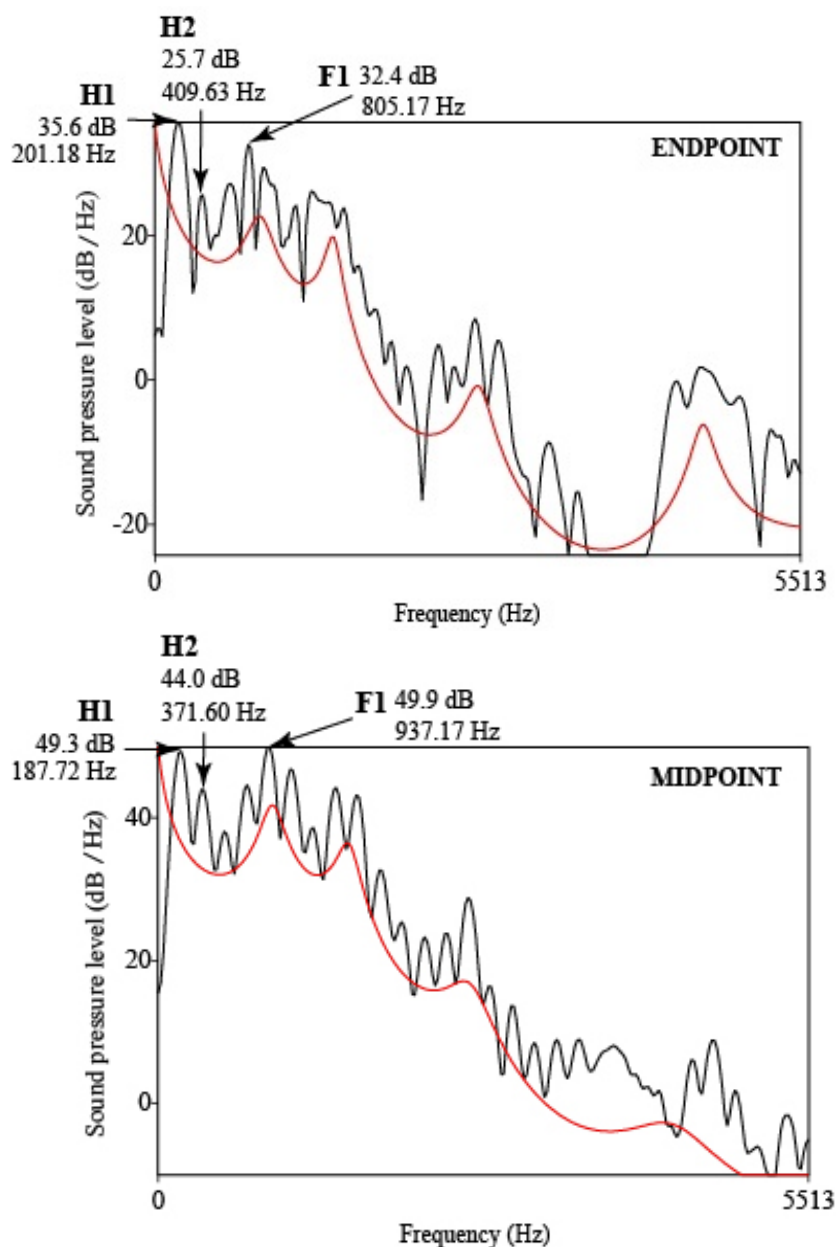


Figure 67 FFT and LPC of DF3's glottal vowel at ENDPOINT (top) and MIDPOINT (bottom), token [jáʔ] 'louse', 2<sup>nd</sup> repetition. The fundamental frequency (H1), the second harmonic (H2) and the first formant (F1) are highlighted.

The peaks in these spectra denote the harmonics. In the endpoint spectrum (top graphic) the first peak signifying H1, has a frequency 201.18 Hz, confirmed by the pitch track in an accompanying spectrogram. The amplitude at this point was 35.6 dB. H2, the peak with a frequency roughly twice that of H1, displayed an amplitude of 25.7 dB. The red line with five peaks overlaying each spectrum represents the LPC; the second peak (or the first free-standing peak) typically aligns with the frequency location of the first formant (F1).

In the midpoint spectrum (bottom graphic), H1 has an amplitude of 49.3 dB, H2, an amplitude of 44.0 dB, and the first formant has an amplitude of 49.9 dB. Table 71 steps through the process of calculating spectral tilt and spectral tilt perturbation from H1 and H2 measures.

**Table 71** Examples from DF3, token [já?] ‘louse’, 2<sup>nd</sup> repetition, showing how spectral tilt (Step I) and spectral tilt perturbation (Step II) was calculated using the (H2-H1) formula.

		H2	-	H1	=	SPECTRAL TILT
STEP I:	ENDPOINT	25.7 dB	-	35.6 dB	=	-9.9 dB
	MIDPOINT	44.0 dB	-	49.3 dB	=	-5.3 dB
		SPECTRAL TILT <sub>ENDPOINT</sub>	-	SPECTRAL TILT <sub>MIDPOINT</sub>	=	SPECTRAL TILT <sub>PERTURBATION</sub>
STEP II:		-9.9 dB	-	-5.3 dB	=	-4.6 dB

The negative values for DF3’s (H2-H1) spectral tilt at vowel offset (-9.9 dB) and vowel midpoint (-5.3 dB) indicate that there was more energy in the lower harmonics

for both locations. This is indicative of more lax voicing. The method of calculating spectral tilt perturbation is to subtract the spectral tilt taken at vowel midpoint from that taken from vowel endpoint. In this case, the (H2-H1) perturbation value is -4.6 dB for DM3's token [jáʔ] 'louse'.

In order to compare the two spectral tilt formulas, I have included the process for (F1-H1) in Table 72 below.

**Table 72** Examples from DF3, token [jáʔ] 'louse', 2<sup>nd</sup> repetition, showing how spectral tilt (Step I) and spectral tilt perturbation (Step II) was calculated using the (F2-H1) formula.

		F1		H1		SPECTRAL TILT
STEP I:	ENDPOINT	32.4 dB	-	35.6 dB	=	-3.2 dB
	MIDPOINT	49.9 dB	-	49.3 dB	=	0.6 dB
		$\text{SPECTRAL TILT}_{\text{ENDPOINT}} - \text{SPECTRAL TILT}_{\text{MIDPOINT}} = \text{SPECTRAL TILT}_{\text{PERTURBATION}}$				
STEP II:		-3.2 dB	-	0.6 dB	=	-3.8 dB

Using (F1-H1), the endpoint and midpoint spectral tilt values are -3.2 dB and 0.6 dB, respectively. Both the (H2-H1) and (F1-H1) formulas yield a lower spectral tilt value for the endpoint than for the midpoint, resulting in negative perturbation values. For the (F1-H1) formula, the perturbation is -3.8 dB.

Revisiting the above examples for spectral tilt perturbation, DF3 had a negative (H2-H1) perturbation value of -4.6 dB. DF3's (F1-H1) perturbation was similar, -3.8dB. These negative scores are indicative of an increase in the amount of lax phonation from

the vowel midpoint to its offset. Similarly stated, DF3 moved from close to modal phonation at the vowel midpoint, to increased lax voicing at the vowel endpoint. In this case, both formulas successfully captured what was evident in the spectrogram and waveform of Figure 66.

The following sections present individual results for spectral tilt taken at vowel endpoint. This is followed by results for spectral tilt perturbation, investigating normalized effects of the following glottal stop. In each section results for (H2-H1) will be presented first, followed by results for (F1-H1).

#### 3.7.4.1 Spectral tilt at vowel endpoint

##### 3.7.4.1.1 (H2-H1) Spectral tilt at endpoint

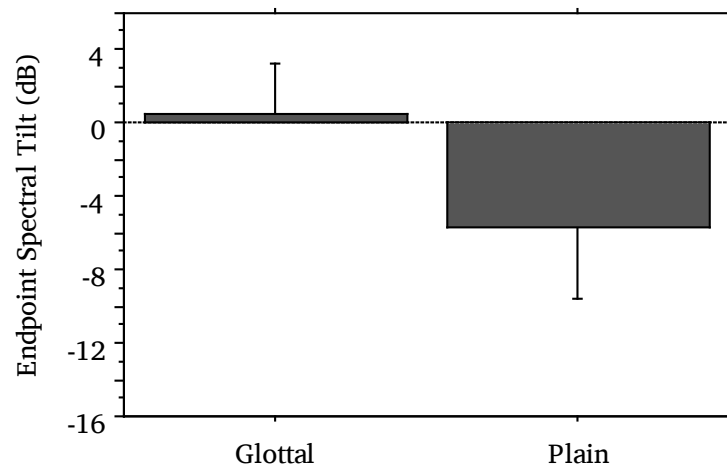
Results of a factorial ANOVA (Endpoint Spectral Tilt (H2-H1) x Glottalization) indicated significant differences for all four speakers between the endpoint spectral tilt of vowels followed by a glottal stop and those in open syllables. All speakers had the same pattern of higher spectral tilt values for the vowels preceding glottal stops than for the vowels in open syllables. Means and variance for each speaker is presented below in Table 73.

**Table 73** Endpoint spectral tilt (H2-H1) means, standard deviations, and significance results for individual speakers. Measures are (dB). Shaded cell indicates positive spectral tilt.

SPEAKER	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV	MEAN	ST DEV	
DF3	[áʔ] -6.52	(4.8)	[à] -10.41	(3.0)	F[1,53] = 13.346, p = .0006
DM4	[áʔ] -1.22	(2.0)	[à] -9.62	(4.1)	F[1,53] = 95.979, p < .0001
HF2	[àʔ] 0.52	(2.7)	[á] -5.67	(4.1)	F[1,55] = 46.457, p < .0001
HM1	[àʔ] -2.80	(3.7)	[á] -10.00	(5.0)	F[1,38] = 27.933, p < .0001

Plain vowels for all speakers showed a negative spectral tilt value; these figures were all lower than the glottal vowel counterparts. All speakers produced more lax phonation in the plain vowels at the vowel endpoint. As for the vowels preceding glottal stops, three of the speakers (DM4, HF2, HM1) produced phonation that was more modal. DF3's glottal vowels at the endpoint showed lax phonation.

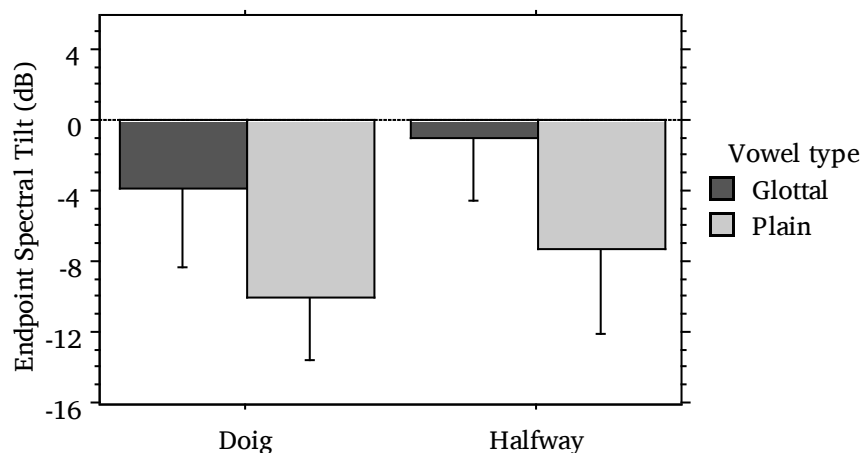
An exemplar of the pattern of higher endpoint spectral tilt values for the vowels preceding glottal stops can be seen in the bar graph of Figure 68, showing means from speaker HF2.



**Figure 68** Bar graph showing means for spectral tilt (H2-H1) at endpoint, speaker HF2. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB).

The plain vowels of HF2 yielded a spectral tilt value of -5.67 ( $s = 4.1$ ), indicating that the lower harmonics had higher amplitude than the higher harmonics, thus more lax phonation. Vowels preceding glottal stops, however, show a positive spectral tilt of 0.52, ( $s = 2.7$ ). This signifies that there was more energy in H2 than H1, demonstrating more modal or even slightly tense voicing.

To explore any emergent patterns based on dialect, pooled measures are offered in Figure 69 below.



**Figure 69** Bar graph showing group means for spectral tilt (H2-H1) at endpoint, separated by dialect. Error bars represent  $\pm 1$  standard deviation(s). Measures are in (dB).

Doig speakers had a mean spectral tilt value of -3.82 ( $s = 5$ ) for the endpoint of vowels preceding glottal stops. Doig plain vowels had a mean of -10.02 ( $s = 3.5$ ). Halfway speakers showed a similar pattern with glottal vowels showing a mean spectral tilt of -1.00 ( $s = 3.6$ ) and the much lower -7.28 ( $s = 4.8$ ) for the plain vowels. Speakers of both dialects produced more lax phonation at the endpoint of vowels in open syllables than in those preceding glottal stops.

#### 3.7.4.1.2 (F1-H1) Spectral tilt at endpoint

Looking at the second spectral tilt measure, (F1-H1), results of a factorial ANOVA also indicated significant differences for all four speakers. Every individual had higher spectral tilt values for their vowels that precede glottal stops than for their vowels in open syllables. For the two Doig speakers, spectral tilt measures were positive, for the

Halfway speakers, these vowels had negative spectral tilt values. I provide the means for all speakers below in Table 74.

**Table 74 Endpoint spectral tilt (F1-H1) means, standard deviations, and significance results for individual speakers. Measures are (dB). Shaded cells indicate positive spectral tilt.**

SPEAKER	GLOTTAL (MARKED TONE)			PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV		MEAN	ST DEV	
DF3	[áʔ] 4.53	(5.08)		[à] -10.83	(5.5)	F[1,53] = 115.259, p < .0001
DM4	[áʔ] 1.83	(4.8)		[à] -14.18	(4.3)	F[1,53] = 169.527, p < .0001
HF2	[àʔ] -1.33	(5.4)		[á] -10.92	(6.1)	F[1,55] = 39.039, p < .0001
HM1	[àʔ] -0.44	(7.7)		[á] -10.76	(4.8)	F[1,38] = 24.711, p < .0001

The two Doig speakers had positive spectral tilt values, indicating more modal or even tense voicing in vowels before the glottal stop. DM4, for example, had a mean of 1.83,  $s = 4.8$  for his pre-glottal stop vowels, signifying slightly tense voicing. He had the lowest spectral tilt value of the plain vowels, -14.18,  $s = 4.3$ , indicating lax phonation.

HF2, on the other hand, had negative spectral tilt values both in her vowels before glottal stops, -1.33,  $s = 5.4$  and in her plain vowels, -10.92,  $s = 6.1$ . These negative results for HF2 indicate that there was a decrease in energy in her higher harmonics, indicating lax voicing. Bar graphs for both DM4 and HF2 are offered in Figure 70.

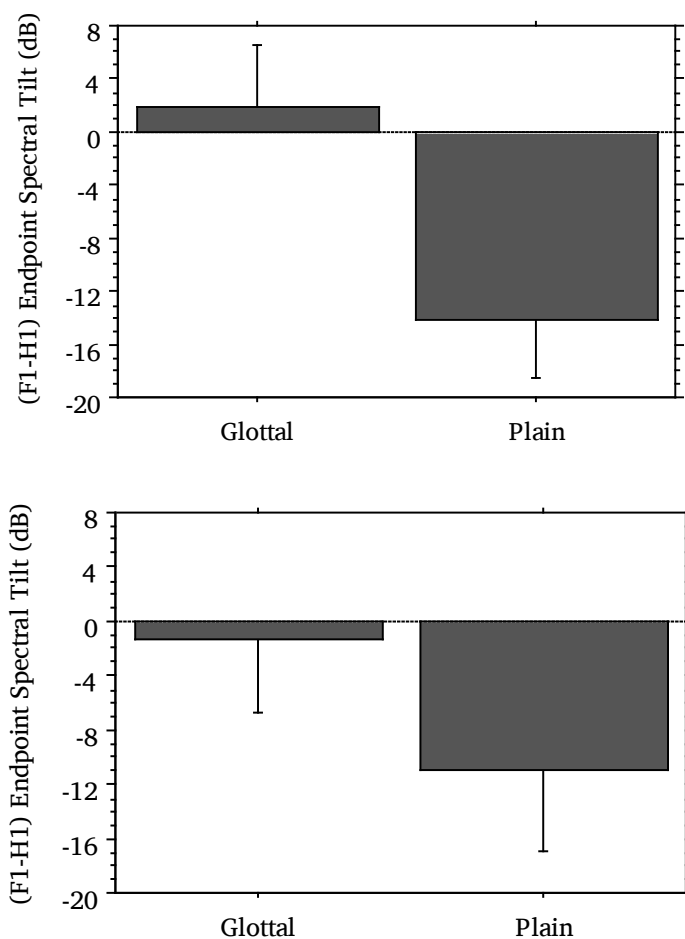
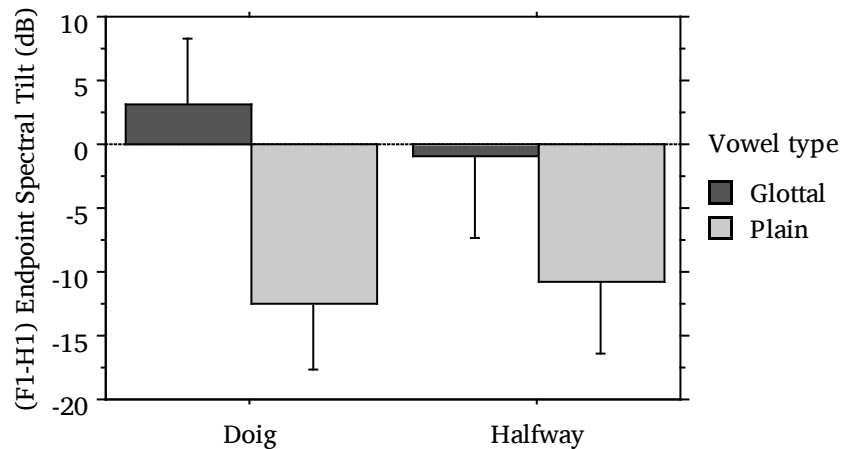


Figure 70 Bar graph showing means for spectral tilt (F1-H1) at endpoint, speakers DM4 (top) and HF2 (bottom). Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB)

For both speakers, the pre-glottal stop vowels had higher spectral tilt values than their plain vowel counterparts. For speaker DM4, vowels preceding glottal stops had somewhat more tense phonation. For HF2, these vowels had somewhat more lax phonation.

Looking at the means based on dialect, I present a bar graph of the two vowel sets, separated by dialect below in Figure 71.



**Figure 71** Bar graph showing dialect means for spectral tilt (F1-H1) at endpoint. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB)

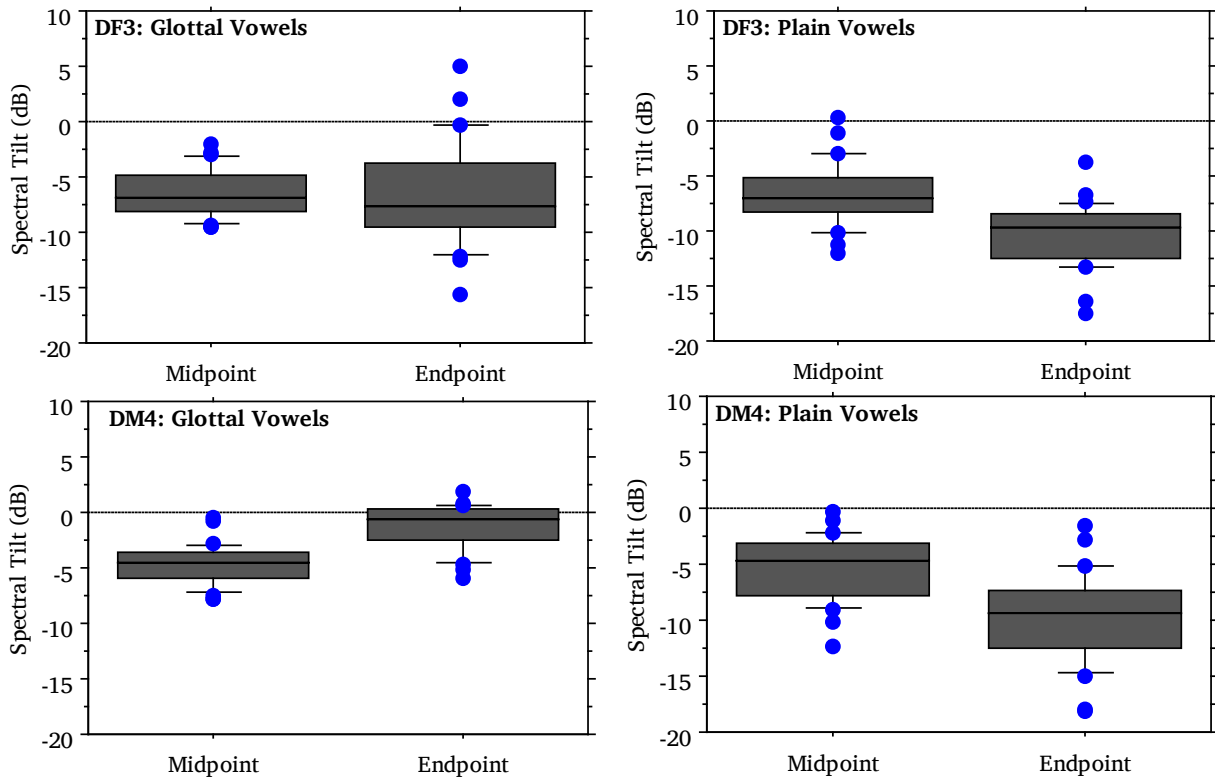
As with the (H2-H1) measure, both dialects produced higher endpoint means for the vowels preceding glottal stop than for the vowels in open syllables. In this case, however, Doig had a positive spectral tilt mean for these vowels, 3.19,  $s = 5.1$ . Halfway had a negative mean, -0.92,  $s = 6.5$ . At the endpoint of the pre-glottal stop vowels, Doig produced more tense voicing than in their plain vowels, -12.47,  $s = 5.2$ ; Halfway produced more modal voicing in these vowels than in their plain vowels, -10.86,  $s = 5.6$ .

### 3.7.4.2 Spectral tilt perturbation

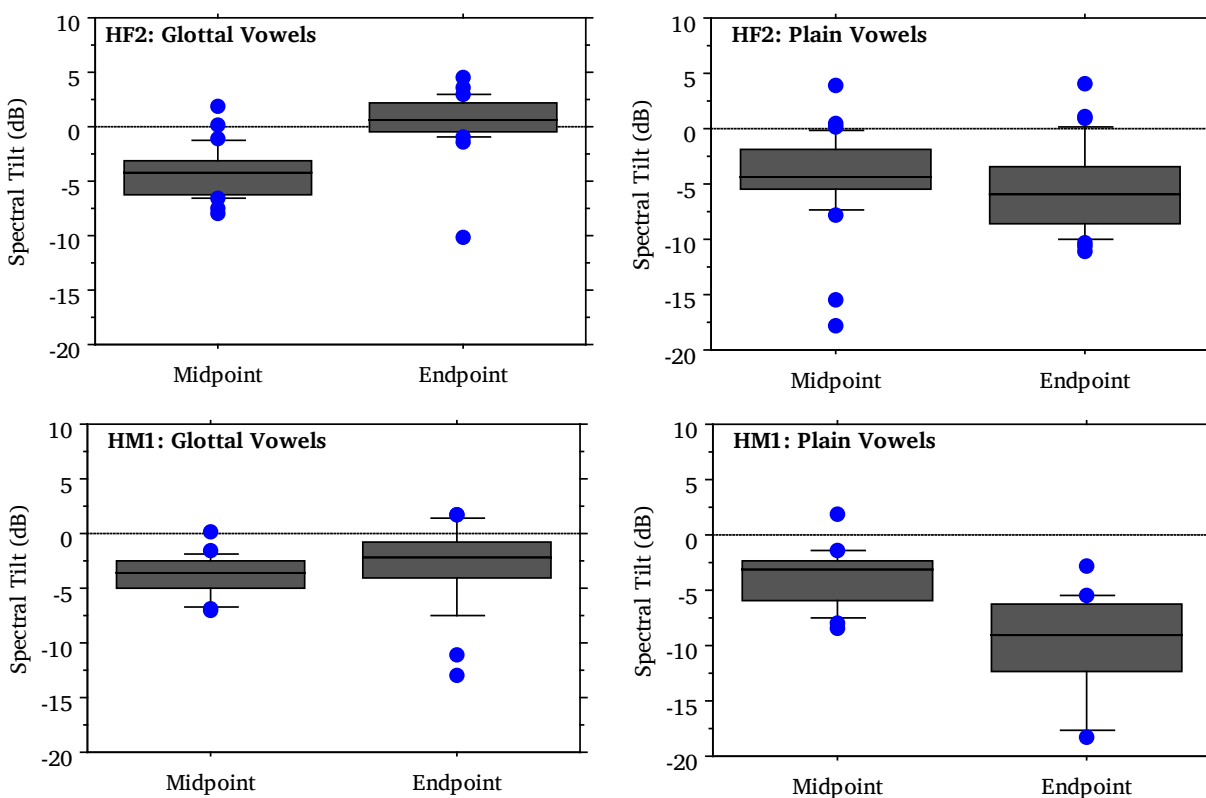
#### 3.7.4.2.1 (H2-H1) Spectral tilt perturbation

Spectral tilt perturbation, as mentioned above, is a measure to quantify the change in phonation from vowel midpoint to its offset. A positive perturbation value indicates an increase in tense voicing from the midpoint of the vowel to the endpoint. Values close to zero mean that little change in the spectral tilt occurred. A negative spectral tilt result designates an increase in lax voicing.

Before presenting the perturbation results, I offer a graphic summary of the spectral tilt means for each speaker. Side-by-side boxplots compare the two locations for measurement for each vowel type. The first set in Figure 72 provides means for the Doig speakers; the second in Figure 73 offers the means for the Halfway speakers.



**Figure 72** Boxplot showing means for spectral tilt (H2-H1) taken at vowel midpoint and endpoint. H-marked Doig speakers represented. Measures are (dB), error bars represent  $\pm 1$  standard deviation(s), dots denote to outlier measures.



**Figure 73** Boxplot showing means for spectral tilt (H2-H1) taken at vowel midpoint and endpoint. L-marked Halfway speakers represented. Measures are (dB), error bars represent  $\pm 1$  standard deviation(s), dots denote to outlier measures.

A general pattern emerges when looking at the spectral tilt measures from the two vowel locations. For the vowels before glottal stops, the endpoint spectral tilt is higher than that of the midpoint, with the exception of DF3. The plain vowels show mirror-image results; endpoint spectral tilt means are consistently lower than those at vowel midpoint.

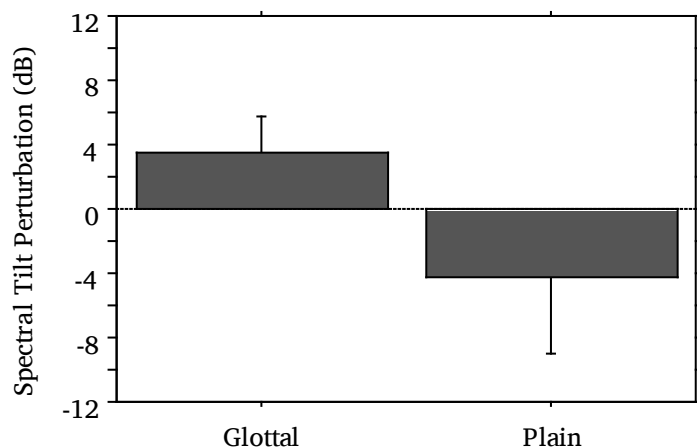
In the one-factor ANOVA analysis, results indicate that for all speakers, Glottalization had a significant effect on Spectral tilt perturbation. Three speakers

(DM4, HF2, HM1) showed positive spectral tilt perturbation means for their glottal vowels. This is indicative of an increase in tense voicing from the midpoint of the vowel to the endpoint. DM3 showed a very slight increase in lax phonation. All four speakers had negative perturbation means for their plain vowels, indicating increased lax phonation from vowel midpoint to endpoint. Means for all speakers are provided in Table 75.

**Table 75 Spectral tilt (H2-H1) perturbation means, standard deviations, and significance results for individual speakers. Measures are (dB). Shaded cells indicate positive spectral tilt.**

SPEAKER	GLOTTAL (MARKED TONE)			PLAIN (UNMARKED TONE)			SIGNIFICANCE
	MEAN	ST DEV		MEAN	ST DEV		
DF3	[áʔ]	-0.10	(5.3)	[à]	-3.76	(3.4)	F[1,53] = 9.493, p = .0033
DM4	[áʔ]	3.47	(2.3)	[à]	-4.23	(4.7)	F[1,53] = 59.365, p < .0001
HF2	[àʔ]	4.80	(3.4)	[á]	-1.22	(4.8)	F[1,55] = 28.917, p < .0001
HM1	[àʔ]	1.00	(4.0)	[á]	-6.32	(4.4)	F[1,38] = 29.817, p < .0001

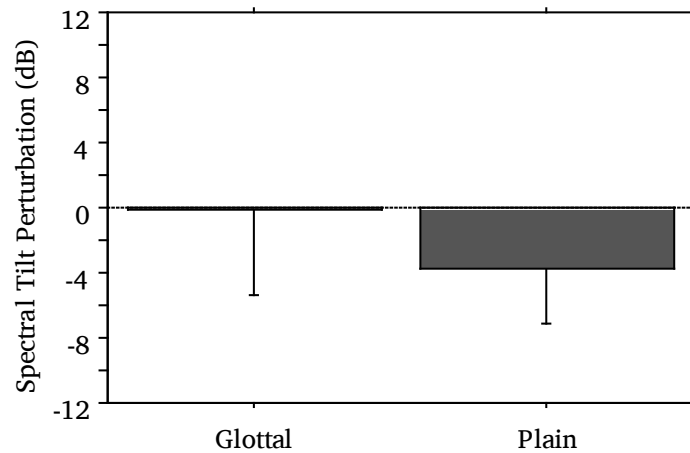
Figure 74 provides the means for speaker DM4, who exemplifies the pattern of a positive spectral tilt perturbation value for the vowels before glottal stops and a negative value for the vowels in open syllables.



**Figure 74** Bar graph showing means for spectral tilt (H2-H1) perturbation, speaker DM4. Measures are (dB), error bars represent  $\pm 1$  standard deviation(s).

For speaker DM4 as well as speakers HF2 and HM1, there was a significant rising of spectral tilt perturbation in vowels preceding glottal stops. The positive perturbation value indicates an increase in tense voicing from the midpoint of the vowel to the endpoint.

The bar graph in Figure 75 provides means for speaker DF3, who shows a negative spectral tilt perturbation for vowels preceding glottal stops; differences between vowel types remain significant.



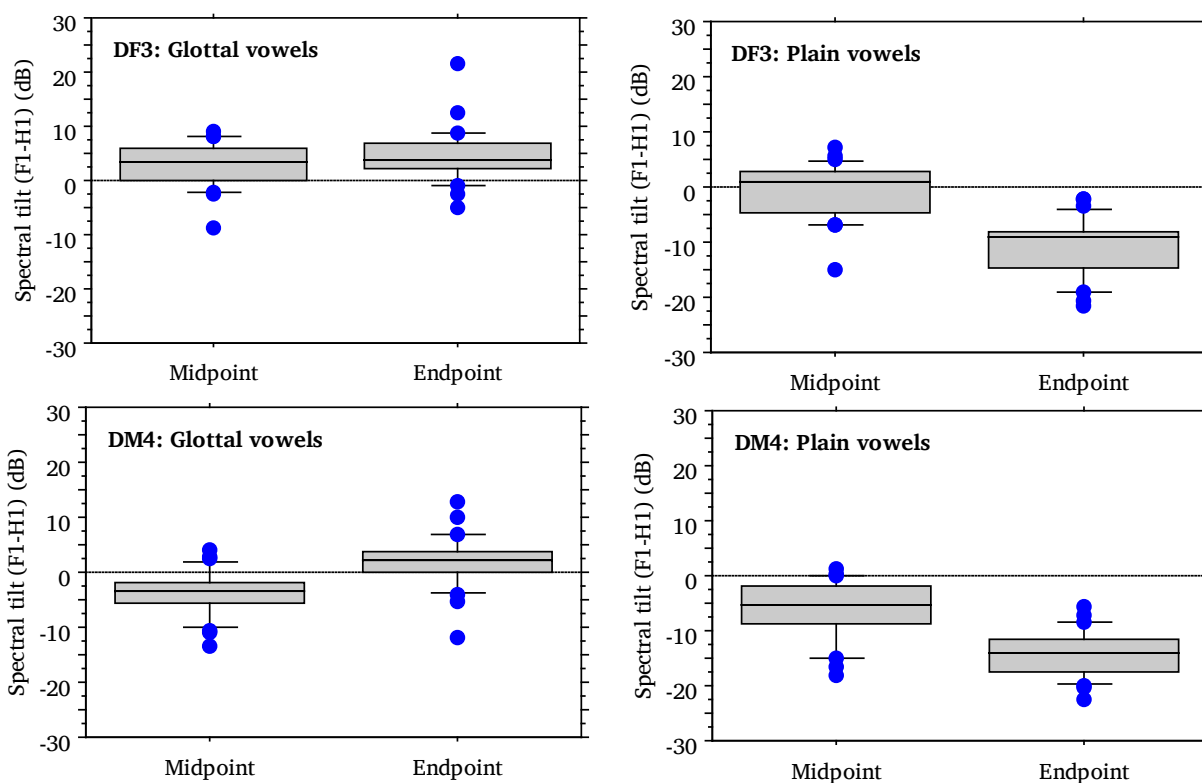
**Figure 75** Bar graph showing means for spectral tilt (H2-H1) perturbation, speaker DF3. Measures are (dB), error bars represent  $\pm 1$  standard deviation(s).

DF3 is an outlier from the group; her glottal vowels show a negative mean for perturbation, though the expected pattern of vowels preceding glottal stops showing a higher level of spectral tilt perturbation still holds, indicating a significant difference between her this set of vowels, -0.10, ( $s = 5.3$ ) and her plain vowels, -3.76 ( $s = 3.4$ ).

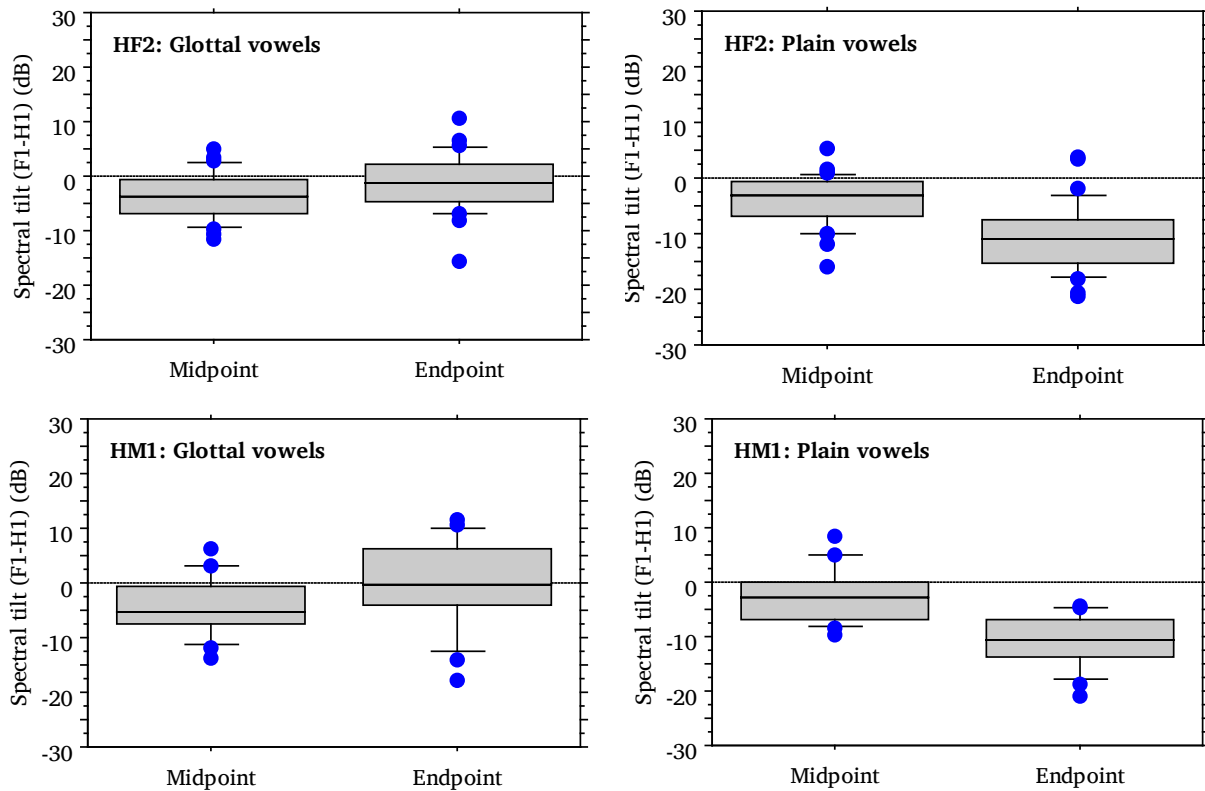
Means based on dialect did not reveal anything noteworthy. The two groups had similar spectral tilt perturbation patterns. Both had positive perturbation values for the glottal vowels.

## 3.7.4.2.2 (F1-H1) Spectral tilt perturbation

Before moving on to the results for (F1-H1) spectral tilt perturbation, I present box plots of the (F1-H1) means taken at vowel midpoint and vowel offset in Figure 76 and Figure 77.



**Figure 76** Boxplot showing means for spectral tilt (F1-H1) taken at vowel midpoint and endpoint. H-marked Doig speakers represented. Measures are (dB), error bars represent  $\pm 1$  standard deviation(s), dots denote to outlier measures.



**Figure 77** Boxplot showing means for spectral tilt (F1-H1) taken at vowel midpoint and endpoint. L-marked Halfway speakers represented. Measures are (dB), error bars represent  $\pm 1$  standard deviation(s), dots denote to outlier measures.

The same pattern emerges in the (F1-H1) measure as we saw in the (H2-H1) measure. In the vowels preceding glottal stops, means were higher at vowel endpoint than midpoint. For plain vowels, the endpoint means were lower than the midpoint means.

To explore differences in spectral tilt that occur from vowel midpoint to vowel offset, I provide individual perturbation means and significance results for the one-factor ANOVA (Glottalization x (F1-H1) Spectral tilt perturbation) in Table 76.

**Table 76 Spectral tilt (F1-H1) perturbation means, standard deviations, and significance results for individual speakers. Measures are (dB). Shaded cells indicate positive spectral tilt.**

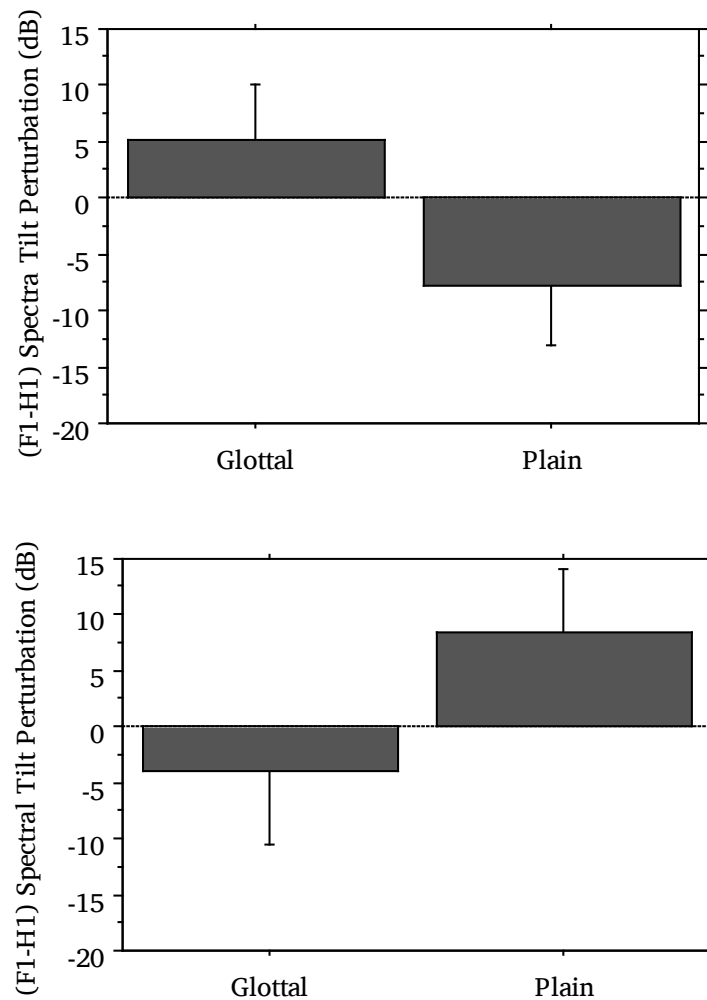
SPEAKER	GLOTTAL (MARKED TONE)		PLAIN (UNMARKED TONE)		SIGNIFICANCE
	MEAN	ST DEV	MEAN	ST DEV	
DF3	[áʔ] 1.85	(5.7)	[à] -9.92	(6.8)	F[1,53] = 48.101, p < .0001
DM4	[áʔ] 5.19	(4.9)	[à] -7.86	(5.2)	F[1,53] = 91.461, p < .0001
HF2	[àʔ] -2.41	(4.5)	[á] 6.98	(5.6)	F[1,55] = 47.145, p < .0001
HM1	[àʔ] -3.89	(6.6)	[á] 8.41	(5.8)	F[1,38] = 38.345, p < .0001

For all four speakers, glottalization had a significant effect on spectral tilt perturbation. Unlike the (H2-H1) perturbation measure from the previous section, the (F1-H1) measure yielded an interesting pattern. For the two H-marked Doig speakers, DF3 and DM4, the positive perturbation values indicate a rise in tense phonation from vowel midpoint to endpoint. For their plain vowel measures, the negative values indicate an increase in lax phonation.

A mirror-image result occurs for two Halfway speakers, HF2 and HM1. Their pre-glottal stop vowels show negative spectral tilt means, indicating an increase in lax voicing from vowel midpoint to offset. The sets of plain vowels for these speakers show positive means, signifying an increase in tense phonation.

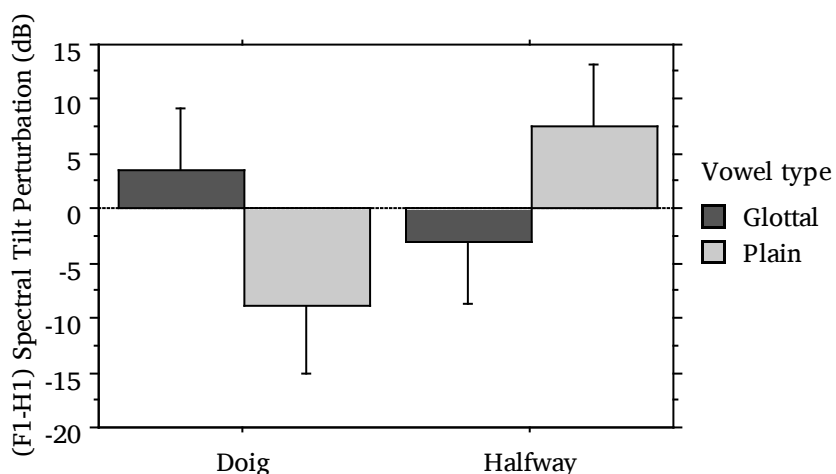
The means of two exemplars from the above four speakers are presented below in Figure 78. DM4, the male speaker from Doig, had a spectral tilt perturbation mean of 5.19, s = 4.9 for his H-marked vowels preceding glottal stops. For his plain vowels,

DM4 had a mean of -7.86,  $s = 5.2$ . HM1, on the other hand, averaged -3.89,  $s = 6.6$  for his pre-glottal stop vowels; his plain vowels yielded a mean of 8.41,  $s = 5.8$ . Bar graphs for DM4 and HM1 are presented below in Figure 78.



**Figure 78** Bar graph showing means for spectral tilt (F1-H1) perturbation, speakers DM4 (top) and HM1 (bottom). Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB)

To informally explore the noteworthy pattern based on dialect, I offer the following bar graph for Doig and Halfway speakers below in Figure 79.



**Figure 79** Bar graph showing dialect means for spectral tilt (F1-H1) perturbation. Error bars represent  $\pm 1$  standard deviation(s). Measures are (dB)

Vowels preceding glottal stops for Doig speakers have a mean (F1-H1) spectral tilt perturbation of 3.55,  $s = 5.5$ , Doig plain vowels average -8.91,  $s = 6.1$ . The Halfway speakers yielded a mean of -3.08,  $s = 5.6$  for their pre-glottal stop vowels. Their plain vowels average 7.51,  $s = 5.6$ ).

### 3.7.4.3 Spectral tilt summary

Effects of word-final glottal stops on measures of spectral tilt at vowel endpoint for both (H2-H1) and (F1-H1) values were significant for all speakers. In every case, the spectral tilt values in vowels before glottal stops was significantly higher than those in vowels of open syllables. For the (H2-H1) measure, all vowel offsets in open syllables

showed lax phonation. Preceding glottal stops, the phonation was found to be either modal or near modal for three speakers, yet lax for one (DF3).

Results for (F1-F2) also yielded lax phonation for all plain vowels at offset. The same three speakers showed modal voicing for the pre-glottal stop vowels. DF3, whose (H2-H1) results indicated lax voicing, had a mean (F1-H1) spectral tilt value indicating tense voicing in these vowels. Auditory clues and characteristics of DF3's spectrograms support the (F1-H1) findings.

Table 77 provides the summary of findings for both (H2-H1) and (F1-H1) endpoint spectral tilt measures. Though phonation falls along a continuum and phonation types are not discrete categories, I am informally defining modal voicing as falling between -2.00 dB and 2.00 dB. Lax phonation would then have a spectral tilt below -2.00 dB; tense phonation would show a spectral tilt above 2.00 dB. Numeric values are included in the table for facilitated comparison.

**Table 77 Vowel endpoint results for effects of glottalization on (H2-H1) and (F1-H1) spectral tilt. Bolded, italicized text indicates statistical significance. Modal voicing defined as falling between 2.00dB and -2.00dB; lax voicing < -2.00dB; tense voicing > 2.00dB.**

SPEAKER	(H2-H1) AT ENDPOINT		(F1-H1) AT ENDPOINT	
	GLOTTAL	PLAIN	GLOTTAL	PLAIN
DF3	<b><i>lax</i></b> (-6.52)	<b><i>lax</i></b> (-10.41)	<b><i>tense</i></b> (4.53)	<b><i>lax</i></b> (-10.83)
DM4	<b><i>modal</i></b> (-1.22)	<b><i>lax</i></b> (-9.62)	<b><i>modal</i></b> (1.83)	<b><i>lax</i></b> (-14.18)
HF2	<b><i>modal</i></b> (0.52)	<b><i>lax</i></b> (-5.67)	<b><i>modal</i></b> (-1.33)	<b><i>lax</i></b> (-10.92)
HM1	<b><i>lax</i></b> (-2.80)	<b><i>lax</i></b> (-10.00)	<b><i>modal</i></b> (-0.44)	<b><i>lax</i></b> (-10.76)

Normalized effects of word-final glottal stops on spectral tilt were determined by the perturbation values. For both (H2-H1) and (F1-H1) measures, the difference in spectral tilt perturbation of vowels preceding glottal stops was significantly different from that of the vowels in open syllables. For the (H2-H1) measure, perturbation values for vowels preceding glottal stops were significantly higher than those for plain vowels, for all speakers. For three speakers, there was an increase in tense phonation from vowel midpoint to vowel offset in the vowels preceding glottal stops. Speaker DF3 had a slight increase in lax voicing. In the plain vowels, there was an increase in lax phonation for all speakers.

The (F1-H1) results were more surprising. All speakers showed significant differences in perturbation between the vowel types. For Doig speakers, this was seen as an increase in tense phonation for the H-marked vowels preceding glottal stops. For the Halfway speakers, this difference was evident in the increased tense phonation of the H-unmarked plain vowels. The Halfway speakers showed a significant increase in lax phonation for vowels preceding glottal stops.

Table 78 summarizes the perturbation findings for all speakers.

**Table 78** Perturbation results for effects of glottalization on (H2-H1) and (F1-H1) spectral tilt. **Bolded, italicized text indicates statistical significance. The arrow (↑) signifies an increase in tense or lax phonation from vowel midpoint to offset. Values are (dB).**

SPEAKER	PERTURBATION (H2-H1)		PERTURBATION (F1-H1)	
	GLOTTAL	PLAIN	GLOTTAL	PLAIN
DF3	↑ <i><b>lax</b></i> (-0.10)	↑ <i><b>lax</b></i> (-3.76)	↑ <i><b>tense</b></i> (1.85)	↑ <i><b>lax</b></i> (-9.92)
DM4	↑ <i><b>tense</b></i> (3.47)	↑ <i><b>lax</b></i> (-4.23)	↑ <i><b>tense</b></i> (5.19)	↑ <i><b>lax</b></i> (-7.86)
HF2	↑ <i><b>tense</b></i> (4.80)	↑ <i><b>lax</b></i> (-1.22)	↑ <i><b>lax</b></i> (-2.41)	↑ <i><b>tense</b></i> (6.98)
HM1	↑ <i><b>tense</b></i> (1.00)	↑ <i><b>lax</b></i> (-6.32)	↑ <i><b>lax</b></i> (-3.89)	↑ <i><b>tense</b></i> (8.41)

Results of the (H2-H1) measure do not support my hypothesis, with the exception of speaker DF3. I expected an increase in tense phonation for the H- tone vowels preceding glottal stops and increased lax phonation for the L-marked pre-glottal stop vowels. The (F1-H1) measure disproved my theory that there would be no effect of final-glottal stop based on tone category. As I mentioned above, it was not possible to isolate marked tone from final glottal stops in this study, so I cannot say there is a definitive interaction between tone category and the effect of glottal stop. What I can say is that the relationship between the first formant and the fundamental frequency at vowel offset is different for Doig and Halfway speakers.

### **3.8 Summary**

#### *3.8.1 Effects of word-final glottal stops*

The goal of this chapter was to explore effects of word-final glottal stops on the voice quality of preceding vowels for two dialects of Dane-zaa, Doig River and Halfway River, and to see whether synchronic support for Kingston's theory of tense vs. creaky phonation can be found in Dane-zaa, with its two different historical developments of tone from glottalization.

I anticipated that the voice quality of vowels preceding word-final glottal stops would be significantly different from that of vowels in open syllables. With the exception of effects on pitch for the Doig speakers, all other aspects of voice quality investigated showed significant effects of word-final glottal stops. Results for pitch, specifically the lack of a significant raising effect of word-final glottal stops for the Doig speakers, indicate that tone may be in transition. Doig is changing from a language that originally had pitch raising as a reflex of the PA constriction, to one in which the trigger for marked tone is no longer manifesting in a measurable way, at least with respect to pitch.

Results for local effects are summarized in Table 79 below.

**Table 79** Local effects (vowel endpoint) of glottalization for vowels preceding glottal stops (Vʔ) and vowels in open syllables (V#). Bolded, italicized results indicate statistical significance. Unexpected results highlighted in red.

DIALECT	SPEAKER	PITCH	INTENSITY	JITTER	(H2-H1)	(F1-H1)
Doig	DF3	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>
	DM4	<i>ʔ? &gt; v#</i>	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>
Halfway	HF2	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>
	HM1	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &lt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>	<b><i>ʔ? &gt; v#</i></b>

Results from this chapter established word-final glottal stops as following the pattern of Kingston’s “slack” ejectives, resulting in lax phonation on the preceding vowel. With the exception of DM4, pitch was lowered for both the H-marked vowels of Doig and the L-marked vowels of Halfway. Intensity was lower preceding glottal stops. Glottal pulses were more irregular preceding glottal stops. Energy was found to increase in the higher harmonics for Doig and Halfway vowels before glottal stops.

Results for normalized effects, exploring changes in voice quality from vowel midpoint to vowel endpoint are presented in Table 80.

**Table 80** Normalized effects (perturbation) of glottalization for vowels preceding glottal stops (V?) and vowels in open syllables (V#). **Bolded, italicized results indicate statistical significance.**

Unexpected results highlighted in red.

DIALECT	SPEAKER	PITCH	INTENSITY	JITTER	(H2-H1)	(F1-H1)
Doig	DF3	<b><i>ú?</i> &lt; v#</b>	<b><i>ú?</i> &lt; v#</b>	<b><i>ú?</i> &gt; v#</b>	<b><i>ú?</i> &gt; v#</b>	<b><i>ú?</i> &gt; v#</b>
	DM4	<b><i>ú?</i> &lt; v#</b>	<b><i>ú?</i> &lt; v#</b>	<b><i>ú?</i> &gt; v#</b>	<b><i>ú?</i> &gt; v#</b>	<b><i>ú?</i> &gt; v#</b>
Halfway	HF2	<b><i>ú?</i> &lt; v#</b>	<b><i>ù?</i> &lt; v#</b>	<b><i>ù?</i> &gt; v#</b>	<b><i>ù?</i> &gt; v#</b>	<b><i>ù?</i> &lt; v#</b>
	HM1	<b><i>ú?</i> &lt; v#</b>	<b><i>ù?</i> &lt; v#</b>	<b><i>ù?</i> &gt; v#</b>	<b><i>ù?</i> &gt; v#</b>	<b><i>ù?</i> &lt; v#</b>

Pitch significantly decreased from vowel midpoint to offset for all but HM1. There was a decrease in energy perturbation preceding these consonants and an increase in the amount of irregularity in glottalic cycles; jitter was higher preceding glottal stops in both dialects. The spectral tilt perturbation for 3 of 4 speakers was positive for the (H2-H1) formula, 2 of 4 for (F1-H1). This discrepancy in results for spectral tilt formulas may be due to the fact that F1 tends to be higher in vowels with tense phonation (Kuang & Keating, 2012). The Halfway speakers significantly lowered F0 from vowel midpoint to endpoint in vowels preceding glottal stops, indicating greater lax phonation in that environment.

### 3.8.2 *Dane-zaa* glottal stops in historical perspective

According to Hargus (2007), if Kingston's theory of tense vs. creaky phonation leading to the development of H and L tones in the tonal Athabaskan languages is correct, then

we should expect that the glottalic consonants that are found to lower pitch should also come with additional correlates to creaky phonation. These include a decrease in intensity, an increase in jitter, and increased energy in the higher harmonics. This was the case for the Halfway speakers. We should also expect that glottal stops contributing to pitch raising would co-occur with other attributes of tense phonation. These characteristics include higher F<sub>0</sub>, decreased intensity, a raised F<sub>1</sub>, and increased energy in the higher harmonics.

It was interesting to find that despite the mirror image tone system of the Dane-zaa dialects, there were no instances of glottal stops acting as pitch raisers, thus comparable to Kingston's "stiff" ejectives, with tense phonation on the following vowels. Despite the fact that glottal stops in the H-marked dialects of Dane-zaa must have had characteristics of "stiff" ejectives at some point to yield H tone from PA constriction, at some point they changed to behave more like the pitch lowering glottal stops of Witsuwit'en and Deg Xinag.

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## **4 Tone and Variation in Style**

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### **4.1 Introduction**

#### *4.1.1 Chapter overview*

This chapter is an investigation into the effects of two speech styles on normalized pitch; I am inquiring into whether lexical tone manifests differently in narratives than in word lists. Firstly, I am positing that these two sets of data are, in fact, distinct speech styles. Secondly, I postulate that tone is a valid sociolinguistic variable.

I first offer a brief introduction as to what I mean by ‘style’, which will be further explained at the end of this introduction, in Section 4.1.5. By ‘style’, I refer to a conception of style in which the linguistic aspect is just one part of the overall landscape of style. A speaker is entitled to draw upon a constellation of linguistic

semiotics (e.g. prosodic cues) and non-linguistic semiotics (e.g. eye-gaze or gesture) that may align with social meaning.

To address the question of tone as a sociolinguistic variable, I turn to the early work of Labov. In his study of language variation in New York, Labov (1966) introduced the concept of the linguistic variable as a construct that can be used to group together a set of fluctuating variants. These variants are thought to be related to the same underlying unit within a target language or dialect (Wolfram, 1991). These variations are systematic; the systematicity lies in the correlation of a language variant to some aspect of speaker or setting. It is the systematic patterning of tonal variation that is the subject of this study.

The chapter is organized in the following manner. In Section 4.1.2, I provide a summary of some of the sociolinguistic works pertaining to style. In Section 4.1.3 I summarize selected works by Hymes and Scollon and Scollon, who provide excellent discussions of style and the important role of oral narratives in linguistic research. In Section 4.1.4 I turn to acoustic studies, summarizing experiments on effects of task in Athabaskan and general phonetics, followed by a summary of two experiments in the field of speech and hearing, investigating effects of task on the determination of habitual loudness and habitual pitch.

Section 4.2 lays out the methodology for this study. In Section 4.2.1, I introduce the research questions to be investigated in this chapter. Section 4.2.2 is dedicated to describing the two speakers who participated in this study in greater detail than in the previous chapters. Section 4.2.3 describes the materials that were collected for analysis and the recording procedure. Section 4.2.4 explains the audio processing used to prepare the data and the measuring methodologies.

Results for this study are presented in Section 4.3. Section 4.3.1 provides raw pitch means and variance for the speakers, before the presentation of normalized pitch that will follow in the remaining analyses. Section 4.3.2 explores the distribution of normalized pitch, focusing on the skewness of the measurements. In Section 4.3.3 I provide inferential results of main effects of speech style and tone category on normalized pitch as well as any interactions between the independent variables.

Section 4.3.4 provides a summary of the findings, where I revisit the research questions and compare the results of this study with the findings of the studies summarized in this introduction. I then offer a detailed discussion of style and the relevance to this study of the various frameworks in sociolinguistics and ethnography.

#### *4.1.2 Style in sociolinguistics*

There have been numerous publications on the topics of style and linguistic variation in sociolinguistic literature; this section summarizes some key concepts in variationist

theory. William Labov has been a principal force in the development of the field of sociolinguistics and empirical approaches to linguistic research. Labov's method of classifying and quantifying style and variation (Labov, 1972) focused on collecting data via linguistic interviews. His classificatory approach designed to characterize speech style is one-dimensional, organized along a continuum of attention paid to speech; at one end is casual, at the other, careful. He did not make it his primary goal to define style; rather he used style to control and identify intra-speaker variation, operationalizing style in order to collect speech via sociolinguistic interviews to get at intra-speaker variability.

Critical of Labov's unidimensional approach and the idea of style based upon attention paid to speech Coupland (2001) considered style to be a situational achievement, a correctly contextualized communicative event in relation to a social situation. Speakers project their complex identities, determine how to convey and contextualize their message (via humor, gestures, respect, etc.) and express referential meanings. Coupland further explains his multi-dimensional theory by distinguishing between *dialect style* and *expressive style*. Dialect style is linguistic variation that follows a semiotic association to expectations of sociolinguistic communities. Expressive style includes manipulation of paralinguistic variables such as select prosodic features or non-linguistic variables that are *not* socially indexed.

Allan Bell has also played an important role in the field of stylistic variation. In (Bell, 1984) and the more recent (Bell, 2001), he outlines the framework for what he has termed audience design. Essentially, speakers actively design their speech style to accommodate their audience. “We should no more conceive of language without audience than of language without speaker” (2001 p.144). Within this dynamic interplay is the desire for a speaker to orient him- or herself to the audience. One method of accomplishing this is through shifts in style. These shifts in style are due to the presence, or perceived presence, of different types of auditors.

#### *4.1.3 Style in ethnography*

Critical of the Chomskyan model of transformational grammar and universal patterns in language, Dell Hymes argued that there was a need to account for linguistic variation in actual spoken language, including that of populations with a largely oral tradition. Hymes, who spent much of his career working on the First Nations languages and literatures of the North Pacific Coast, stressed the importance of documenting Native American verbal art, as it contains not only vital linguistic information, but it also provides rich cultural elements.

Hymes’ 1962 article outlining his Ethnography of Speaking approach to categorizing language in use was an influential treatise on style and variation in communication, filling the gap between what is written in grammars and what is

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written in ethnographies. Hymes explored what he referred to as *ways of speaking*, covering concepts such as ‘means of speech’, what speakers can and do say, and ‘speech economy’, the communal context in which speech occurs. According to Hymes, not only is it necessary to speak a language correctly, but one must also know the context in which the words are used. Communicative competence is what Hymes called the ability speakers possess allowing them to use language in ways that are not only correct, but also appropriate in a given social context.

Another significant contribution attributed to Hymes was the SPEAKING model<sup>35</sup> (1972). This mnemonic code word was developed to assist researchers in remembering the key speech components within a speech economy. These components form part of the larger theory of the interaction between language and social life.<sup>36</sup> Hymes’ SPEAKING model is presented below in (15).

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<sup>35</sup> Hymes states that “such a schema can only be an etic, heuristic input to descriptions. Later it may assume the status of a theory of universal features and dimensions” (Hymes, 1972 p.58).

<sup>36</sup> These components of a speech event were adapted from communication theory to linguistics by Roman Jakobson (1960).

## (15) Hymes' SPEAKING mnemonic

**Setting** – *the physical setting and scene*

**Participant** – *speaker/sender, hearer/receiver, addressor/addressee*

**Ends** – *the goal of the speech event, the anticipated outcome*

**Act Sequence** – *the message form and message content*

**Key** – *expressive act in speech or gesture carrying meaning (sarcasm, posture, a wink)*

**Instrumentalities** – *forms and styles of speech*

**Norms** – *social rules in speech event involving both interaction and interpretation*

**Genre** – *categories such as poem, song, narrative, myth*

These components are now considered to be key elements of metadata required by language documentation projects as a means to fully describe a recorded speech event.

In Section 4.2.3.2 I will utilize Hymes' SPEAKING mnemonic to contextualize the narratives used for this study.

Much like Hymes' communicative competence, research of the ethnographers Ron and Suzanne Scollon focused on the competence of the speaker, specifically the inter-ethnic aspects of communicative competence (Scollon & Scollon, 1979, 1981). Additionally, the authors explore the notion of the narrative as a means of transmitting knowledge. Based on their research into the ethnography of speaking in a Chipewyan (Dëne Sųłiné) community (1981), the authors establish that Athabaskan oral narratives are interactive in nature, suggesting that a common communicative competence is needed from both the speaker and the audience in order for the successful transmission of knowledge to occur.

He [the narrator] must assume that the audience shares interpretive conventions for grammar and morphology, intonation, pausing, gesture, and body placement. These in turn signal higher level interpretation of time, location, events, and general human activity. (Scollon & Scollon, 1981, p.113)

Scollon and Scollon mention the reciprocity necessary from the audience, such as minimal gestures or comments, signaling their comprehension to the speaker. This interplay furthers the communicative act, following conventions of a shared speech economy.

In my experience, collecting narratives in First Nations communities was most successful when I brought along other members of the community to act as the audience. As a non-Dane-zaa speaker, I was not able to participate in this reciprocity. Allowing the speaker to interact with members of his speech community yielded eloquent, fluent stories, usually averaging 30-45 minutes per narrative.

The next section moves away from natural communicative events, focusing on laboratory experiments into influences of task on the speech signal.

#### *4.1.4 Effects of task in phonetics and the speech and hearing sciences*

This section presents synopses of selected acoustic studies in the fields of phonetics and the speech and hearing sciences. They are relevant to the current study in that they attempt to quantify effects of task on selected acoustic parameters (F0, F1, F2,

duration, intensity). The tasks were designed to elicit speech styles falling along various points on a continuum. The continuum is less defined by a scale of formality or the make-up of an audience, as was the case in the sociolinguistic studies summarized above. Rather, the scale used in these studies gauges the degree of energy necessary to successfully communicate with an interlocutor (Lindblom, 1990) or the degree of articulatory precision a speaker utilizes (Brink et al., 1998). It is not the case that these researchers offer any language-external explanations for the differences in speech collected using the various elicitation tasks. At the end of this chapter I will address the importance of seeking social explanations, going beyond quantifying cognitive load and self-monitoring as a means to denote a difference in types of speech.

Referencing Lindblom's work on Hypo- and Hyper-speech theory (1990), many of these studies designate the poles of this continuum as Hyper-articulated and Hypo-articulated speech. Hyper-articulated speech results when a speaker compensates his or her speech to accommodate situations where communication is problematic (e.g. a noisy room, non-native interlocutor, speech directed toward an infant). For successful communication to occur, the speaker must expend greater energy, either by increasing volume, speaking more slowly, or carefully articulating the segments within an utterance. Characteristics of Hyper-articulated speech include a slower speaking rate, higher overall volume and an expanded vowel space. Hypo-articulated speech is considered reduced, more natural and occurs in less demanding communicative

situations. The speaker uses as little energy as possible, while still successfully communicating his or her message. Characteristics of this speech include lower overall volume, reduced vowel space and a faster speaking rate.

As a method to elicit different ways people speak in a laboratory setting, the Speech Research Laboratory at Indiana University have conducted a series of experiments and published the results as a collection of annual progress reports (Brink, et al., 1998) (Harnsberger & Pisoni, 1999) and (Harnsberger & Goshert, 2000) and a related, more recent study (Harnsberger et al., 2008). These are summarized below.

In the Harnsberger and Goshert study (2000), the authors used an elicitation technique developed in two previous studies, (Brink, et al., 1998) and (Harnsberger & Pisoni, 1999), in order to explore acoustic effects of Hypo-articulated (Reduced), Citation and Hyper-articulated speech styles on sentence duration, word duration and F1-F2 vowel space. While Citation speech tends to be uniform in features at the word- and utterance-level, more naturalistic speech such as conversations may include both Hyper-articulated and Hypo-articulated speech. Hypo-articulated speech and Citation speech can differ in utterance duration, word duration, degree of vowel centralization and amount of pauses. Hyper-articulated speech may differ from Citation speech in that the vowel space expands, speaker rate is slower, the duration and number of pauses increase.

Regarding duration results for this study, the outcome of a two-factor ANOVA, Style factors (Reduced, Citation, Hyper-articulated), Unit of analysis (Keyword, Sentence) indicates that there were main effects for Style, Unit of Analysis and a significant interaction between the two variables. As they predicted, longer durations corresponded to more articulatorily precise styles. For the sentence measures, only seven of the twelve participants differentiated the three styles by manipulating some aspect of the temporal property of the sentence. As for vowel dispersion, the authors predicted that vowels would be less centralized in the articulatorily more precise styles. All twelve participants had a Hyper-articulated style that differed from the Reduced and Citation styles for this measure. Only eight of the twelve had a difference between Reduced and Citation. Eight participants showed the predicted difference in vowel dispersion across all speech styles.

In the study by Harnsberger, et al. (2008), the authors set out to refine the method for collecting Hypo-articulated (reduced) speech using controlled elicitation materials. Because it is difficult to simulate Hypo-articulated speech in a laboratory setting, the authors proposed a task intended to increase the cognitive load of the speaker, thus decreasing the amount of self-monitoring that would otherwise occur. Each speaker underwent a digit span task to determine how many numbers they could successfully recall. They were presented with digits (0-9) and went through 25 trials to determine the greatest sequence of numbers they could successfully recall. Once this

was calibrated, in order to elicit the reduced speech style, each speaker was first presented with their individualized number of digits (displayed on screen for 2.0 s), then a sentence was presented to be read aloud, after which, they were asked to recall the numbers in the same sequence.

For the remaining two speech styles, following (Brink, et al., 1998), Citation speech was collected by prompting the speaker to read aloud a sentence presented on the screen. In the Hyper-articulated condition, the subject was asked to read a sentence aloud. They were then prompted to do so ‘more carefully’, twice. The third instance was taken to represent the Hyper-articulated style for the analysis.

The researchers then conducted a series of acoustic and impressionistic judgement experiments designed to determine if the distractor task successfully elicited speech that resembled the reduced style. With minor adjustments in the subsequent experiments to refine the cognitive load for the individual speakers, results of the tests improved. In the end, however, it was determined that many complex issues affect the outcome of collecting reduced speech with this elicitation method. For example, a speaker could have been overwhelmed by the distractor task (cognitive load too high) and simply recited the utterance as Citation speech. On the other hand, the speaker may have been successful with the digit span task, but merely bored (cognitive load too low) and produced speech that was not Reduced speech.

Turning to the speech and hearing sciences, a set of studies were carried out to investigate the effects of task on speech. One such study, (Zraick et al., 2000), examines the effect of task on the determination of habitual pitch in clinical voice evaluations. Habitual pitch, or Speaking Fundamental Frequency (SFF), is defined as the average pitch in a continuing speech sample. 36 speakers (12 adult males, 12 adult females, 12 prepubescent children) were recorded performing the following tasks in a randomized order for each speaker:

1. Counting from 1-10
2. Reading a passage for 10 seconds
3. Producing 10 seconds of spontaneous speech
4. Producing the vowel /a/ for 8 seconds
5. Saying “um-hum” with a closed mouth
6. Counting 1-3, with the /i/ of the “three” sustained for 1 second
7. Saying “uh-huh” with an open mouth

There was significance effect for task on the speakers’ habitual pitch for only the adult female speakers ( $p < .001$ ). Wilcoxon matched-pairs signed-rank tests and a sign test were used to determine if any one task showed different habitual pitch. These tests showed that each of the seven tasks were significantly different from at least one of the other tasks. For example, of the seven tasks for the adult female group, the lowest mean<sup>37</sup> (186.78 Hz) was found in the counting 1-10 task, as well as the lowest pitch

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<sup>37</sup> All pitch measures for the Zraick, et.al. study were raw, non-normalized Hz.

range (140-61-217.85 Hz). The pitch span for this was 77.24 Hz. The second task, ten seconds of reading aloud, had a mean that ranked in the center of all the other tasks, (192.26 Hz), a pitch range of 142.73-225.62 Hz and a wide span of 100.55 Hz.

The authors speculate on various factors that may have had an effect on the outcome. First, the length of a given utterance, such as that of “uh-huh” was considerably shorter than the 10-seconds of spontaneous speech, and perhaps too limited in what information it could provide. Also speech style possibly played a role, as the authors note that there are differences in how people read aloud versus speak. They also concede that sex had a role in the results; this is corroborated by past studies of interactions of sex and task and their effects on speech parameters other than pitch. The authors suggest that for adult female clients, one would need to use more than one type of task.

In another study (Zraick et al., 2004), the authors set out to examine effects of task in the determination of habitual loudness, defined as the loudness level of the voice used by the speaker for the majority of vocalization. In this study, 30 female speakers were recorded performing the following four tasks, again presented in a randomized order:

1. Counting for 30 seconds (Automatic speech)
2. 30 seconds describing a picture (Elicited speech)
3. Reading a passage for 30 seconds (Reading aloud)
4. 30 seconds of spontaneous speech (Spontaneous speech)

To determine significance across tasks, the authors ran an ANOVA. Results showed a main effect for task. A Bonferroni/Dunn post hoc test provided results for pair-wise comparisons. Mean habitual loudness was measured in dB Sound Pressure Level (SPL). SPL is a logarithmic measure of the sound pressure of a given sound, relative to its reference point. Results indicated that Automatic speech was significantly lower than Spontaneous speech ( $p < .05$ ) as well as the Reading task ( $p < .001$ ). Automatic speech was not significantly quieter than Elicited speech. The authors had hypothesized that reading aloud would be significantly louder than spontaneous speech. They based this hypothesis on the opinion that when reading aloud, one usually does so to an audience. “In real-world situations, when one reads aloud, they are most likely doing so at a level that is greater than their most comfortable (and by extension, habitual) loudness” (Zraick, et al., 2004, p.179). Their hypothesis was not confirmed in this case. The authors suggest that reading aloud was not significantly higher than spontaneous speech due to the fact that the speakers were instructed to use their “most comfortable pitch, rate and loudness” (p. 179).

And finally, in a phonetic study of consonant duration in Kwadacha Tsek'ene (Athabaskan), Hargus (2010) investigated the potential effects of three factors on the

duration of voiceless fricatives, voiced fricatives and sonorants: Stress (stressed, unstressed), Position (initial, medial) and Task (word list, sentence). It is important to note that *word list* in this study covers words read from a list, spoken in isolation. The *sentences* were uttered immediately following the word in isolation; speakers were asked to use the word in a sentence of their own design. Hargus notes that speakers needed occasional coaching during the recording sessions to read the words on the word list, as there was varying knowledge of the Tsek'ene orthography. Group results of a repeated measures ANOVA found a significant effect for task ( $F[1,3] = 53.300$ ,  $p = .0053$ ). The consonants in the word list set were significantly longer than those in the sentence set. However, when a factorial ANOVA was carried out for the individual speakers, Task was not significant for anyone.

#### 4.1.5 Summary

My conceptualization of style follows closely to Coupland's, specifically the distinction between dialect style and expressive style. In the following sections, I will show the importance of noting linguistic as well as non-linguistic semiotic cues to style.

Hymes' discusses the need to account for linguistic variation in actual spoken language, moving toward filling the gap that had been overlooked in transformational grammar. I also find this to be an important paucity to address, and hope that my work will add to what is known about the phonetics of First Nations narrative data.

Regarding the instrumental studies summarized above, they present a common outcome: the different tasks used to collect data showed varying degrees of effects on the acoustic parameters of speech. In the studies summarized above, hyper-articulated speech was determined to yield higher F0, exaggerated pitch ranges and expanded vowel space. Hypo-articulated speech showed reduced intensity (volume), reduced vowel space, and faster speech rates. Citation speech was found to produce unvarying phonetic features. As previously mentioned, the tasks in these studies collect different types of speech based on differing levels of automaticity, but they do not explain variability that is motivated by linguistic-external factors, aside from the sex of the participant having an effect in some of the studies.

The tasks used to collect data for this chapter were chosen as a means to elicit different styles of speech in order to explore variability. In the next section I explain the methodology used to achieve this goal.

## **4.2 Methodology**

I begin in Section 4.2.1 by outlining the research questions to be investigated for the current experiment. In Section 4.2.2 I discuss the background of the speakers who participated in this study. In Section 4.2.3 I outline the two types of speech styles analyzed, including the recording techniques used in the collection of this data.

Section 4.2.4 follows with a discussion of methodologies of the audio processing and subsequent measurement of the data.

#### *4.2.1 Research questions for current study*

In this study I explore the possibility that there are significant differences in the normalized pitch falling within both word list and narrative speech. The primary research question for this study is presented below in three parts (16).

#### **(16) Research Question for effects of speech style on normalized pitch:**

- a) What are the pitch targets, pitch ranges and overall distribution of pitch in syllables taken from word list data? From narrative data?
- b) Is there a significant difference in normalized pitch between the two speech styles?
- c) Are there significant interactions with Speech style and Tone category?

The questions in (16) have been designed to address paucity in the literature of what is known about phonetics of tone in different speech styles of an Athabaskan language.

The first question (16a) is designed to offer a description of how speakers produce lexical tone in the two different speech styles. My general hypothesis for this question is that H and L tone categories will remain salient in word list data as well as narrative data. The second question in (16b) explores differences in pitch within the two speech styles. I hypothesize that due to the higher degree of attention paid to speech during

the word list elicitation sessions, this data will have significantly less variation and narrower pitch spans than the pitch of the narrative data. The last question (16c) will compare the text and word list pitch. Are the H marked tones of the text data similar to the H tones of the word list data? Is the pattern similar for the L tone categories? I posit that there will be a significant effect for speech style and that differences between H and L tone categories of the text data will manifest differently than the differences between the H and L tone categories of the narrative data.

#### *4.2.2 Speakers*

Data for this chapter was collected from two male speakers, DM3 and DM5, whose ages range between 60 and 70 years. They are both bilingual in Dane-zaa and English and belong to what is assumed to be the same speech community: Doig River First Nation Reserve.

Speakers DM3 and DM5, although unrelated, share a similar linguistic competence; Dane-zaa was their mother tongue and the only language they spoke until approximately age 12, at which point they were made to learn English. These speakers use both English and Dane-zaa on a daily basis. Over the past four decades, these two men have taken active roles in Doig community language efforts including Dane-zaa literacy, and have engaged in work as language specialists for language description and documentation projects. It is also the case that DM3 and DM5 share a similar

communicative competence; both are traditional song-keepers and are considered to be exceptional speakers and story-tellers by other members of the Doig Reserve, as well as by researchers in the fields of anthropology, linguistics and folklore who have worked with them for decades. They have taken on roles as emissaries outside of their community for events focusing on educating people of the Dane-zaa language and culture. There is one notable difference between the two speakers; for part of his youth, DM3 was raised ‘out bush’, away from the rest of the Doig Dane-zaa community. His speech is described as a more conservative variant of Dane-zaa. Many Dane-zaa describe his speech as sounding like ‘the old talkers’. That said, I still posit that they are demographically similar enough to compare their speech. The Doig community members agree with this supposition, as they actively chose these two elders as representative speakers.

### *4.2.3 Materials*

#### *4.2.3.1 Word list*

The word list data was collected on two separate occasions. The word list tokens used in the current study for speaker DM3 come from the set used in the tone study in Chapter 2 of this dissertation, with the addition of supplementary pairs to better match tokens from DM5. DM5’s set was collected for an earlier study (Miller, 2007a). The method of elicitation described in Section 2.3.2.2 also applies to this earlier

experiment; target words were embedded in carrier phrases in utterance-medial positions. 22 tokens from each speaker were used in the current study. Each sentence was elicited three times, in randomized order, creating approximately 66 word list data points for each speaker.

Table 81 Word list tokens elicited from DM3. Target syllable bolded in polysyllabic tokens.

MARKED TOKENS			
Categories	IPA	Dane- <u>z</u> aa	Gloss
N, stem	[t <sup>h</sup> áʂ]	tá <u>ʂ</u>	'arrow'
N, stem	[mɛ́ɬ]	mɛ́lh	'snare'
N, stem	[ts <sup>h</sup> áʔ]	tsáʔ	'beaver'
N, stem	[tʃú]	júú	'these'
N, stem	[t <sup>h</sup> íʂ]	tíʂ	'crutch'
N, stem	[jáʔ]	yááʔ	'louse'
V, stem	[tás.láʔ]	dááslááʔ	'I bought O'
V, prefix	[tás.láʔ]	dááslááʔ	'I bought O'
V, prefix	[ná.tʃ'ɛ]	náách'ɛ	'he dreams'
V, prefix/stem	[tás.lɛh]	dááslɛh	'I buy O'
V, prefix/stem	[ná.tʃ <sup>h</sup> ɛ]	nááçɛ	'it is raining'
UNMARKED TOKENS			
Categories	IPA	Dane- <u>z</u> aa	Gloss
N, stem	[xʌʂ]	h <u>as</u>	'pus'
N, stem	[tʂ <sup>h</sup> ɛ́ɬ]	t <u>ʂ</u> ɛ́lh	'axe'
N, stem	[sa]	saa	'month'
N, stem	[tʃu]	juu	'now'
N, stem	[tʂ <sup>h</sup> ɪtʂ <sup>h</sup> ]	t <u>ʂ</u> ɪt <u>ʂ</u>	'duck'
N, stem	[ja]	yaa	'sky'
V, stem	[tás.lɛh]	dááslɛh	'I buy O'
V, prefix	[h <u>a</u> .jé.la]	haayélaa	'he did it'
V, prefix	[y <u>a</u> .tʃi]	ghajii	'they say'
V, prefix/stem	[h <u>a</u> .jé.l <u>a</u> ]	haayélaa	'he did it to O'
V, prefix/stem	[h <u>é</u> .l <u>a</u> ]	hél <sup>h</sup> aa	'he did it'

Table 82 Word list tokens elicited from DM5. Target syllable bolded in polysyllabic tokens.

MARKED TOKENS			
Categories	IPA	Dane-zaa	Gloss
N, stem	[mΛ. <b>ká</b> h]	magááh	'beside him'
N, stem	[tséh]	dzéh	'gum'
N, stem	[a. <b>lá</b> ʔ]	alááʔ	'boat'
N, stem	[tʃú]	júú	'these'
N, stem	[tʃí.tʃe]	jíje	'berry'
N, stem	[jáʔ]	yááʔ	'louse'
V, prefix	[t <sup>h</sup> á.té.ʃa]	táádézhaa	'he went up'
V, stem	[á.tá.tʃáʔ]	áádáájááʔ?	'each became'
V, prefix	[a.tá.ʃa.leh]	aadáághaleh	'he buys it'
V, prefix	[á.tʃ'éʔ]	áách'éʔ	'he stayed'
V, prefix/stem	[ná.tʃ <sup>h</sup> é]	nááchɛ	'it is raining'

UNMARKED TOKENS			
Categories	IPA	Dane-zaa	Gloss
N, stem	[kah]	gaah	'rabbit'
N, stem	[wΛ.teh]	wadeh	'in front of'
N, stem	[Λs.pa]	asbaa	'mountain goat'
N, stem	[tʃu]	juu	'now'
N, stem	[tʃɪ.ge]	jige	'earth'
N, stem	[ja]	yaa	'sky'
V, prefix	[t <sup>h</sup> a.té.ʃa]	tadézhaa	'he got lost'
V, stem	[á.na.tʃáʔ]	áánaajááʔ	'he became again'
V, prefix	[ta.sa.tl'ɔ]	daasatl'ɔ	'he set snares'
V, prefix	[a.tʃ'é]	aach'ɛ	'he is staying'
V, prefix	[ah.tʃ <sup>h</sup> é]	aahch'ɛ	'you (pl.) stay'

Of the 22 words, 11 carried H-marked target syllables and 11, L-marked. Target words were balanced for lexical category; target syllables were matched for prefix vs. stem morphology, whenever possible. As was the case in the previous studies of Chapter 2 and (Miller, 2007a), I read the English sentence aloud and the respondent was asked to say the Dane-zaa equivalent. This method was successful due to the simple structure of the sentences; there was little room for varying word order. The speakers are both literate in English; however, they were not comfortable reading the Dane-zaa orthography to perform this as a reading task. Despite this not being a reading task, I would still characterize this material as Citation speech. As noted in (Harnsberger, et al., 2008), Citation speech is fairly uniform in its characteristics. These utterances collected as word list data for this dissertation were all short, declarative sentences.

I'll situate the word list recording sessions utilizing some of the more relevant components of Hymes' etic SPEAKING mnemonic concept (Hymes, 1962, 1964). The *Settings* were at various locations, typically inside the speaker's home. The *Participants* included just me and each speaker, individually. The *End*, or goal, was to help me further my understanding of the Dane-zaa language, and to provide whatever pedagogical materials as appropriate to the community. The *Act sequence*, or message form, was a response to the original interview question: 'How do you say \_\_\_\_\_ in Dane-zaa?', though it was not necessary to restate the question, once the interaction

was negotiated. This speech was not considered to be a typical communicative event. Although there have been other researchers in the two communities, eliciting material for linguistic (Randoja, 1990; Story, 1989) or anthropological analyses (Brody, 1981, 1988; Hennessy, 2010; Ridington, 1968), the rules for the recording session needed to be explained to each participant, as no one had previously recorded their speech in the same manner.

#### 4.2.3.2 Texts

Narratives are frequently reminiscences that bring back a way of speaking associated with the situation about which the narrative is told. Viewed less passively, one might consider that a competently told narrative is done in a dialect appropriate to the situations portrayed in the narrative itself. (Eckert, 2001, p. 121)

The two narratives used in this study were recorded in the summer of 2005 as part of a web-based exhibition for the Virtual Museum of Canada, co-sponsored by the DOBES / Volkswagen Foundation.<sup>38</sup> The impetus behind the project was to collect stories addressing the tangible and intangible heritage of the Dane-zaa. This goal complemented the main objectives of the VW language documentation project:

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<sup>38</sup> The web project offers excerpts of selected narratives:

<http://www.virtualmuseum.ca/Exhibitions/Danewajich/english/index.html>. See (Hennessy, 2010) for a detailed description of the event and her analysis of the project.

documenting the importance of ‘place’ for the Doig Dane-zaa community. All stories were intrinsically tied to the land. The elders, chief and council decided upon the locations of the recording sessions, topics of the narratives and who would tell the stories. It was understood by all involved that these stories would be made available to the general public via the internet, and to be used by the researchers for their respective university work, and finally, for community pedagogical materials. The two narratives used for this study were chosen from this corpus, which is archived in the DoBeS archive at the Max Planck Institute for Psycholinguistics, Nijmegen.<sup>39</sup> Below is a sample from one narrative, formatted for the internet, which was not used in this current study. The quote is from Doig elder, Tommy Attachie, as he shares his goal for the web project.

“E ii k’aasenéhtah iidekéh, guukeh  
wɔwajiih jii haak’íi nahanaajuunuu,  
hóch’ii ?é, ii t’q gwe náęchesne  
jédzé?. Kénaasjiih dah  
náághaghaęché? de shin hááda?ah  
dé. Gwe k’éh juu?úú, je hááké?  
náásehjiihdeh háákaa juuhdzénéh, ii  
hesadóh nahaazeduu.”

-**Tommy Attachie**, Doig River First Nation, 2005

“I am going to tell you about how  
our ancestors lived and where the  
Dreamers were. We remember  
where they lived, where they  
dreamed the songs that they  
brought back [from Heaven]. That  
is how we live today... We keep on  
teaching each other.”

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<sup>39</sup> One can browse the DoBeS (Documentation Bedrohter Sprachen or Documentation of Endangered Languages) online digital archive for the Beaver (Dane-zaa) project using the following link:  
[http://corpus1.mpi.nl/ds/imdi\\_browser?openpath=MPI689499%23](http://corpus1.mpi.nl/ds/imdi_browser?openpath=MPI689499%23)

The narratives were recorded on two different days; however, they are comparable communicative events. In order to show the similarity of the events, I'll again refer to Hymes' SPEAKING mnemonic.

As mentioned above, *Settings* were decided upon by the two speakers and the Doig River chief and council. Aesthetics, as well as the spiritual, historical, political and cultural importance of the location played a role, as these sessions were to be filmed and made available on the internet. Each speech event occurred on location, out in the bush. The speaker was seated; the landscape pertinent to the narrative was behind him.

The *Participants* in the two sessions were similar for both narrative recording events. The individual *senders* were the two male elders, DM3 and DM5, respected cultural leaders in their community (hunters, storytellers, drummers, song keepers), who have participated in Dane-zaa language and cultural events over the years. The *receivers* were made up of the same individuals for both events: Dane-zaa speaking elders and other adults, non-Dane-zaa speaking adults and teenagers, and the researchers (linguists, anthropologists, folklorists).

The *End*, or goal, of each event was to tell a story about the past and to educate the Dane-zaa youth and outside community in the rich Dane-zaa cultural heritage. As discussed in Scollon and Scollon (1981), "[...] it is essential for knowledge to be

contextualized in the experience of individuals” (p. 105). In this case, the individuals are audience members, which could be people who are physically present for the recording event, as well as those who may access the stories later via the internet. And as Doig elder Tommy Attachie tells the participating elders during the organizational meeting for the project, “You should tell them about the things you can remember.”<sup>40</sup>

The *Act sequences*, or the message of the narratives, were comparable by design. Both DM3 and DM5 discuss the importance of a specific geographic location to the Doig Dane-zaa people. Most of the collected narratives include some mention of the importance of aboriginal environmental management. In the case of DM3’s story of Snare Hill, emphasis was placed on the fact that the Dane-zaa people were able to survive difficult times due to the fact that moose could always be found at Snare Hill. The mythical transformation of the man into moose brought to the moose population a special insight into the habits of men, thus allowing them to occasionally elude the hunters, keeping their population healthy. DM5’s narrative of Sweeney Creek touches upon the importance of their ancestors’ knowledge that allowed them to survive

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<sup>40</sup> Translated into English from Dane-zaa. The complete speech can be accessed via this link: <http://www.virtualmuseum.ca/Exhibitions/Danewajich/english/stories/video.php?action=fla/tommyatcomplex>

famine. People were expected to work hard, even though times were quite difficult. One change in behavior that has developed to accommodate new environmental conditions is the importance of not killing animals that are caring for their young.

The *Key*, or tone, in both of these narratives is serious and educational. The speakers convey the importance of the topics being shared, expressing sincerity and deep respect for the knowledge contained in the stories. There is a poetic aspect to these stories that is not extant in all Dane-zaa narratives. Repetition and pauses played a role in the narratives of both speakers. Hand gestures and eye gazes were utilized by one of the speakers.

The *Instrumentality* of the speech events, or linguistic code, is also shared. The variety of language used by both speakers is one that is recognized community-wide. As these speakers were chosen by the community to speak these stories on their behalf, it can be accepted that they use a well-established register for these types of narratives.

*Norms*, or social rules which govern the speech act, are also similar for both narratives. In certain Dane-zaa story-telling situations I have encountered, it was expected that someone was designated as a specific receiver of the story, offering prompts or simple back-channeling, such as *azqɑ* ‘yes, I see’ which was ubiquitous throughout the shorter personal narratives. However, in the narratives used for this

study, there were no interruptions from the audience; each story-teller spoke individually and fluidly for a minimum of thirty minutes.

And finally, the *Genres* of the two events fall into the same category: historical narratives. These were stories about ancestors of the Dane-zaa and the land they were deeply dependent upon for survival. Embedded within each narrative was a tale of spiritual or supernatural importance. For DM3, it was the transformation of the man into moose. For DM5, it was the man who had been in a state of near-death for nine days and then returned to life as a wiser man who then became a Dreamer. The speakers knew these stories beforehand, as did most of the audience. Narratives such as these are the primary means of sharing cultural and historical knowledge with the listeners.

With the help of Professor Patrick Moore and Dane-zaa language specialists Eddie Apsassin and Billy Attachie, nearly all of the narratives that were collected during this event had at least one pass at a free-translation completed while still in the field, as well as a first-pass transcription into the Dane-zaa orthography. Over the following year in Seattle, these two stories were further refined to include consistent word-for-word glossing and more accurate transcriptions. Once the transcriptions were considered to be completed, I scanned approximately five minute selections from the two chosen texts in order to find token matches for the word list data. The word list and text syllables were matched for location in an utterance, lexical category of the

word containing the target syllable, morphological category (prefix vs. stem) of the syllable, comparability in the flanking segments of the tone-bearing vowel, quality of the vowel and, of course, the tone. Below I offer examples of a word list sentence from speaker DM3 in (17), and the paired utterance from DM3's text data in (18).

(17) Token example from DM3 word list: has [hʌʂ] 'pus'

**Askaa has ghaʔéʔ.**

askaa has ghaʔéʔ

boy pus 3sS.see

*'The boy sees some pus.'*

ref: DM3-word list, L-unmarked-pair01, rep 01

Figure 80 below is a screenshot of the waveform and spectrogram, zoomed in to the target word [hʌʂ]. The point of measurement is the 30ms selection highlighted at the vowel midpoint, where the formants are in a steady state.

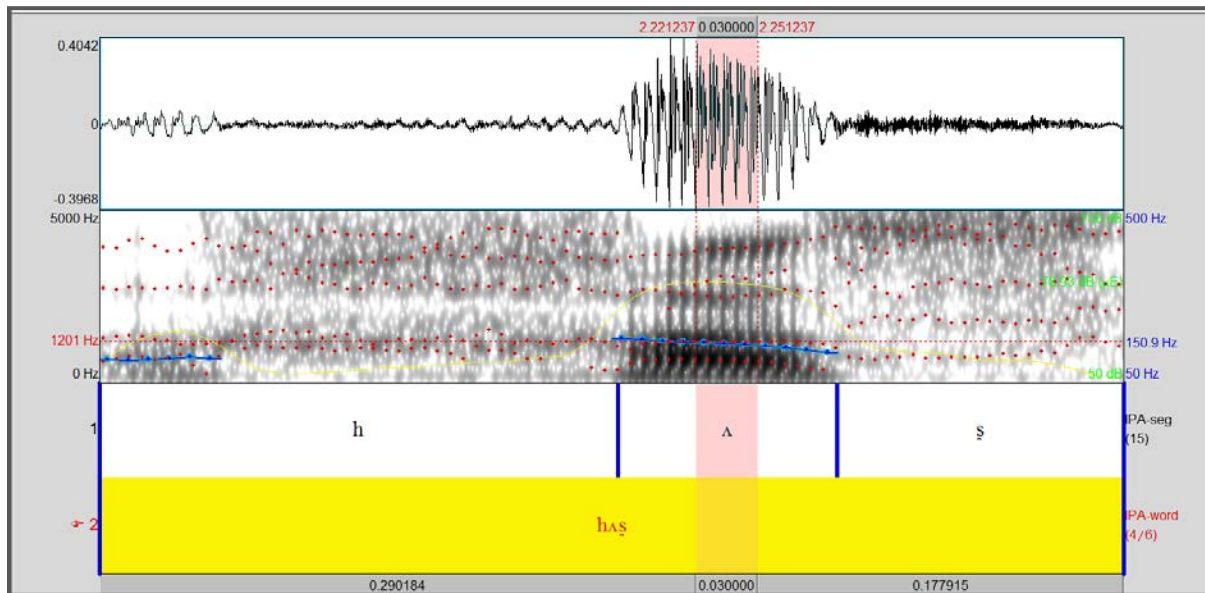


Figure 80 PRAAT screenshot of DM3's word list token [hʌʂ]. Measurement was taken across a 30ms selection at the midpoint of the steady-state of the vowel [ʌ].

(18) Token example from DM3 text: **yaʂ** [jʌʂ] 'snow'

**Ii tl'qh yaʂ natl'q.**

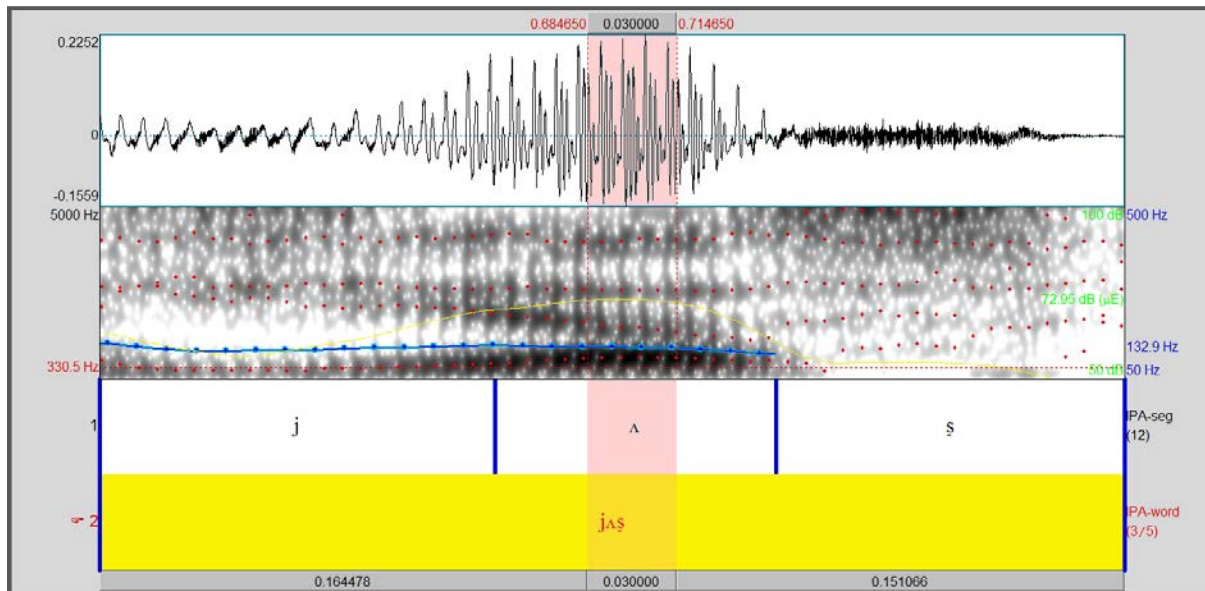
ii tl'qh yaʂ natl'q

and.then snow lots

'There was lots of snow.'

ref: sh-007

Figure 81 is the PRAAT screenshot of the corresponding token from the text data, [jʌʂ].



**Figure 81** PRAAT screenshot of DM3's text token [jʌs]. Measurement was taken across a 30ms selection at the midpoint of the steady-state of the vowel [ʌ].

I include the above images as a means to show that despite voicing of the segment [j] in example (18), there is no discernible consonantal influence of voicing at the point of measurement.

Another pair of word list and text tokens is presented below in (19) and (20) from DM5's data. This example includes two-syllable tokens; the target syllable is outlined.

(19) Token example from DM5 word list: **magááh** [mΛ.káh] ‘beside me’

**K’ajuu magááh dasii.**

k’ajuu ma-gááh dasii.

again 3sO-beside 1sS.say

‘I say ‘beside him’ again.’

ref: DM5-word list, H-marked-pair01, rep03

(20) Token example from DM5 text: **guugááh** [ku.káh] ‘beside them’

**Háá guugááh sô jijigé náánesdaah.**

háá guu-gááh sô jijigé náánesdaah.

EMPH 3pO-beside must.be right.there 3sS.sit.back.up

‘Then he sat up again.’

ref: sc-058

Each five-minute selection of the glossed narratives can be found in Appendix 4 (Snare Hill) and Appendix 5 (Sweeney Creek).

In the following two tables, I present the word list target syllables along with the matched text syllables for each speaker. There is one instance of the word list syllable in the table; however three repetitions were elicited of each carrier phrase containing the target word. The three paired text syllables were selected to be near matches for their word list counterparts. I attempted to select syllables from the texts that have the same vowel and flanking segments whenever possible. Choosing these three text syllables is, in a sense, a means to match the three repetitions of each token in the word list data.

**Table 83 Target syllables for speaker DM3. Text tokens come from the Snare Hill story. Word list target syllables provided for comparison.**

TARGET MARKED SYLLABLES			TARGET UNMARKED SYLLABLES		
Word list	Text	Text source	Word list	Text	Text source
[t <sup>h</sup> áʂ]	[t <sup>h</sup> áʂ]	sh_015	[xaʂ]	[jaʂ]	sh_007
	[há]	sh_085		[jaʂ]	sh_018
	[há]	sh_088		[as]	sh_021
[mɛ́ɬ]	[mɛ́ɬ]	sh_082	[tɕ <sup>h</sup> ɛ́ɬ]	[tɛ]	sh_063
	[mɛ́h]	sh_060		[tɛ]	sh_065
	[mɛ́h]	sh_094		[teh]	sh_056
[ts <sup>h</sup> áʔ]	[há]	sh_004	[sa]	[ta]	sh_051
	[há]	sh_004		[ta]	sh_019
	[há]	sh_058		[ta]	sh_012
[tʃú]	[ú]	sh_053	[tʃu]	[tʃu]	sh_004
	[ú]	sh_038		[tʃu]	sh_026
	[ú]	sh_046		[tʃu]	sh_028
[t <sup>h</sup> íʂ]	[í]	sh_016	[tɕ <sup>h</sup> íʂ <sup>h</sup> ]	[tsis]	sh_049
	[í]	sh_021		[tsis]	sh_050
	[í]	sh_059		[tsis]	sh_051
[jáʔ]	[há]	sh_005	[ja]	[ta]	sh_011
	[há]	sh_061		[ta]	sh_070
	[há]	sh_017		[ta]	sh_043
[láʔ]	[tá]	sh_003	[ɬeh]	[teh]	sh_009
	[tá]	sh_005		[neh]	sh_078
	[tá]	sh_008		[t <sup>h</sup> eh]	sh_065
[tás]	[ná]	sh_032	[ha]	[ya]	sh_004
	[ná]	sh_048		[ya]	sh_019
	[ná]	sh_092		[ya]	sh_041
[ná]	[ná]	sh_047	[ya]	[ya]	sh_012
	[há]	sh_083		[ya]	sh_043
	[ná]	sh_033		[ya]	sh_070
[tás]	[há]	sh_002	[la]	[t <sup>h</sup> a]	sh_063
	[ná]	sh_042		[t <sup>h</sup> a]	sh_064
	[há]	sh_047		[t <sup>h</sup> ah]	sh_078
[ná]	[ná]	sh_094	[la]	[na]	sh_010
	[ná]	sh_017		[na]	sh_043
	[ná]	sh_036		[na]	sh_076

Table 84 Target syllables for speaker DM5. Text tokens come from the Sweeney Creek story.

Word list target syllables provided for comparison.

TARGET MARKED SYLLABLES			TARGET UNMARKED SYLLABLES		
Word list	Text	Text source	Word list	Text	Text source
[káh]	[káh]	sc_053	[kah]	[kah]	sc_023
	[káh]	sc_057		[kah]	sc_025
	[káh]	sc_058		[za]	sc_041
[tséh]	[ké]	sc_021	[teh]	[ne]	sc_004
	[ké]	sc_068		[ne]	sc_011
	[ké]	sc_035		[keh]	sc_047
[láʔ]	[há]	sc_019	[pa]	[lah]	sc_070
	[há]	sc_047		[la]	sc_013
	[há]	sc_013		[la]	sc_033
[tʃú]	[tʃú]	sc_008	[tʃu]	[tʃu]	sc_013
	[tʃú]	sc_008		[tʃu]	sc_003
	[tʃú]	sc_008		[tʃu]	sc_073
[tʃí]	[í]	sc_021	[tʃi]	[ki]	sc_061
	[í]	sc_036		[ki]	sc_053
	[í]	sc_068		[ki]	sc_057
[jáʔ]	[há]	sc_009	[ja]	[la]	sc_011
	[táʔ]	sc_010		[la]	sc_022
	[há]	sc_015		[la]	sc_030
[tʰá]	[néŋ]	sc_036	[tʰa]	[neŋ]	sc_063
	[jéh]	sc_043		[je]	sc_039
	[téh]	sc_055		[tse]	sc_017
[tá]	[ná]	sc_005	[na]	[na]	sc_025
	[ná]	sc_062		[na]	sc_016
	[ná]	sc_072		[na]	sc_027
[tá]	[tá]	sc_002	[ta]	[ta]	sc_023
	[tá]	sc_012		[ta]	sc_025
	[tá]	sc_012		[tah]	sc_039
[á]	[ná]	sc_058	[a]	[na]	sc_063
	[ná]	sc_034		[na]	sc_042
	[ná]	sc_047		[na]	sc_030
[ná]	[ná]	sc_068	[ah]	[a]	sc_003
	[ná]	sc_012		[a]	sc_041
	[ná]	sc_029		[a]	sc_038

Intrinsic differences in the pitch of vowels, as pointed out by (Wassink et al., 2007) and (Whalen & Levitt, 1995) is certainly an issue to consider. There is a tendency for high vowels to have higher F0 than low vowels. For this study I controlled, as best as the data would allow, for vowel quality by matching a given target vowel in token sets between speakers and between speech styles.

#### *4.2.4 Audio processing and pitch measurement methodology*

As mentioned previously, DM3's word list data comes from the material collected for Chapter 2 of this dissertation. Equipment used for that elicitation session is explained in Section 2.3.3. The word list data of DM5 was collected for a previous, yet similar tone study (Miller, 2007a). For this study, an Audio Technica AT 4041 cardioid microphone was utilized. The speaker was approximately 12-15 inches from the microphone. Both sets of word list recordings were recorded at 48 kHz, and then down-sampled to 22 kHz files, using Sound Forge 7.0. Each utterance was then segmented into separate .wav files.

The narratives for both DM3 and DM5 were collected using a Sony DSR-PD170 professional video camera. An external cardioid microphone was linked to the camera via an XLR connection. The recording was captured from the digital video tape as an .avi; the audio was then extracted in .wav format, 48kHz. This was then downsampled to 22kHz for analysis.

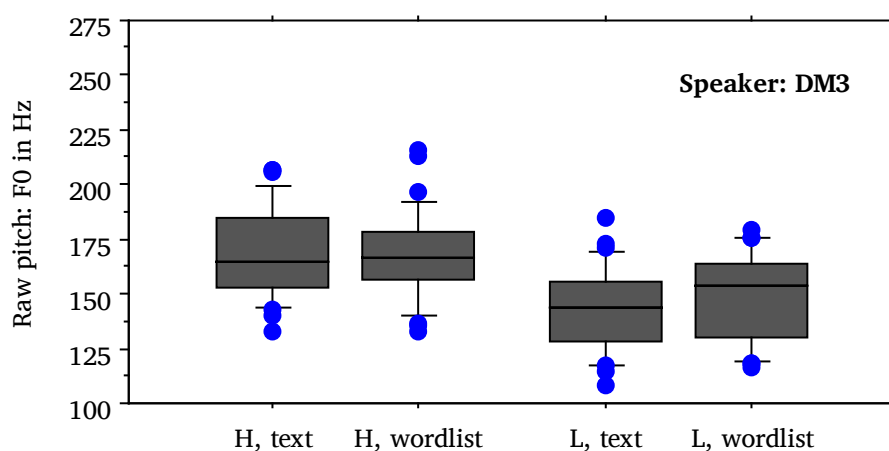
For both the text and word list tokens, raw pitch measurements were taken across a 30ms window within the steady-state of the target tone-bearing vowel, as shown above. As with the tone study of Chapter 2, each of the measures was then normalized using a z-transform for statistical analysis.

### **4.3 Results**

This section presents results from experiments designed to investigate effects of speech style on normalized pitch. For these experiments, a presentation of the descriptive statistics is offered, in addition to inferential results. Section 4.3.1 begins the discussion of pitch and speech styles by presenting raw pitch measures for each speaker, including pitch means and pitch spans. Section 4.3.2 moves on to the normalized pitch values, offering an overview of the distribution of pitch measures for both speakers, focusing on the skewness of measures for speech style, grouped by H and L tones. Section 4.3.3 presents results of a two-factor ANOVA experiment, investigating main effects of Speech style and Tone category and offers results of potential interactions between the two variables.

### 4.3.1 Raw pitch measures

To begin with, I'd like to provide an overview of raw pitch levels and spans for both speakers in word list and narrative data. These values represent the non-normalized measures for tone. The boxplot of means for speaker DM3 is given below in Figure 82.



**Figure 82** Boxplot of H and L raw pitch measures for text and word list tones, speaker DM3. Error bars represent  $\pm 1$  standard deviation(s). Dots represent outliers in the outer 10<sup>th</sup> percentiles.

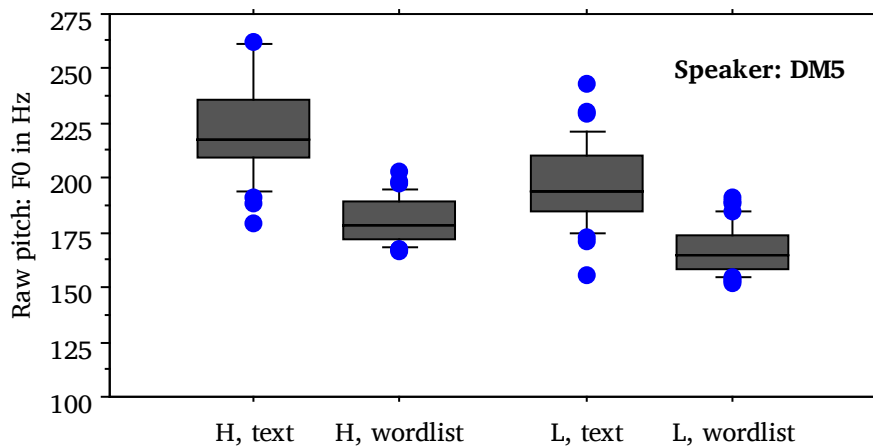
On the left of the graphic, DM3's H raw pitch values are displayed. His H text and H word list means are similar, with the H word list tokens showing slightly more variation and more outliers in the top 10<sup>th</sup> percentile. On the right, DM3's L text and L word list means share similar pitch levels, both lower than the H tones. In this case, more outliers are found in the L text measures. For a numerical comparison, I provide the values for all DM3's categories below in Table 85.

**Table 85** Raw pitch values and pitch spans for speaker DM3; H and L tones, both speech styles.  
Standard deviation for means is in parentheses.

SPEAKER	H	H SPAN	L	L SPAN	SPEECH STYLE
DM3	168.05 (20.08)	74.56	144.58 (18.8)	76.85	Text
	168.60 (19.8)	82.84	149.31 (19.4)	63.09	Word list

DM3's H means are higher than his L means. His word list means for H and L tones are slightly higher than their H and L text counterparts. The means for the H tone data are similar, irrespective of the speech style category. Overall, the variation found in all categories is comparable.

Raw pitch means for speaker DM5 are presented below in boxplot of Figure 83.



**Figure 83** Boxplot of H and L raw pitch measures for text and word list tones, speaker DM5.  
Error bars represent  $\pm 1$  standard deviation(s). Dots represent outliers in the outer 10<sup>th</sup> percentiles.

DM5's pitch level is noticeably higher than DM3. It is also the case that his pitch span is narrower for the word list data. He shows a high degree of variation in the H test tokens, as seen in the long error bars as well as many outliers in the L text tones. Also noteworthy, DM5's H tone means are not all higher than those of his L tones. Table 86 offers the numeric results for speaker DM5.

**Table 86** Raw pitch values and pitch spans for speaker DM5; H and L tones, both speech styles. Standard deviation for means is in parentheses.

SPEAKER	H	H SPAN	L	L SPAN	SPEECH STYLE
DM5	224.21 (26.8)	114.29	196.82 (18.4)	87.71	Text
	180.45 (10.2)	36.96	167.28 (11.3)	39.25	Word list

Within speech style categories, H tone means remain higher than their L tone counterparts; however, unlike DM3, it is not the case that all H tone means are higher than all L tone means for DM5. What is striking is that his H word list mean is lower than his L text mean. The pattern that emerges is that word list tones for DM5 are lower than his text tones, regardless of tone category. This result differs from that of DM3; DM3's word list means were higher than his text means, and the differences in tone category were not influenced by speech style.

Overall, both DM3 and DM5 retain salient H and L tone categories. The interesting difference between the two speakers is how these tone categories behave in the two speech styles. This section was an informal presentation of the raw pitch

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values measures in Hz. Before moving on to the inferential analysis of possible effects of speech style on pitch, the next section describes the distribution of normalized pitch.

#### *4.3.2 Distribution of normalized pitch measures*

This section offers a brief discussion on the distribution of pitch measures within a given speech style. Reporting mathematical moments can help characterize the location and variability of a set of measures. I have already incorporated the 2<sup>nd</sup> moment throughout earlier chapters in this dissertation: standard deviation. The third moment, skewness, is the focus of this section.

Skewness is a measure of the symmetry in distribution of the data points. For instance, data having a skewness measure of zero would show a normal distribution that is balanced, having equal measures situated below and above the mean. If there were a negative skew, the distribution of measures would be greater above the mean, having a longer tail in the lower range of measures. Conversely, a positive skew would indicate more measures below the mean, and a longer tail in the higher range. A skew of greater than  $\pm 1$  would indicate significantly skewed data.

Histograms are a visual means to display and discuss differences in distribution of measurements, including skewness. As mentioned in Chapter 2, in a histogram, each measurement is like a block that gets placed upon the x-axis; repeated instances of z-scores are stacked upon one another. Below in Figure 84, two sample graphics are

provided in order to explain the skewness measures and the anatomy of the histograms that will be presented in this section.

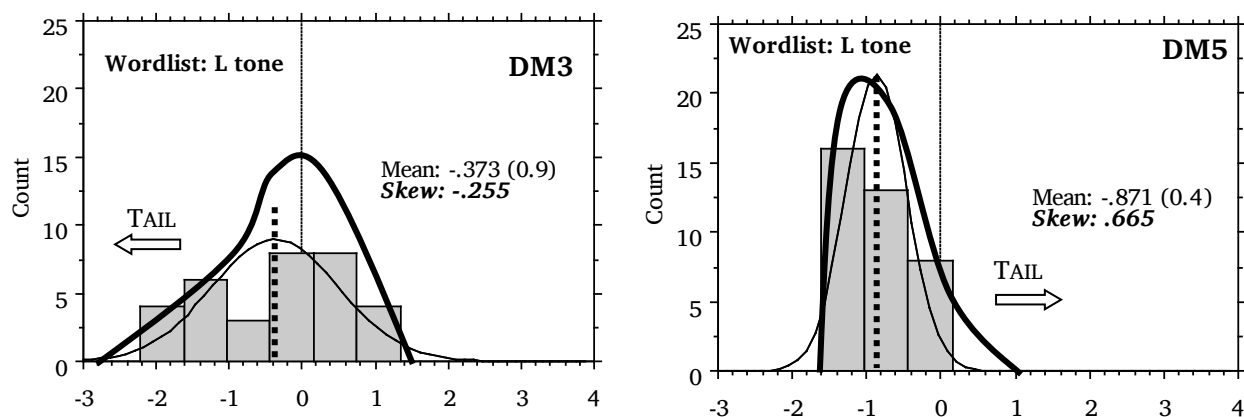


Figure 84 Sample histograms showing distribution of z-scores.

Within each histogram of Figure 84, a curve delimited by a thin line was automatically generated by the StatView software to represent the location of the mean. I've highlighted this location by placing an accompanying thick, dotted vertical line. Numeric representations of the mean, standard deviation (in parentheses) and skewness measures are situated in the right half of each graphic. The curve delimited by the thick, solid line was hand-generated in the above graphic (i.e. not generated by the statistics software) to help illuminate the shape of the skew of distribution and to highlight the direction of the tail.

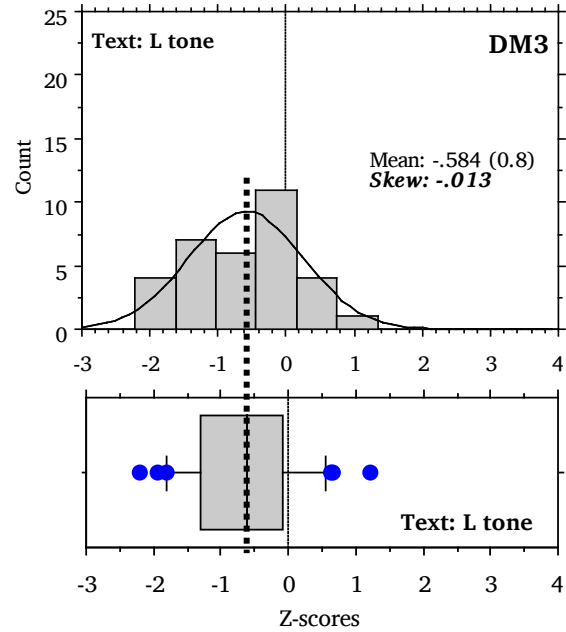
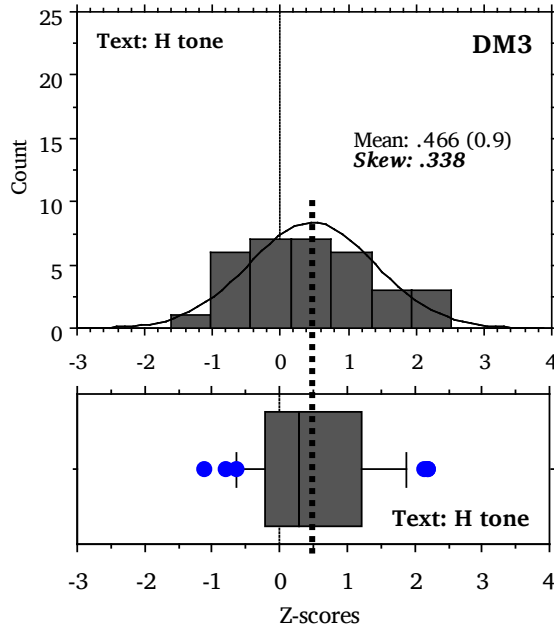
In the left-hand graphic, the skew is negative (-.255). The tail of the distribution is to the left of the mean, indicating outliers in the lower range. This signifies a distribution where the majority of pitch measures fall in the speaker's higher pitch

range. In the right-hand graphic, the skew is positive (.665); the tail is to the right of the speaker's mean. This skewness measure signifies that the majority of the distribution falls in the speaker's lower pitch range.

Having explained the composition of the histogram graphics, I will move on to present the results of this section, which provide the distribution of H and L pitch measures within both text and word list data for both speakers. The numbers of tokens in this analysis for each speaker are comparable; DM3 has 66 tokens from text data and 66 from word list data, while speaker DM5 has 66 tokens from text data and 72 from word list data. Along with each histogram I have added the corresponding mean boxplot aligned beneath it. As described in Chapter 2, boxplots are another method of graphically displaying data. In the boxplots previously presented in this dissertation, pitch levels and spans were arranged so that the z-scores were measured against the y-axis. Note that the orientation of the boxplots below has been rotated relative to the boxplots presented in Chapter 2; what I had earlier assigned the y-axis is the now x-axis, matching the histograms for a facilitated comparison.

Figure 85 presents the H and L measures from the text data of speakers DM3 and DM5.

## SPEAKER DM3



## SPEAKER DM5

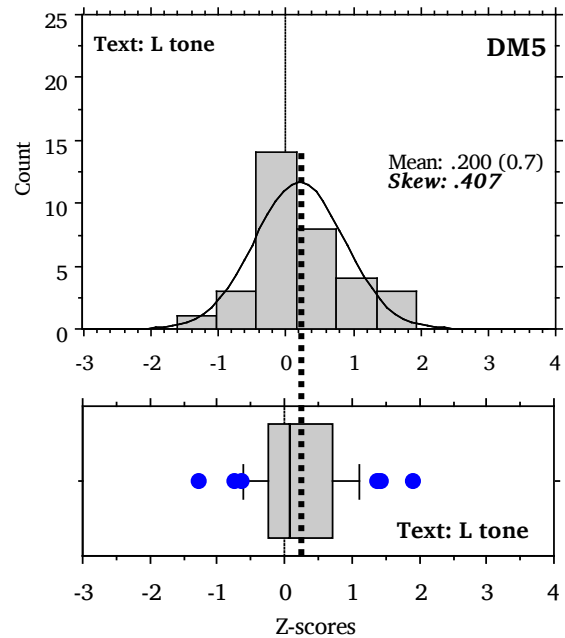
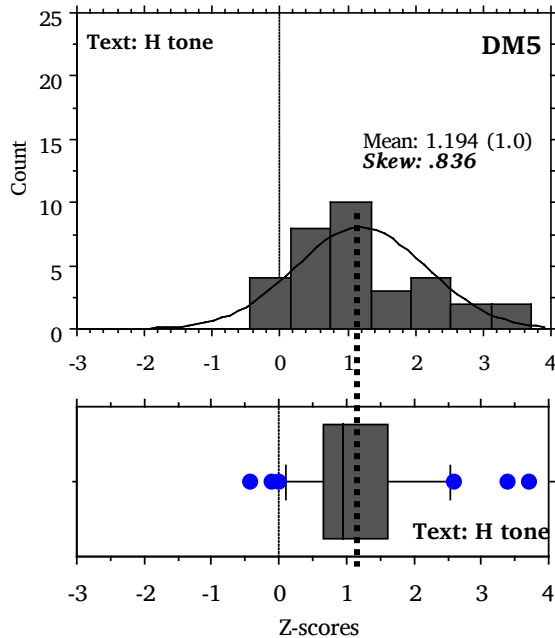


Figure 85 Text tone histograms and boxplots, speakers DM3 (top), DM5 (bottom). Left column represents H tones; those on the right represent L tones. Thick dotted line indicates mean within tonal category.

For all but DM3's L text tones, the data show a positive skew, indicating that the bulk of these z-score measures fall to the left, or below their respective means.

Regarding DM3 and DM5's H tone text measures, both have positive skewness values, signifying that there is a tendency to produce more extreme high outliers in the H-marked tone tokens than with the L-unmarked tone tokens.

The L tone text measures of DM3 exhibit the lowest skew measure (-.013) for the text data. This low skew indicates a near equal distribution of pitch measures on either side of his mean; 17 measures fall below his mean (z-score -.584), 16 measures fall above. DM3 has one outlier that falls above 1.0, creating the positive skew. The bulk of his measures, though equally distributed around the mean, fall at 0.00 or below.

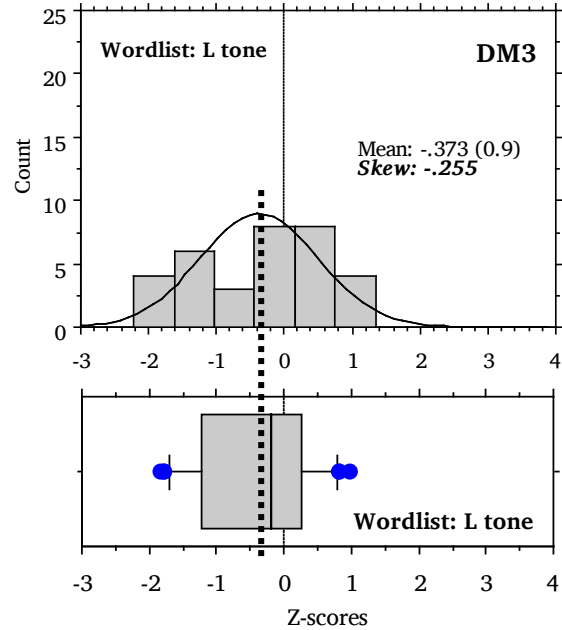
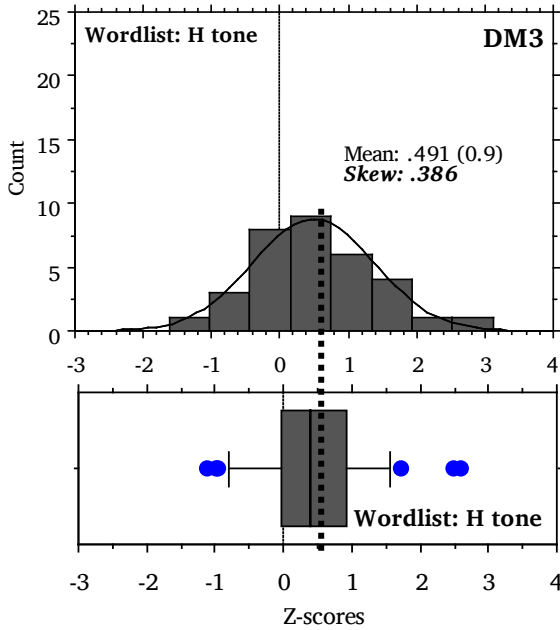
DM5's H text measures demonstrate the highest positive skew (.836). 12 measures fall above his mean (z-score 1.20), 21 below. DM5 shows outliers in his higher range, specifically two above 3.00, thus giving a positive skew to his data. In Figure 85, illustration of these high outliers can be seen in the accompanying boxplot; the error bar to the right is relatively long, representing measures between the 75<sup>th</sup> and 90<sup>th</sup> percentile of DM5's upper pitch range.

For the H-marked text tones, both speakers show relatively high levels of variability, standard deviation ranging between 0.9 and 1.0. This variation is also

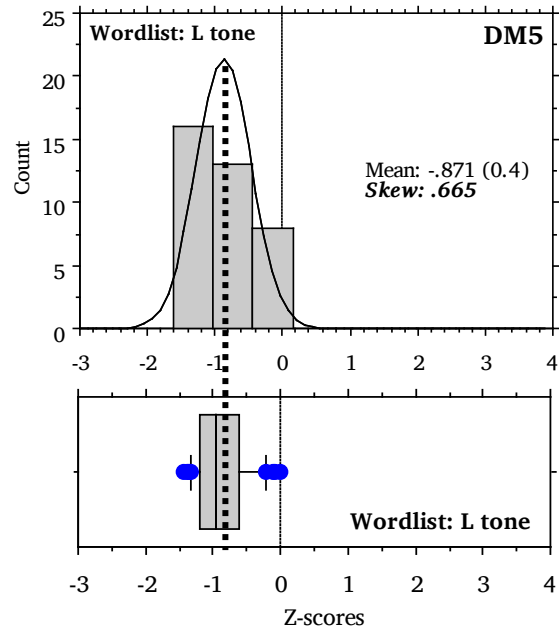
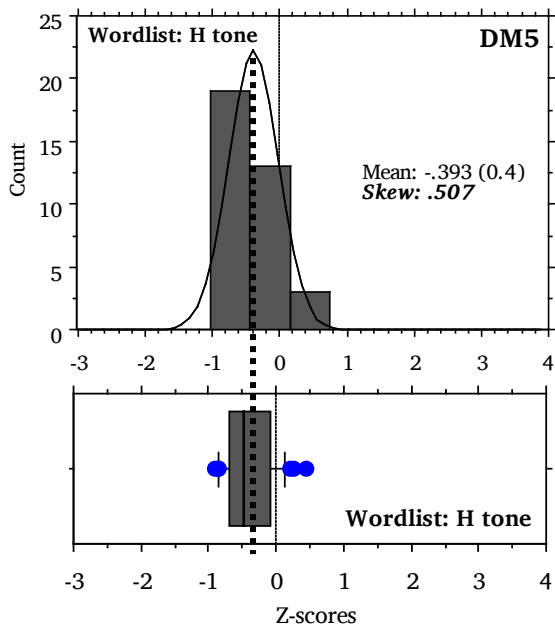
reflected in the error bars of the associated boxplots. The L-unmarked text tones show slightly less variation, DM3 showing a standard deviation of 0.8 and DM5, 0.7.

Moving on to the word list measures, Figure 86 presents the distribution of H and L word list results for both speakers.

**SPEAKER DM3**



**SPEAKER DM5**



**Figure 86** Word list tone histograms and boxplots, speakers DM3 (top), DM5 (bottom). Left column represents H tones; those on the right represent L tones. Thick dotted line indicates mean within tonal category.

What is noteworthy in Figure 86 is the shape of the distribution for DM5's H and L word list tones. He shows little variability in his tone production when taking part in the word list task. The measures cluster very near his means, H (-.393) and L (-.871); this fact is mirrored in the relatively short error bars in the accompanying boxplots of Figure 86. Both the H and L distributions for DM5 exhibit the highest skew measures for the word list data. The outliers, though neither extreme, nor plentiful, create a tail to the right, indicating the majority of his H and L tones are produced in his lower range. The little amount of variability, noted by the standard deviation value of (0.4), indicates a level of regularity for tone production for DM5's word list tones not seen in his text tone production. This lack of variability is not evident in either DM3's word list tone production or his text production.

DM3 again shows a negative skew measure, this time for his for L word list tones, indicating a predominance of those tones manifesting in the higher range; 20 measures fall above his mean (-.373), 14 below. The outliers in DM3's L word list measures are quite low; there are 5 measures between -1.50 and -2.00 of the normalized pitch range. On the other hand, most of DM3's H tone word list measures, mean of (.491), are evenly distributed between -0.05 and 1.50; however, the two extreme outliers near 2.50 create the positive skew to the data.

The positive skew results indicate that within the pitch range of a given tone category and speech style, DM3 (excluding his L text tones) and DM5 tended to

produce tones in the lower range. Most of the extreme outliers fell in the higher pitch range, for both the H-marked and the L-unmarked tones. I present the numeric results for skewness in Table 87.

**Table 87** Summary table of skewness measures for speakers DM3 and DM5, both speech styles.

SPEAKER	H	L	SPEECH STYLE
DM3	.338	-.013	Text
	.386	-.255	Word list
DM5	.836	.407	Text
	.507	.665	Word list

The most notable pattern is that DM5 has the highest skewness measures for every category. This result indicates that DM5 has a tendency to produce the majority of his H and L tone targets in his lower pitch range. Another pattern that emerged is that the distribution of DM3's L tones for both speech styles showed negative skewness values. His L-unmarked tones were produced with more outliers in his lower pitch range.

#### 4.3.3 *Effects of Tone category and Speech style on normalized pitch*

This section presents results of the two-factor ANOVA experiment designed to explore effects of speech style on normalized pitch. Independent variables in this experiment include Speech style (Text, Word list) and Tone category (H, L), the dependent variable is Normalized pitch (z-scores). In Section 4.3.3.1 I will present results for main effects

of Tone category and Speech style. Section 4.3.3.2 will present findings of interactions between the two variables.

#### 4.3.3.1 Main effects

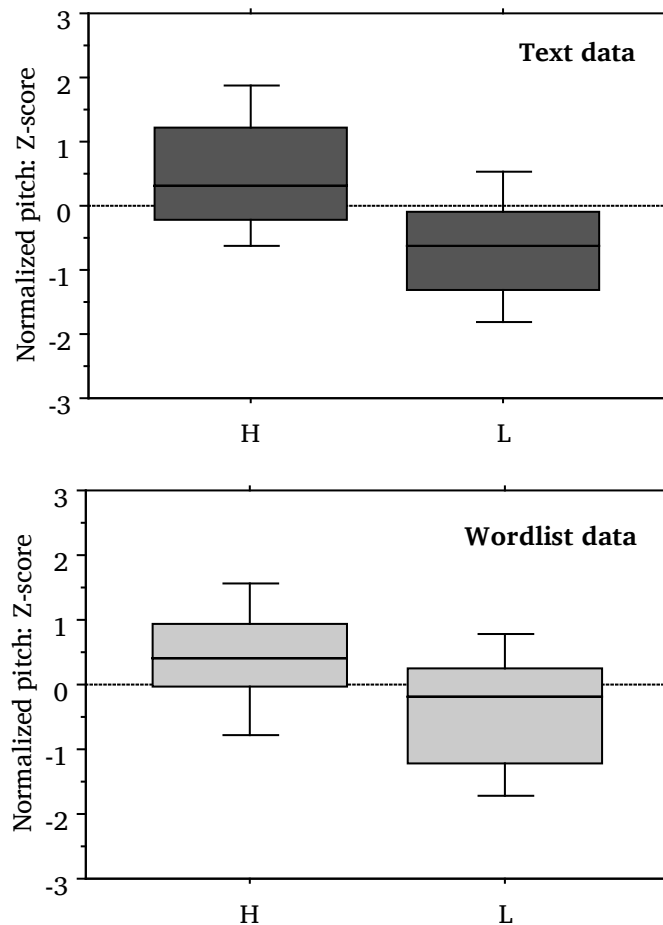
##### 4.3.3.1.1 Tone category

It has been noted in Chapter 2, Section 2.4 and previous work on Dane-zaa tone (Miller, 2003, 2007a) that across speakers, H tones have significantly higher normalized pitch values than L tones. This section investigates whether or not this finding holds when investigating tone within two different speech styles. My hypotheses are restated below in (21).

(21) **Hypotheses for effects of Tone category:**

- a) H tones will be higher than L tones in tokens falling within word list data as well as narrative speech data
- b) This difference will be statistically significant

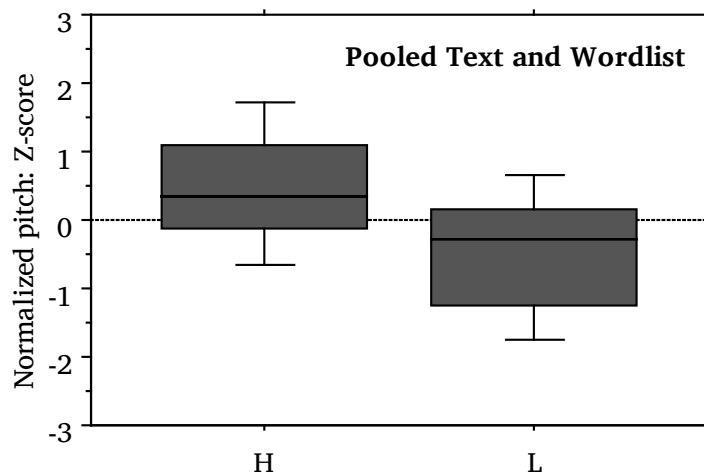
In order to discuss Tone category as an isolated factor, the means presented in the boxplots below report each speech style separately. Figure 87 provides the H and L means of the text and word list tokens for DM3.



**Figure 87** Boxplots of H and L normalized pitch measures for text tones (top) and word list tones (bottom), speaker DM3. Error bars represent  $\pm 1$  standard deviation(s).

For speaker DM3, H text tones show a mean of .466 ( $s = 0.9$ ), the L tones, a mean of  $-0.584$  ( $s = 0.8$ ). This pattern holds with his word list data; DM3's H word list means, .491 ( $s = 0.9$ ) are higher than his L word list means,  $-0.373$  ( $s = 0.9$ ). Results of the two-factor ANOVA, focusing on the effect of Tone category, indicate that the difference between H and L tone categories for speaker DM3 is significant, ( $F[1,128] = 38.694$ ,  $p < .0001$ ).

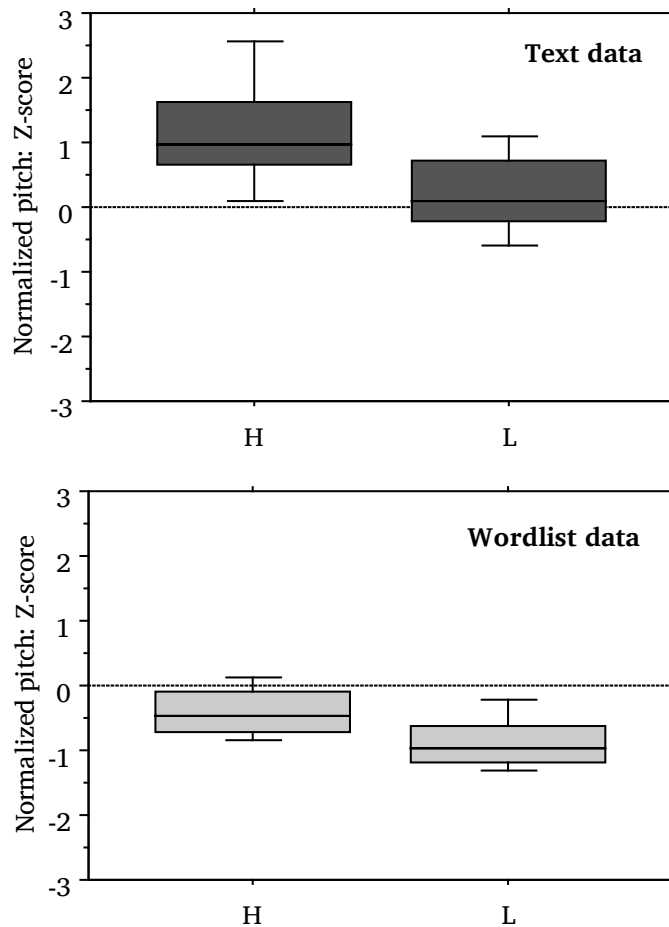
To evaluate DM3's pitch means and spans for H and L tones averaged across Speech style, I offer the boxplot in Figure 88 below.



**Figure 88** Boxplot for H and L means of normalized pitch measures pooled across Speech style, speaker DM3. Error bars represent  $\pm 1$  standard deviation(s).

Pooled results show a mean of .479 ( $s=0.9$ ) for DM3's H tones, with a pitch span of 3.712. His L tones yield a mean of -.479 ( $s=0.9$ ) and a span of 3.441. These means support my hypothesis that H tones will be higher than L tones, even when text and word list data are averaged together.

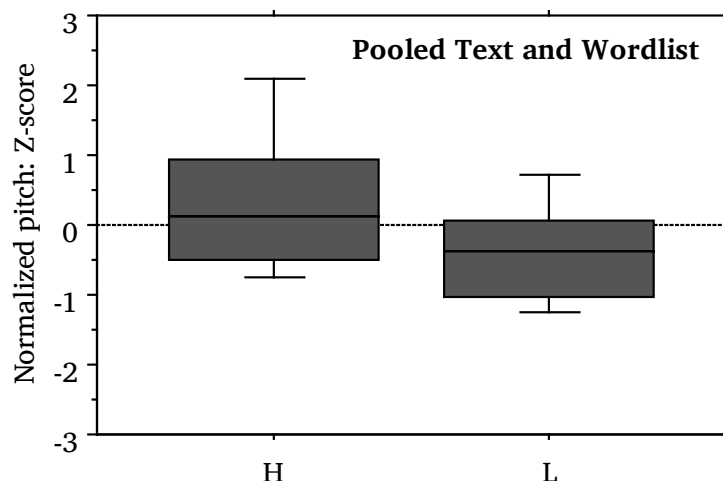
DM5 shows the same anticipated pattern of H tones yielding higher normalized pitch measures than his L tones. Figure 89 presents means for speaker DM5, separated by speech style.



**Figure 89** Boxplots of H and L normalized pitch measures for text tones (top) and word list tones (bottom), speaker DM5. Error bars represent  $\pm 1$  standard deviation(s).

H text tones for DM5 yield a mean of 1.194 showing a relatively high degree of variation ( $s = 1.0$ ), as seen in the top error bar. L text tones for DM5 present a lower mean, .200 ( $s = 0.7$ ). Regarding the word list means for DM5, the H tones -.393 ( $s = 0.4$ ) are higher than his L tones, -.871 ( $s = 0.4$ ). ANOVA results, again focusing on the effect of Tone category, confirm that these differences in tone category are significant, ( $F[1,134] = 45.211$ ,  $p < .0001$ ).

Pooled results for DM5's H and L tones, averaged across Speech style are presented in Figure 90.



**Figure 90** Boxplot for H and L means of normalized pitch measures pooled across Speech style, speaker DM5. Error bars represent  $\pm 1$  standard deviation(s).

For DM5, H tone measures pooled across text and word list data show a mean of .377 ( $s = 1.1$ ) and a span of 4.611. His L tone mean is  $-0.365$  ( $s = 0.8$ ). These results support my prediction that H text and H word list tones, when pooled together will be higher than their L pooled counterparts. It is important to remember that, as seen earlier in in the raw pitch results in Figure 83, speaker DM5 had similar pitch means for his H word list and L text tones and the pitch level for the texts was higher than his word list level. Even after normalization of the data, DM5's pitch levels for both H and L tones are higher than DM3's. It is also the case that the difference between H and L is less extreme for DM5.

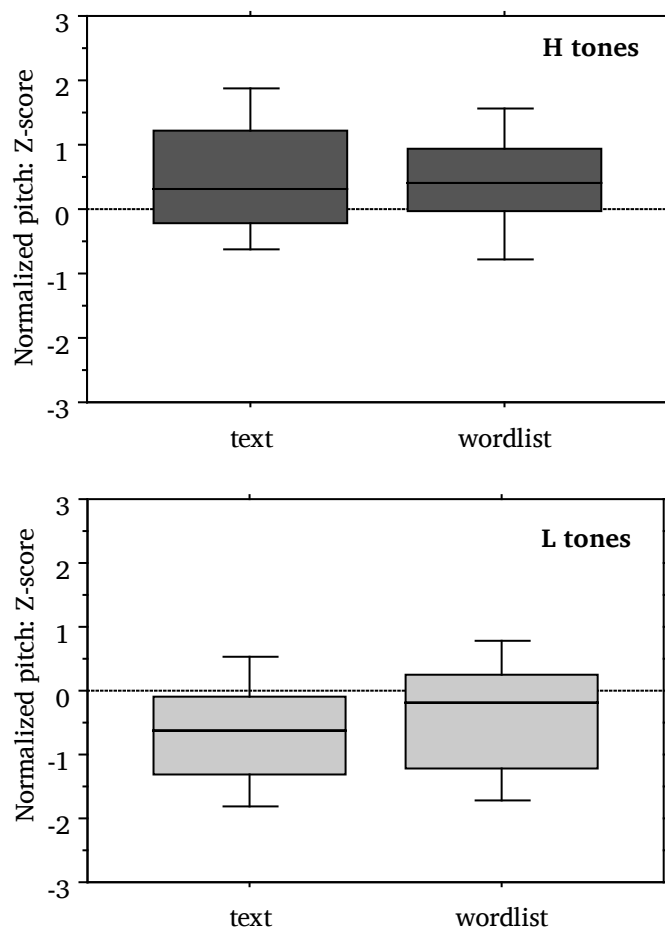
Overall, for both DM3 and DM5, my hypothesis from (21) was supported. It is the case that for both speakers, H and L tones retained their salient categories. H tones were statistically higher than L tones, across both speech styles.

#### 4.3.3.1.2 Speech style

Continuing on to the results for the second factor, Speech style, I begin with the assertion that word list and text speech are, in fact, distinct speech styles and will have different effects on pitch. I propose that the word list speech is a less natural speech style and therefore participants will have paid more careful attention to their speech than during the narrative elicitation session. My hypothesis for this experiment is restated below in (22).

(22) **Hypothesis for effects of Speech style:** Speakers will exhibit more variation and a wider pitch span for tones found in text data

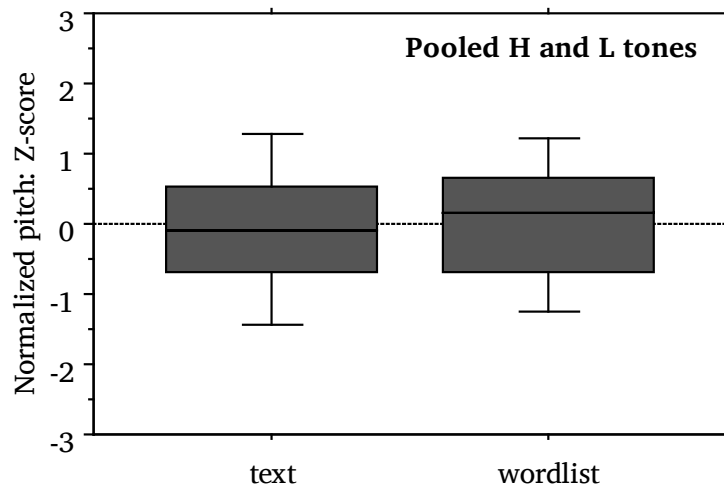
Figure 91 presents the boxplots of normalized pitch means for text and word list data for speaker DM3. As above, in order to isolate Speech style as a factor, results are separated by Tone category. These results are the same means presented for Tone category above, merely rearranged for side-by-side comparison of the two styles.



**Figure 91** Boxplots of text and word list means of normalized pitch measures for H tones (top) and L tones (bottom), speaker DM3. Error bars represent  $\pm 1$  standard deviation(s).

Focusing on DM3's H tone data, the text mean of .466 ( $s=0.9$ ) and word list mean of .491 ( $s=0.9$ ) are relatively similar. DM3's L text mean of  $-.584$  ( $s=0.8$ ) is also similar to his L word list mean,  $-.373$  ( $s=0.9$ ). Results of the two-factor ANOVA indicate that there is no significant effect of Speech style on Normalized pitch for speaker DM3.

In order to address the research question pertaining to overall pitch span and variation, I present the same data below, averaged across Tone category.

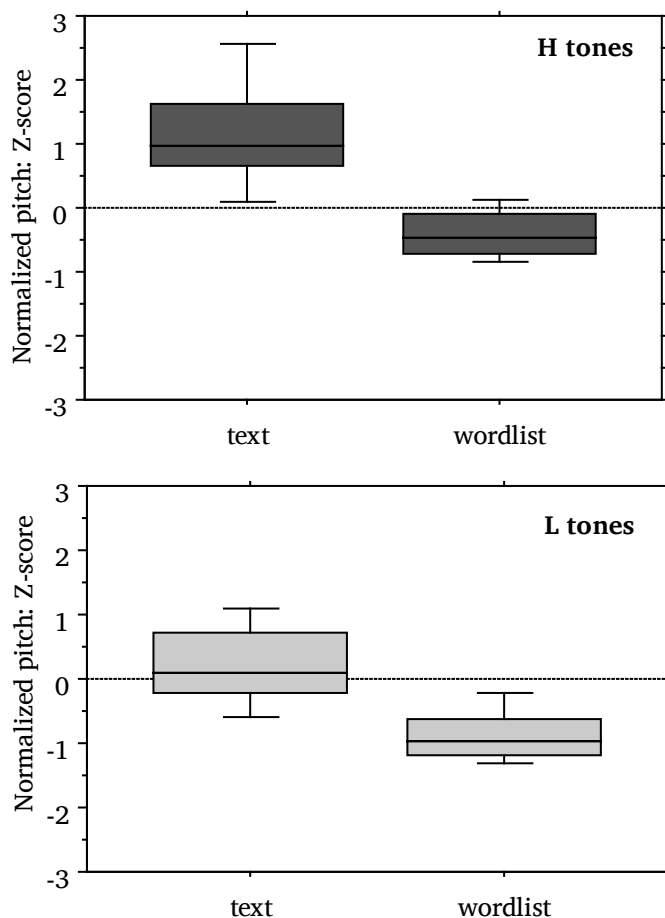


**Figure 92** Boxplot for text and word list means of normalized pitch measures pooled across Tone category, speaker DM3. Error bars represent  $\pm 1$  standard deviation(s).

Pooled results for DM3 show a mean of  $-.059$  ( $s = 1.0$ ) for text tones, with a pitch span of 4.222. His word list data averaged  $.059$  ( $s = 1.0$ ) and a similar pitch span of 4.424.

Results from DM3 do not support my hypothesis; his pitch span is not wider for his text data.

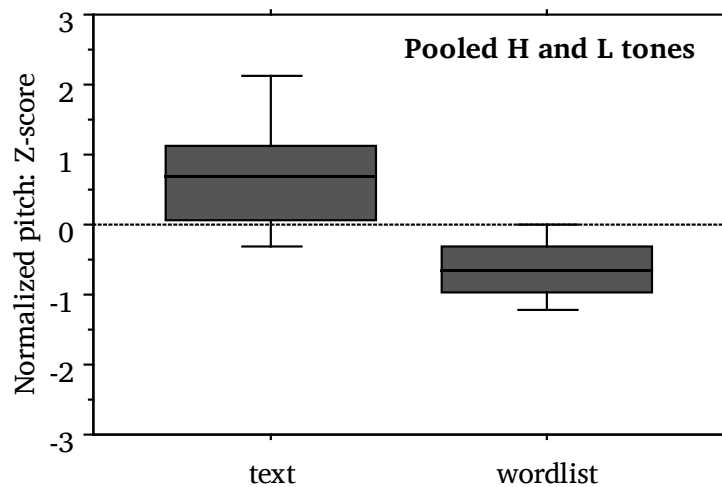
Moving on to DM5's results, Figure 93 provides a boxplot of his text and word list means, separated by H and L tone category.



**Figure 93** Boxplots of text and word list means of normalized pitch measures for H tones (top) and L tones (bottom), speaker DM5. Error bars represent  $\pm 1$  standard deviation(s).

DM5's H tone text tokens show a mean of 1.194 ( $s = 1.0$ ); his H tone word list mean is much lower: .200 ( $s = 0.7$ ). The L tone tokens follow a similar pattern; DM5's L text average is -.393 ( $s = 0.4$ ) and his L word list tones are lower still, averaging -.871 ( $s = 0.4$ ). Results of the two-factor ANOVA indicate that for speaker DM5, there was a significant main effect for Speech style ( $F [1,134] = 147.656, p < .0001$ ). DM5's text

tones were significantly different from his word list tones. A boxplot presenting results averaged across Tone category is presented in Figure 94 below.



**Figure 94** Boxplot for text and word list means of normalized pitch measures pooled across Tone category, speaker DM5. Error bars represent  $\pm 1$  standard deviation(s).

DM5 has a relatively high mean for his text tones, .697 ( $s = 1.0$ ), and a pitch span of 4.996. His word list tones yield a mean of -.639 ( $s = 0.5$ ); the pitch span is compressed in comparison to the text tones, 1.862. As can be noted in the long error bar of his text data, DM5 shows more variability in the upper 75th - 90th percentile range of his text data, than in the lower range of his text measures, or those of his word list measures.

I had predicted that speakers would exhibit a wider pitch span in text data than in word list data. This was borne out for DM5, who exhibited a wider pitch span for his text tones. DM3, did not follow the anticipated pattern of a wider pitch span for

text speech. In the next section I present results for interactions between the variables in order to further characterize the effects of speech style on normalized pitch.

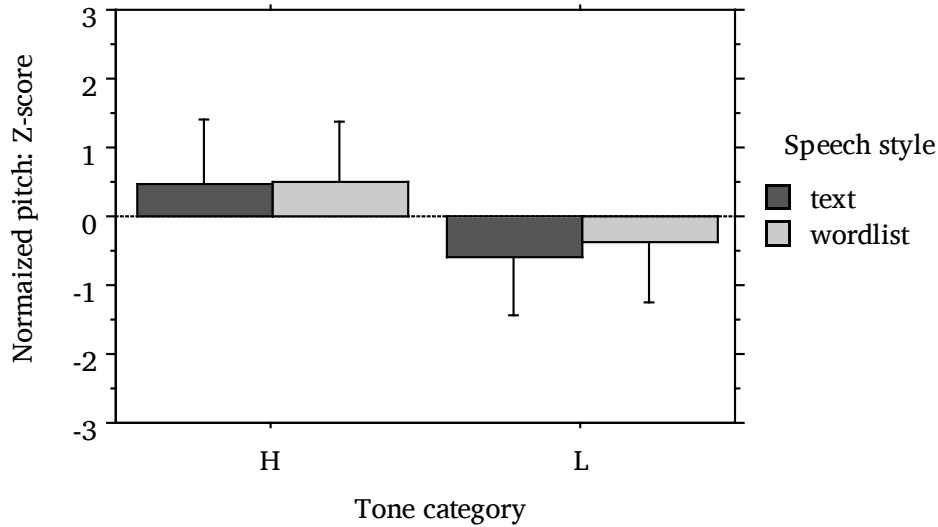
#### 4.3.3.2 Interactions

For this investigation, I set out to determine H text tones manifest differently than H word list tones, and the same for their L tone counterparts. The hypotheses for this experiment are presented below in (23).

**(23) Hypotheses for Interactions between Tone category and Speech style:**

- a) The mean of H tones in text data will be *higher* than the mean of H tones in word list data
- b) The mean of L tones in text data will be *lower* than the mean of L tones in word list data

Figure 95 below provides a boxplot of the means for speaker DM3, separated by Tone category and Speech style.



**Figure 95** H and L tone means of normalized pitch measures (z-scores) for Speech style x Tone category, speaker DM3. Error bars represent  $\pm 1$  standard deviation(s).

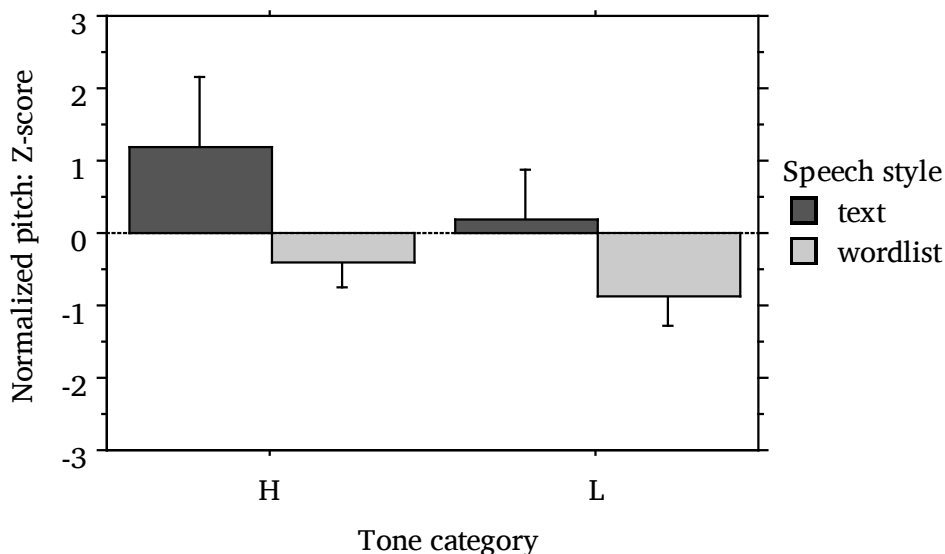
As was noted in above section of main effect of Speech style, DM3's text and word list measures do not show much difference, pooled across Tone category. It is also the case that his H text tones appear similar to his H word list tones. The same similarity is found in the corresponding L tone speech styles. Below I provide the numeric results for these means and standard deviations in Table 68.

**Table 88** Normalized pitch measures for speaker DM3; H and L tones, both speech styles. Measures are z-scores, standard deviation for means are in parentheses.

SPEAKER	H	H SPAN	L	L SPAN	SPEECH STYLE
DM3	.466 (0.9)	3.338	-.584 (0.8)	3.441	Text
	.491 (0.9)	3.709	-.373 (0.9)	2.969	Word list

Descriptive results from DM3 show little difference between the means of his H text and word list data, and the corresponding L categories. His spans are also similar with the exception of the slightly more compressed span for his L-unmarked word list tones. Results of the two-factor ANOVA indicate that DM3 did not show any interactions between Tone category and Speech style. That is to say, DM3's H tones in word lists are not significantly different from the H tone in his texts, as is the case with his L tones.

Moving on to speaker DM5, Figure 96 presents the normalized pitch means, separated by Tone category and Speech style.



**Figure 96** H and L tone means of normalized pitch measures (z-scores) for Speech style x Tone category, speaker DM5. Error bars represent  $\pm 1$  standard deviation(s).

As was noted in the results for raw pitch in Figure 83, DM5's H text tones are quite different from the H word list tones. This difference is still the case for the normalized results. His H text tones fall well above the 0.0 mark; his H word list tones, below. A similar pattern is found in his L-marked tones; his L word list tones fall well below his L text tones. Numeric results for DM5's means and standard deviations are presented in Table 89.

**Table 89 Normalized pitch measures for speaker DM5; H and L tones, both speech styles. Measures are z-scores, standard deviation for means are in parentheses.**

SPEAKER	H	H SPAN	L	L SPAN	SPEECH STYLE
DM5	1.194 (1.0)	4.146	.200 (0.7)	3.181	Text
	-.393 (0.4)	1.340	-.871 (0.4)	1.425	Word list

Within a given speech style, the H tone means are higher than those of the L tones; DM5's H text measures are higher than his L text measures and his H word list tones are higher than his L word list tones. However, it is not the case that all of DM5's H tones yield higher means than his L tones. His H tone word list mean is lower than his L text mean. This anomaly is corroborated as a significant interaction between Tone category and Speech style, ( $F [1,134] = 5.554, p = .0199$ ).

In the end, only results from DM5 supported my hypothesis that H text and H word list tones would manifest differently, as with their L tone counterparts. Generally, the pattern of higher H tones in text data than in word list data was only

held by DM5. As predicted, DM3's L tones were lower in his word list data. This was also the case for DM5, supporting my idea that the more formal speech style would yield lower pitch.

#### 4.3.4 Summary for effects of Tone category and Speech style on normalized pitch

This chapter investigated differences in normalized pitch due to effects and interactions of Tone category and Speech style. To summarize the ANOVA findings, the significance results for each of the experiments are presented below in Table 90.

**Table 90** Summary of significance results for factorial ANOVA Tone category x Speech style.

FACTORIAL RESULTS	
SPEAKER	TONE CATEGORY X SPEECH STYLE X LEXICAL CATEGORY
DM3	Tone: F [1,123] = 38.694, p < .0001
	SpeechStyle: not significant
	Tone*SpeechStyle: not significant
DM5	Tone: F [1,134] = 45.211, p < .0001
	SpeechStyle: F [1,134] = 147.656, p < .0001
	Tone*SpeechStyle: F [1,134] = 5.554, p = .0199

Both DM3 and DM5 showed significant categorical distinctions for tone categories. This tells us that even in connected speech; tone category is salient for both speakers. The manner in which the two speakers diverge is that the categorical differences for DM5 look very different within a given speech style. Not so for DM3.

Also, DM5 has a comparatively compressed pitch range for his word list task. The wider pitch span and high variability found in DM5's results for speech style may gloss over some important prosodic details. It is possible that there are genre-specific prosodic contours in story-telling that might explain what the wider pitch range might mean. That the variation might not stem from spurious pitch production, rather from controlled intonational phrasing. This last point would require further analysis of the intonational system of Doig in order to shed any light on the matter.

#### **4.4 Discussion**

Sociolinguistic variation is constrained by unconscious licit variation in a phonological system. Within a given speech style H and L tone categories were retained. Even when one considers the broader landscape of style, one beyond linguistic cues, speakers may draw from this broader landscape to mark style in a way that is meaningful to them; however it is not mandatory in order for a speaker to remain faithful to the communicative event.

In Figure 97 I provide two images captured from video of the Sweeney Creek narrative, showing speaker DM5. In both pictures DM5 can be seen using eye gaze and gesture; he does so liberally throughout the narrative. These non-linguistic semiotic cues were not used by him during the elicitation of the word list data. Recall that speaker DM5 showed a much greater disparity between the tones of the word list and

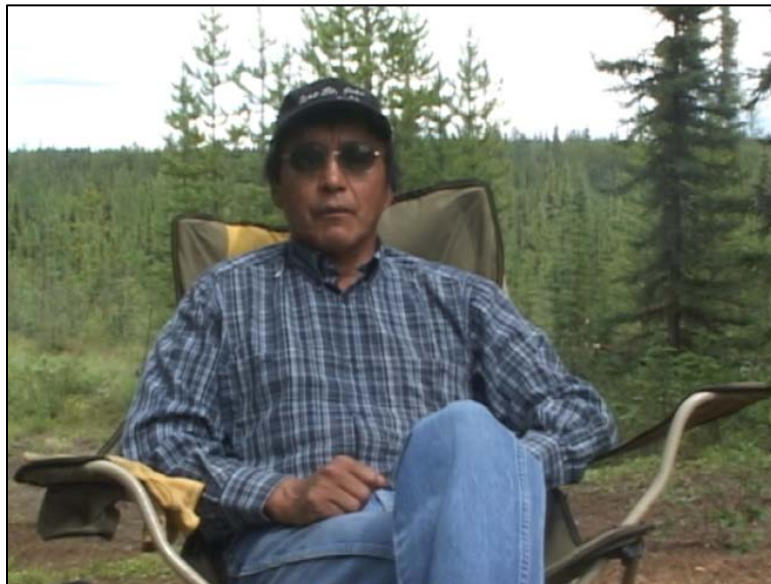
those of the narrative. Additionally, he had a significant difference in how H and L tones manifested within each speech style. DM5's H tones within the word list data were lower than the L tones of his narrative. He did retain a significant difference between tone categories within a given speech style, however. He was able to adhere to the expected use of lexical tone in his language, while simultaneously manipulating his pitch range significantly as a means to signify a difference in style utilizing language-internal semiotics. I assert that he was expressing style via language-external features of gesture and eye gaze, in addition to the linguistic feature of pitch, exemplifying Coupland's idea of expressive style.



**Figure 97** Images captured from video footage of Sweeney Creek narrative. Speaker DM5 using gesture and eye gaze throughout story-telling event.

Presented below, Figure 98 shows two images captured from the video of the narrative Snare Hill, with speaker DM3. This speaker did not rely upon non-linguistic

semiotic cues to mark style; neither did he utilize non-linguistic cues. The images are taken from speaker DM3's telling of the Snare Hill story. Throughout the speech event, the speaker's hands moved very little and his gaze remained fixed. He did not show a significant difference in pitch between his word list data and his narrative data.



**Figure 98** Images captured from video footage of Snare Hill narrative. Speaker DM3 not utilizing gesture or eye gaze; speaker kept hands still and eyes forward throughout narrative event.

Recall that this speaker did retain a significant difference between the H and L tone categories within each speech style, but his H tones in his word list data

resembled the H tones in the narrative; and the same pattern was found in the L tone categories. Additionally, he did not utilize gesture or eye gaze during the narrative.

The two speakers chosen by their community to tell stories in the Dane-zaa language did so successfully. The stories were submitted to the online webpage with full community approval. It is clear that both speakers remained faithful to the speech event. That said, the two speakers did not differentiate style in the same manner. DM5 marked style with both linguistic and non-linguistic semiotic cues; DM3 did not stylistically differentiate the word list from the storytelling. It is possible DM3 utilized other semiotic cues to mark the difference in style, but this falls outside the purview of the current study.

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## 5 Conclusion

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### *5.1 Summary of research findings*

The preceding chapters of this dissertation provided a detailed investigation into the acoustic properties of lexical tone in the Doig River and Halfway River dialects of Dane-zaa, specifically two dialects with mirror-image tone systems. The chosen research questions were designed to address the paucity of instrumental investigations into Athabaskan tonal languages, specifically one with a unique mirror-image tone system. The H- and L-marked dialects offered fertile ground for exploring tonal contrasts in different environments.

Chapter 2 explored effects of linguistic features on normalized pitch, including tone, lexical and morphological categories for eight Doig speakers and six Halfway

speakers. The first research question was designed to revisit effects of expected tone category on the pitch of both marked and unmarked target syllables. I was interested in exploring differences in how marked tone is expressed in each dialect, as well as differences that manifest at the individual level. Due to the extant variation found in both Doig and Halfway dialects regarding lexical tone in previous studies (Miller, 2003, 2007a), I wanted to revisit the question of whether or not H and L tone categories would be significantly distinct when more speakers from both dialects were investigated. My hypothesis was supported for distinct differences between tone categories; all speakers produced higher pitch in H tone syllables than in L tone syllables, though for four of the fourteen speakers this difference was not significant.

The next question was to determine if pitch falling within a verb might somehow manifest differently than that falling within a noun or adverb. I hypothesized that target syllables within verbs would have significantly lower pitch than those of non-verbs, for both the high-marked and low-marked dialects. Krauss (1979, 2005, 1996b) had noted that Athabaskan verbs exhibit a tendency for pattern leveling such as pitch lowering of verbs in sentence-final positions. This investigation was to determine if there remained an effect of lexical category, beyond that which was due to location in utterance.

The general outcome was that pitch on verbs was indeed lower than that of non-verbs. As I had controlled the location of targets in sentence-medial locations in carrier

phrases, the SOV nature of the language did not influence these findings. Upon looking to individual results, speakers deviated from the expected trend in the L tone targets; for each dialect, half of the speakers produced higher pitch in the L verbs than in L non-verbs. McDonough (1999) offers an interesting point. In Navajo, as in all Athabaskan languages, verbs are complete propositions, thus potentially carrying a sentence-level intonation pitch contour. In this dissertation, it was not the case that pitch lowered in L tone verbs for all speakers. Further research needs to be performed to determine the source of variation for the L tone verbs.

The last part of this chapter explored tone of prefixes and stems. I anticipated that there would be significant differences in pitch, depending on the type of morpheme in which the target syllable fell. Drawing upon results from the previous experiment which focused on effects of lexical category, this experiment further investigated the idea of a possible influence of a sentential intonational contour. Krauss (1996a) had determined that in Minto final verb stems, whether marked or unmarked, are neutralized to a low tone. Tuttle (1998) confirmed this with phonetic evidence; there was no statistically significant difference between the pitch of Minto H and L stems. She did find that the L marked stems had higher pitch than did the unmarked H stems, though she did not speculate as to why.

For this study, I had proposed that stem tones would yield lower pitch than prefix tones, for both the high-marked and low-marked dialects, regardless of tone

category. Group results indicated that there was no significant difference in pitch between the two morpheme types. At the individual level, however, an interesting pattern came about. For the L tone targets, thirteen of the fourteen speakers of both dialects produced lower tone on the stems than prefixes. For the H tone tokens, two of the eight Doig speakers did not follow the expected trend of lowering stem tone. The surprising pattern was that all six Halfway speakers produced higher tone on the H stems than on the H prefixes. I could speculate that this means there is no L% boundary tone for Halfway as was found in the Northern Alberta dialect of Dane-zaa (Müller, 2009), thus the H stems are not lowered as they are in Doig. Or as McDonough (1999) points out, there is a bifurcation of rules pertaining to H and L tones in Navajo; it may be that the falling pitch in final L stems is due to a boundary tone which lowers final L tones, but does not affect H tones. There may also be a difference in stress assignment between the two dialects, whereby stress is assigned to stems in Halfway, but in Doig, stress assignment is overridden by the L%. As mentioned in Chapter 2, Athabaskan stems, enclitics and suffixes are typically the stress attractors, so it is unlikely that Doig prefixes are stressed and stems are not. Clearly the topics of a special status for final L tones in stems, as well as differences between the disjunct, conjunct and stems domains require further investigation.

Chapter 3 offered an exploration into the effects of word final glottal stop on voice quality in a tonal Athabaskan language. This experiment was designed to see

whether I could find synchronic evidence to support Kingston's theory of Proto-Athabaskan tense vs. creaky phonation leading to tonogenesis of both H and L tone in Dane-zaa. I hypothesized that the voice quality of vowels preceding word-final glottal stops would be significantly different from that of vowels in open syllables. I anticipated that for Doig speakers, H-marked vowels preceding glottal stops would show significantly higher pitch and greater tense phonation than vowels in open syllables. For Halfway speakers, I expected that these pre-glottal stop L-marked vowels would show significantly lower pitch and greater lax or creaky phonation than those in open syllables. Despite the mirror-image tone marking, both dialects had lower energy, greater jitter and greater spectral tilt measures at the endpoint of vowels preceding glottal stops. For the group results based on dialects, word-final glottal stops lowered the pitch of the preceding vowel for the Halfway dialect. For the Doig dialect, there was no significant effect on pitch. This result is interesting especially for the Doig speakers, as these segments had a historical pitch raising effect, thus the H-marked status of Doig.

Chapter 4 explored the possibility of differences in the realization of tone between word list and narrative speech for two speakers of the Doig dialect. Collecting one type of speech would yield a limited set of results. To observe intra-speaker variation, it was necessary to collect more than one style of speech. My general hypothesis for this investigation was that H and L tone categories would remain salient

in word list data as well as narrative data. I further hypothesized that due to the higher degree of attention paid to speech, word list data would have significantly less variation and a narrower pitch span than that of narrative data. I also posited that there would be a significant effect for speech style and that differences between H and L tone categories of the text data would manifest differently than those of their counterparts in the narrative data.

My proposition that H and L tones would remain salient categories within narrative speech as they did for the word list data was confirmed. It was not the case that all H tone means were higher than all L tone means; however, within a given speech style, all H means were higher than their L counterparts. The hypothesis that speakers would exhibit a wider pitch range in text data than in word list data was confirmed for only one speaker. The other speaker exhibited a slightly wider pitch span for his word list tones. Results for skewness indicated that both speakers had a tendency to use the lower range of pitch within each tone category, with a few outliers in their higher pitch range.

## 5.2 Discussion

### 5.2.1 Contribution to Athabaskan linguistics

Over the past decade there has been an increase in the number of instrumental studies of Athabaskan languages (Navajo (McDonough, 2003), Dëne Sų́líné (Gessner, 2005), Tsek'ene (Hargus, 2010, In preparation), Witsuwit'en (Hargus, 2005, 2007), Deg Xinag (Hargus, 2005, In progress), Tanacross (Holton, 2005), Apache (Tuttle, 2005)). Some gaps in what is known about tone in Athabaskan have been addressed in this dissertation, specifically pertaining to the effects of tone category, lexical category and morphological category on the manifestation of pitch. Additionally, the topic of speech style has never been investigated for an Athabaskan language outside of the ethnographic work by Scollon and Scollon (1979).

A surprising pattern presented itself concerning the status of tone in the Doig dialect. Out of the eight Doig speakers, four of them (two men, two women) did not have a significant difference between H and L tone categories. Additionally, having explored effects of word-final glottal stops on the voice quality of preceding vowels, Doig word-final glottal stops were found to not raise the pitch on the pre-glottal stop vowels. This fact is surprising because at some stage in Proto-Athabaskan, or during a later phase of an innovative tone reversal, the word-final constriction would have

raised pitch in order for H tone to be the marked reflex of PA glottalization. These facts can be taken as evidence that tone is in a transitional stage in Doig.

There is a paucity of studies on style in First Nations languages; much of the extant research addresses the larger topics of language identity, language contact or language shift. As for First Nations narratives, most studies tend toward ethnographic or ethnopoetic approaches. This dissertation broached a previously uninvestigated topic in an Athabaskan language: acoustic interactions between speech style and lexical tone. The topic of linguistic and non-linguistic semiotic manifestations of stylistic variation is one that I plan to pursue with further analyses of conversational data, folktales, historical narratives, among other genres that have already been recorded.

Returning to the topic of variation along the continuum of Athabaskan languages (or dialects) briefly discussed in Section 1.3.2, there is the ongoing question of whether or not Dane-zaa and Tsek'ene are, in fact, the same language. After investigating the Doig and Halfway dialects of Dane-zaa it is evident that intra-language variation exists to a great degree. The dimensions by which these dialects diverge are unpredictable (e.g. tone marking, statistically robust tonal categories, effects of flanking glottalic segments, presence/absence of dental consonant series). I am unable to make solid predictions as to how one dialect will behave linguistically, based on the other. Dane-zaa and Tsek'ene diverge even more than do Doig and

Halfway. Recall that Doig and Halfway dialects have an asymmetric intelligibility; Halfway speakers can understand Doig speakers, but it is not the case that Doig speakers can easily understand the Halfway speakers. The dialect survey of Dane-zaa and Tsek'ene mentioned in Section 1.3.2 indicated that there was a high level of lexical overlap (77%) between Doig and Halfway, but a 62% overlap between Halfway and Tsek'ene.

### 5.2.2 *Implications for Athabaskan tonogenesis*

The findings of this dissertation, specifically the examination of effects of word-final glottal stops on the voice quality of the preceding vowel, shed new light on what is known about Athabaskan tonogenesis, including the possible classification of the Dane-zaa glottal stop as either “stiff” or “slack”. For the Halfway speakers, word final glottal stop had the characteristics of Kingston’s “slack” ejectives, causing vowel offset to have lower pitch, lower energy, greater irregularity in the glottal pulses, and less intensity in the higher formants. Doig speakers showed similar equivalent results, with the exception of pitch; endpoint F0 was not significantly affected by the glottal stop at vowel offset. In other words, there was no synchronic pitch raising of glottal stops in Doig to match the historical pitch raising effect of final glottal stop. Final pitch before glottal stop was not different from final pitch in other types of syllables. There was

increased irregularity in glottal pulses, lowered energy, and an increase in intensity in the higher formants.

Results for the general pitch lowering observed in Dane-zaa due to word-final glottal stops supports Leer's (1999) hypothesis that pitch lowering may have been the cardinal outcome of PA constriction and that H tones came about as an areal innovation. Conceivably it is the case that Doig glottal stops are reverting to this default nature.

### **5.3 Future Investigations**

As mentioned above, one area for further research would be a more refined analysis of tone within the two prefix domains: conjunct and disjunct. As this part of my analysis showed the most variation, I anticipate that more careful structuring of the study would yield a clearer pattern. Disjunct tones are associated with the vowel of the prefix and surface in a predictable manner. Certain conjunct tones can be associated with a consonantal prefix, such as those of the n- and s-conjugation prefixes, assigning the tone to the preceding vowel if it falls within the same domain, otherwise the tone does not surface (Randoja, 1990; Rice, 1989). In Navajo, conjunct tones are underlyingly toneless; it is reported that tone in the conjunct domain is syntagmatic (McDonough, 1999). Perhaps this is the case for Dane-zaa. I would propose a

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comparison between the two prefix domains as well as a comparison of the disjunct tones and stem tones.

Another topic for proposed research pertaining to Kingston's theory of tonogenesis would be an acoustic comparison of word-final ejectives and syllable onset ejectives. Much of his analysis relies upon his proposition that the coda ejectives behave as onset ejectives do. I would like to add evidence one way or the other that this is plausible. Dane-zaa has no ejectives in coda position, so such a study would be restricted to onset and coda glottal stops. It may be the case that glottal stops and ejective consonants do not behave similarly; however, a controlled analysis of glottal stops alone would be beneficial.

Over the course of the six year Dane-zaa language documentation project, numerous narratives were collected which have not yet been transcribed or translated. Further collaborative work with the Dane-zaa speaking communities is needed to process these recordings in order to conduct textual analyses. This data comprises many speech styles including conversations, procedurals, personal histories, myths, and descriptions of frightening situations.

An especially interesting and unforeseen issue that became apparent when transcribing and translating the texts used in this dissertation was the fact that sentence breaks, i.e. where one might choose to put a period in the English free translation, did

not always match the intonational breath phrases. It was sometimes the case that the intonation contour bridged what was glossed as separate sentences. These utterances were excluded from the current study as a means to control for interference on lexical tone from an intonational pattern that is different from the basic declarative pattern collected with the word list material. This clash between oral traditions and literacy, or as Barton (2001) refers to as our “textually-mediated social world” demands a careful approach to transcribing oral texts, again following the work by Hymes in ethnopoetics. I posit that a successful approach would include textual analysis, as well as prosodic.

Further work with connected speech such as personal and historical narratives, conversations and traditional folklore would offer greater insight into intonation patterns within the different speech styles for Doig and Halfway, which could then be compared to the findings of Müller (2009) in her analysis of the Northern Alberta Dane-zaa dialect.

It would also be motivating to have definitive evidence that the L% boundary tone Müller (2009) found in Northern Alberta Dane-zaa exists in Doig and Halfway, thus explaining the pitch lowering patterns found in stems. And finally, as touched upon by Müller (2009) it would be of great benefit to determine whether intonational tones are affected by the tone marking of a given language. The Doig and Halfway dialects of Dane-zaa are well suited to address this question.

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## 6 Sources

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- Andruski, Jean E., & Ratliff, Martha. (2000). Phonation types in production of phonological tone: A case of Green Mong. *Journal of the International Phonetic Association*, 30(1/2), 37-61.
- Barton, David. (2001). Directions for literacy research: Analysing language and social practices in a textually mediated world. *Language and education*, 15(2&3), 92-104.
- Bell, Allan. (1984). Language style as audience design. *Language in society*, 13(2), 145-204.
- Bell, Allen. (2001). Back in style: Reworking audience design. In Penelope Eckert & John R. Rickford (Eds.), *Style and Sociolinguistic Variation* (pp. 139-169). Cambridge: Cambridge University Press.
- Blankenship, Barbara. (2002). The timing of nonmodal phonation in vowels. *Journal of Phonetics*, 30, 163-191.
- Boersma, Paul, & Weenink, David. (2012). Praat: doing phonetics by computer [Computer program]. Version 5.3.04, retrieved 12 January 2012 from <http://www.praat.org/>.
- Brink, James, Wright, Richard, & Pisoni, David B. (1998). Eliciting speech reduction in the laboratory: Assessment of a new experimental method. *Research on spoken language processing, progress report No. 22* (pp. 395-420). Bloomington: Speech Research Laboratory, Indian University.
- Brody, Hugh. (1981, 1988). *Maps and dreams: Indians and the British Columbia frontier* (2nd ed.). Vancouver: Douglas & McIntyre Ltd.
- Collins, Raymond, & Petruska, Betty Esai. (Eds.). (1979) *Dinak'i (Our Words)*. Upper Kuskokwim Athabaskan Junior Dictionary. Anchorage: National bilingual materials development center, Rural education affairs.

- Coupland, Nikolas. (2001). Language, situation and the relational self: Theorizing dialect-style in sociolinguistics. In Penelope Eckert & John R. Rickford (Eds.), *Style and Sociolinguistic Variation* (pp. 185-210). Cambridge: Cambridge University Press.
- de Jong, Ken, & McDonough, Joyce. (1993). Tone and tonogenesis in Navajo. *UCLA WPP*, 84, 173-182.
- Eckert, Penelope. (2001). Style and social meaning. In Penelope Eckert & John R. Rickford (Eds.), *Style and Sociolinguistic Variation* (pp. 119-126). Cambridge: Cambridge University Press.
- Esposito, Christina M. (2006). *The Effects of Linguistic Experience on the Perception of Phonation* Doctorate, UCLA, Los Angeles.
- Esposito, Christina M. (2012). An acoustic and electroglottographic study of White Hmong tone and phonation. *Journal of Phonetics*, 40, 466-476.
- Fischer-Jørgensen, E. (1967). Phonetic analysis of breathy (murmured) vowels. *Indian linguistics*, 28, 71-139.
- Fishman, Joshua. (1991). *Reversing Language Shift: Theoretical and Empirical Foundations of Assistance to Threatened Languages*. Clevedon: Multilingual Matters.
- Fulop, Sean, & Golston, Chris. (2008). Breathily and whispering voicing in White Hmong. *The Journal of the Acoustical Society of America*, 123(5), 3883.
- Garellek, Marc, & Keating, Patricia. (2011). The acoustic consequences of phonation and tone interactions in Jalapa Mazatec. *Journal of the International Phonetic Association*, 41(2), 185-205.
- Gessner, Suzanne C. (2005). Properties of tone in Dene Soun'liné'. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody*. Amsterdam: John Benjamins.
- Gobl, Christer, & Ní Chasaide, Ailbhe. (2010). Voice source variation and its communicative functions. In William J. Hardcastle, John Laver & Fiona E. Gibbon (Eds.), *The Handbook of Phonetic Sciences (Second edition)*. Oxford: Blackwell.
- Goddard, Ives (ed.) (1996). *Handbook of North American Indians* (Vol. 17: Languages). Washington D.C.: Smithsonian.
- Gordon, Matthew. (1998). The phonetics and phonology of nonmodal vowels: a cross-linguistic perspective. *Berkeley Linguistics Society*, 24, 93-105.
- Gordon, Matthew. (2001). *Linguistic aspects of voice quality with special reference to Athabaskan*. Paper presented at the Athabaskan Languages Conference.
- Gordon, Matthew, & Ladefoged, Peter. (2001). Phonation types: A cross-linguistic overview. *Journal of Phonetics*, 29, 383-406.
- Halle, Morris, & Stevens, Ken. (1971). A note on laryngeal features *Quarterly progress report* (Vol. 101, pp. 198-213): Research Laboratory of Electronics, MIT.
- Hargus, Sharon. (1988). *The Lexical Phonology of Sekani*. New York: Garland Publishing, Inc.
- Hargus, Sharon. (2005). Prosody in two Athabaskan languages. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 393-423). Amsterdam: John Benjamins.
- Hargus, Sharon. (2007). *Witsuwit'en Grammar: Phonology and Morphology*. Vancouver: UBC Press.

- Hargus, Sharon. (2010). Effects on consonant duration in Fort Ware Tsek'ene Athabaskan/Dene Languages Conference. Eugene, OR.
- Hargus, Sharon. (In preparation). *Kwadacha (Fort Ware Sekani) Grammar*.
- Hargus, Sharon. (In progress). Deg Xinag final laryngealized consonants and voice quality.
- Hargus, Sharon, & Rice, Keren. (2005). Introduction. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 1-45). Amsterdam: John Benjamins.
- Harnsberger, James D., & Goshert, Lori A. (2000). Reduced, citation and hyperarticulated speech in the laboratory: Some acoustic analyses *Research on spoken language processing progress report, No. 24* (pp. pp. 357-368). Bloomington: Indiana University.
- Harnsberger, James D., & Pisoni, David B. (1999). Eliciting speech reduction oin the laboratory II: Calibrating the cognitive load for individual talkers. *Research on spoken language processing, progress report No. 23* (pp. 339-351). Bloomington: Speech Research Laboratory, Indiana University.
- Harnsberger, James D., Wright, Richard A., & Pisoni, David B. (2008). A new method for eliciting three speaking styles in the laboratory. *Journal of Phonetics, 50*, 323-336.
- Hennessy, Kate. (2010). *Repatriation. Digital Technology and Culture in a Northern Athapaskan Community*. Doctor of Philosophy PhD, University of British Columbia, Vancouver.
- Hirano, Minoru. (1974). Morphological Structure of the Vocal Cord as a Vibrator and its Variations. *Folia Phoniatica et Logopaedica, 26*(2), 89-94.
- Holdstock, Jean, & Holdstock, Marshall. (1984). *A Beaver Indian dictionary for school use*: Summer Institute of Linguistics.
- Holdstock, Marshall, Holdstock, Jean, & Committee, Doig River Beaver Literacy. (1976). The Beaver alphabet. Goodlow, British Columbia: Doig River Beaver Literacy Committee.
- Holton, Gary. (2000). *The phonology and morphology of the Tanacross Athabaskan language*. PhD PhD Dissertation, University of California Santa Barbara, Santa Barbara.
- Holton, Gary. (2005). Pitch, tone, and intonation in Tanacross. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 249-276). Amsterdam: John Benjamins.
- Hombert, Jean-Marie. (1977). Consonant types, vowel height and tone in Yoruba. *Studies in African linguistics, 8*(2), pp. 173-190.
- Hombert, Jean-Marie. (1978). Consonant types, vowel quality, and tone. In Victoria Fromkin (Ed.), *Tone: A Linguistic Survey* (pp. 77-111). New York: Academic Press.
- Honigmann, John J. (1981). Kaska. In J. Helm (Ed.), *Handbook of North American Indians: Subarctic* (Vol. Vol. 6, pp. 442-450). Washington D.C.: Smithsonian Institute.
- Hymes, Dell H. (1962). The Ethnography of Speaking. In Thomas Gladwin & William Curtis Sturtevant (Eds.), *Anthropology and Human Behavior* (pp. 13-53). Washington DC: Anthropological Society of Washington.
- Hymes, Dell H. (1964). Introduction: Toward Ethnographies of Communication. *American Anthropologist, 66*(6), 1-34.
- Hymes, Dell H. (1972). Models of Interaction of Language and Social Life. In John Gumperz & Dell H. Hymes (Eds.), *Directions in Sociolinguistics: The Ethnography of Communication* (pp. 35-71). New York: Holt.

- Jackson, Michel, Ladefoged, Peter, Huffman, Marie, & Antonanzas-Barroso, Norma (1985). Measures of spectral tilt. *UCLA Working Papers*, 61, 72-78.
- Jakobson, Roman. (1960). Linguistics and Poetics. In Thomas A. Sebeok (Ed.), *Style in Language* (pp. 350-377). Cambridge: Harvard University Press.
- Kahn, Sameer ud Dowla. (2012). The phonetics of contrastive phonation in Gujarati. *Journal of Phonetics* 40, 780-795.
- Kari, James, & Buck, Mildred. (Eds.). (1975) Ahtna noun dictionary. Fairbanks: Alaska Native Language Center.
- Keating, Patricia, Esposito, Christina M., Garellek, Marc, Kahn, Sameer ud Dowla, & Kuang, Jianjing. (2010). Phonation contrasts across languages *UCLA Working Papers in Phonetics* (Vol. 108, pp. 188-202). Los Angeles: UCLA.
- Kingston, John. (2005). The phonetics of Athabaskan tonogenesis. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 137-184). Amsterdam: John Benjamins.
- Kirk, Paul L., Ladefoged, Peter, & Ladefoged, Jenny. (1984). Using a spectrograph for measures of phonation types in a natural language *UCLA Phonetics Laboratory Working Paper* (Vol. 59, pp. 102-113). Los Angeles: UCLA.
- Koike, Yasuo. (1973). Application of some acoustic measures for evaluation of laryngeal dysfunction. *Studia Phonologica*, 7, 17-23.
- Krauss, Michael. (1964). Proto-Athabaskan-Eyak and the problem of Na-Dene I: Phonology. *International Journal of American linguistics*, 30, pp. 118-131.
- Krauss, Michael. (1979, 2005). Athabaskan Tone. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 55-136). Amsterdam: John Benjamins.
- Krauss, Michael. (1996a). *Report on field session with Ellen Frank, March 17, 1996, and tentative conclusions about Minto tone*. [.]. Alaska Native Language Archive, Fairbanks.
- Krauss, Michael. (1996b). Status of Native American Language Endangerment. In G. Cantoni (Ed.), *Stabilizing Indigenous Languages*. Flagstaff: Center for Excellence in Education, Northern Arizona University.
- Krauss, Michael, & Golla, Victor. (1981). Northern Athapaskan languages. In J. Helm (Ed.), *Handbook of North American Indians: Subarctic* (Vol. 6, pp. 67-86). Washington D.C.: Smithsonian Institute.
- Kuang, Jianjing, & Keating, Patricia. (2012). Glottal articulations of phonation contrasts and their acoustic and perceptual consequences *UCLA Phonetics Laboratory Working Paper* (Vol. 111). Los Angeles: UCLA.
- Labov, William. (1966). *The Social Stratification of English in New York City*. Washington, DC: Center for Applied Linguistics.
- Labov, William. (1972). The isolation of contextual styles. In *Sociolinguistic Patterns* (pp. 70-109). Philadelphia: University of Pennsylvania Press.
- Ladd, Robert. (1996). *Intonational Phonology*. Cambridge: Cambridge University Press.
- Ladefoged, Peter. (1971). *Preliminaries to Linguistic Phonetics*. Chicago: University of Chicago Press.
- Ladefoged, Peter, & Maddieson, Ian. (1996). *The Sounds of the World's Languages*. Oxford: Blackwell.

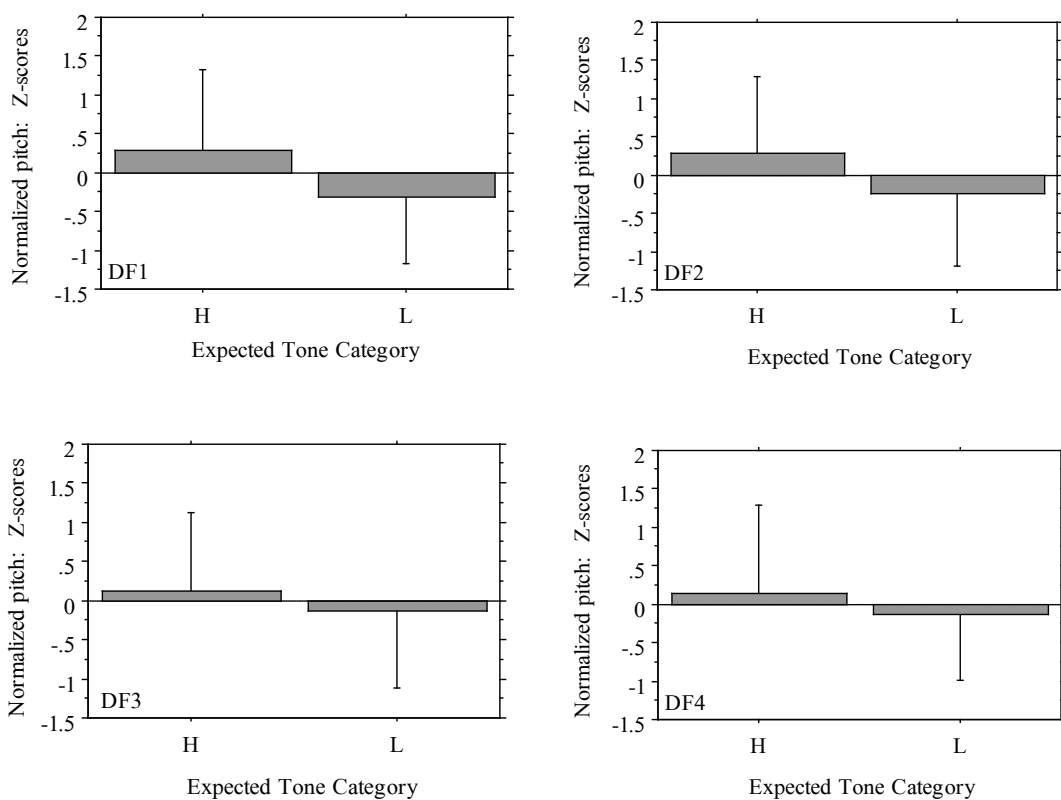
- Laver, John. (1980). *The phonetic description of voice quality*. Cambridge: Cambridge University Press.
- Leer, Jeff. (1979). *Proto-Athabaskan Verb Theme Categories: I. Phonology*. Unpublished manuscript. Alaska Native Language Center, University of Alaska Fairbanks. Fairbanks.
- Leer, Jeff. (1999). Tonogenesis in Athabaskan. In Shigeki Kaji (Ed.), *Cross-linguistic studies of tonal phenomena, tonogenesis, typology, and related topics* (Vol. 1, pp. 37-66). Tokyo: Institute of the Study of the Languages and Cultures of Asia and Africa, Tokyo University of Foreign Studies.
- Leer, Jeff. (2005). How stress shapes the stem-suffix complex. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 277-318). Amsterdam: John Benjamins.
- Li, Fang-Kuei. (1946). Chipewyan. In Harry Hoiijer (Ed.), *Linguistic Structures of Native America* (Vol. 6, pp. 398-423). New York: Viking Fund Publications in Anthropology.
- Lindblom, Björn. (1990). Explaining phonetic variation: A sketch of H & H theory. In William J. Hardacastle & A. Marchal (Eds.), *Speech Production and Speech Modelling* (pp. 403-439). Dordrecht: Kluwer Academic Publishers.
- Maddieson, Ian, & Ladefoged, Peter. (1985). "Tense" and "lax" in four minority languages of China. *UCLA Working Papers*, 60, 59-83.
- Matisoff, James. (1970). Glottal dissimilation and the Lahu high-rising tone: A tonogenetic case-study. *Journal of the American Oriental Society*, 90(1), 13-44.
- McDonough, Joyce. (1999). Navajo tone. *Anthropological Linguistics*, 41, 503-540.
- McDonough, Joyce. (2003). The prosody of interrogative and focus construction in Navajo. In Andrew Carnie, Heidi Harley & MaryAnn Willie (Eds.), *Formal Approaches to Function in Grammar*. Amsterdam: John Benjamins.
- Miller, Julia Colleen. (2003). An acoustic analysis of Doig River and Blueberry River Beaver (Athabaskan). *ANLC Working papers*, No. 3.
- Miller, Julia Colleen. (2007a). *Dane-zaa tone production study: The marked versus the unmarked*. Manuscript. University of Washington, University of Washington.
- Miller, Julia Colleen. (2007b). *Language variation in Dane-zaa: A social network approach*. Manuscript. University of Washington, University of Washington.
- Mithun, Marianne. (1999). *The Languages of Native North America*. Cambridge: Cambridge University Press.
- Müller, Gabriele. (2009). *Intonation and prosodic structure in Beaver (Athabaskan)*. PhD, Universität zu Köln, Köln.
- NSDA. (2013). National Spasmodic Dysphonia Association: Anatomy. Retrieved 28 March 2013, from <http://www.dysphonia.org/anatomy.php>
- Randoja, Tiina K. (1990). *The phonology and morphology of Halfway River Beaver*. PhD PhD Dissertation, University of Ottawa.
- Rice, Keren. (1989). The Phonology of Fort Nelson Slave Stem Tone: Syntactic Implications. In E.-D. Cook & Karen Rice (Eds.), *Athabaskan Linguistics: Current Perspectives on a Language Family* (pp. 229-264). Berlin: Berlin: Mouton de Gruyter.
- Rice, Keren. (1990). Prosodic constituency in Hare (Athapaskan). *Lingua*, 82, 210-245.

- Ridington, Robin. (1968). *The Environmental Context of Beaver Indian Behavior*. PhD Dissertation, Harvard University.
- Ridington, Robin. (1969). Kin Categories versus Kin Groups: A Two-section System without Sections. *Ethnology*, 8, 460-467.
- Ridington, Robin. (1988). *Trail to Heaven*. Iowa City: University of Iowa Press.
- Ridington, Robin. (1990). *Little Bit Know Something: Stories in a language of anthropology*. Iowa City: University of Iowa Press.
- Ridington, Robin, & Ridington, Jillian. (2013). *Where Happiness Dwells: A History of the Dane-zaa First Nations*. Vancouver: University of British Columbia Press.
- Rose, Phil. (1987). Considerations in the normalization of the fundamental frequency of linguistic tone. *Speech Communication*, 6, 343-351.
- Rose, Phil. (1991). How effective are long term mean and standard deviation as normalisation parameters for tonal fundamental frequency? *Speech Communication*, 10, 229-247.
- Scollon, Ronald, & Scollon, Suzanne B. (1979). *Linguistic Convergence: An Ethnography of Speaking at Fort Chipewyan, Alberta*. New York: Academic Press.
- Scollon, Ronald, & Scollon, Suzanne B. (1981). *Narrative, literacy and face in interethnic communication*. Norwood: Ablex Publishing Corporation.
- Statistics Canada. (2012a). Boyer 164, Alberta (Code 4817842) and Alberta (Code 48) (table). Census Profile. 2011 Census. *Statistics Canada Catalogue no. 98-316-XWE* Released October 24, 2012. Retrieved February 19, 2013, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- Statistics Canada. (2012b). Child Lake 164A, Alberta (Code 4817843) and Alberta (Code 48) (table). Census Profile. 2011 Census. *Statistics Canada Catalogue no. 98-316-XWE* Released on October 24, 2012. Retrieved February 19, 2013, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- Statistics Canada. (2012c). Doig River 206, British Columbia (Code 5955804) and British Columbia (Code 59) (table). Census Profile. 2011 Census. *Statistics Canada Catalogue no. 98-316-XWE* Released October 24, 2012. Retrieved February 19, 2013, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- Statistics Canada. (2012d). Halfway River 168, British Columbia (Code 5955808) and British Columbia (Code 59) (table). Census Profile. 2011 Census. *Statistics Canada Catalogue no. 98-316-XWE* Released October 24, 2012. Retrieved February 19, 2013, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- Statistics Canada. (2012e). West Moberly Lake 168A, British Columbia (Code 5955802) and British Columbia (Code 59) (table). Census Profile. 2011 Census. *Statistics Canada Catalogue no. 98-316-XWE* Released October 24, 2012. Retrieved February 19, 2013, from <http://www12.statcan.gc.ca/census-recensement/2011/dp-pd/prof/index.cfm?Lang=E>
- Stevens, Kenneth N. (1998). *Acoustic Phonetics*. Cambridge: MIT Press.
- Story, Gillian. (1989). Problems of phonemic representation in Beaver. In E.-D. Cook & Karen Rice (Eds.), *Athabaskan Linguistics: Current Perspectives on a Language Family* (pp. 63-98). Berlin: Berlin: Mouton de Gruyter.

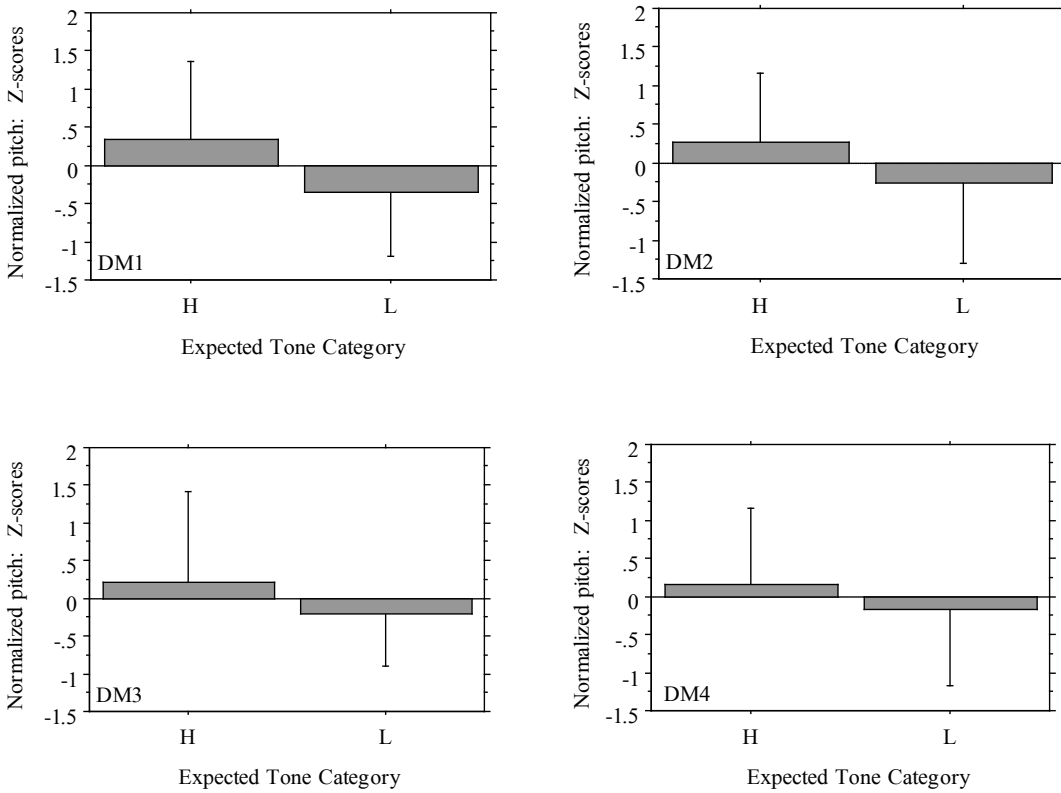
- Tuttle, Siri. (1998). *Metrical and tonal structures in Tanana Athabaskan*. PhD Dissertation, University of Washington, Seattle.
- Tuttle, Siri. (2005). Duration, intonation and prominence in Apache. In Sharon Hargus & Keren Rice (Eds.), *Athabaskan Prosody* (pp. 319-344). Amsterdam: John Benjamins.
- Wassink, Alicia Beckford, Wright, Richard A., & Franklin, Amber D. (2007). Interspeaker variability in vowel production: An investigation of motherses, hyperspeech and Lombard speech in Jamaican speakers. *Journal of Phonetics*, 35, 363-379.
- Whalen, Doug H., & Levitt, Andrea G. (1995). The universality of intrinsic F0 of vowels. *Journal of Phonetics*, 23, 349-366.
- Wright, Richard A., Hargus, Sharon, & Davis, Katherine. (2002). On the categorization of ejectives: Data from Witsuwit'en. *Journal of the International Phonetic Association*, 32(1), 43-77.
- Xu, Ching X., & Xu, Yi. (2003). Effects of consonant aspiration on Mandarin tones. *Journal of the International Phonetic Association*, 32(2), pp. 165-181.
- Yip, Moira. (2002). *Tone*. Cambridge: Cambridge University Press.
- Zraick, Richard I., Marshall, Whitney, Smith-Olinde, Laura, & Montague, James C. (2004). The effect of task on determination of habitual loudness. *Journal of Voice*, 18(2), 176-182.
- Zraick, Richard I., Skaggs, Sheri, D., & Montague, James C. (2000). The effect of task on determination of habitual pitch. *Journal of Voice*, 14(4), 484-489.

## 7 Appendices

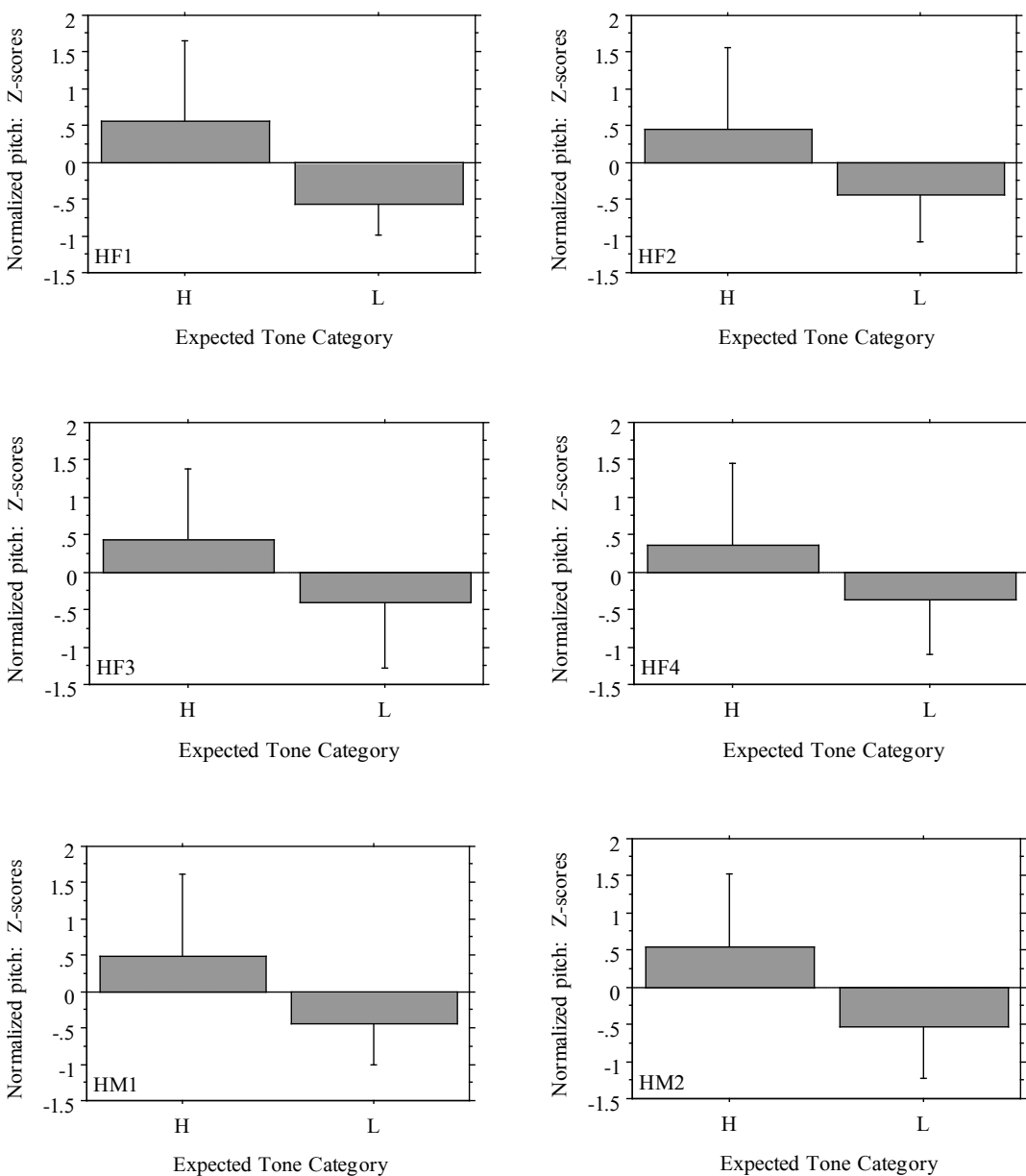
### Appendix 1 Factorial analysis individual means: Tone category x Normalized pitch



**Figure 99** Bar graphs showing individual results for high-marked Doig female speakers. Results from one-factor ANOVA, independent variable: Tone category (H, L), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

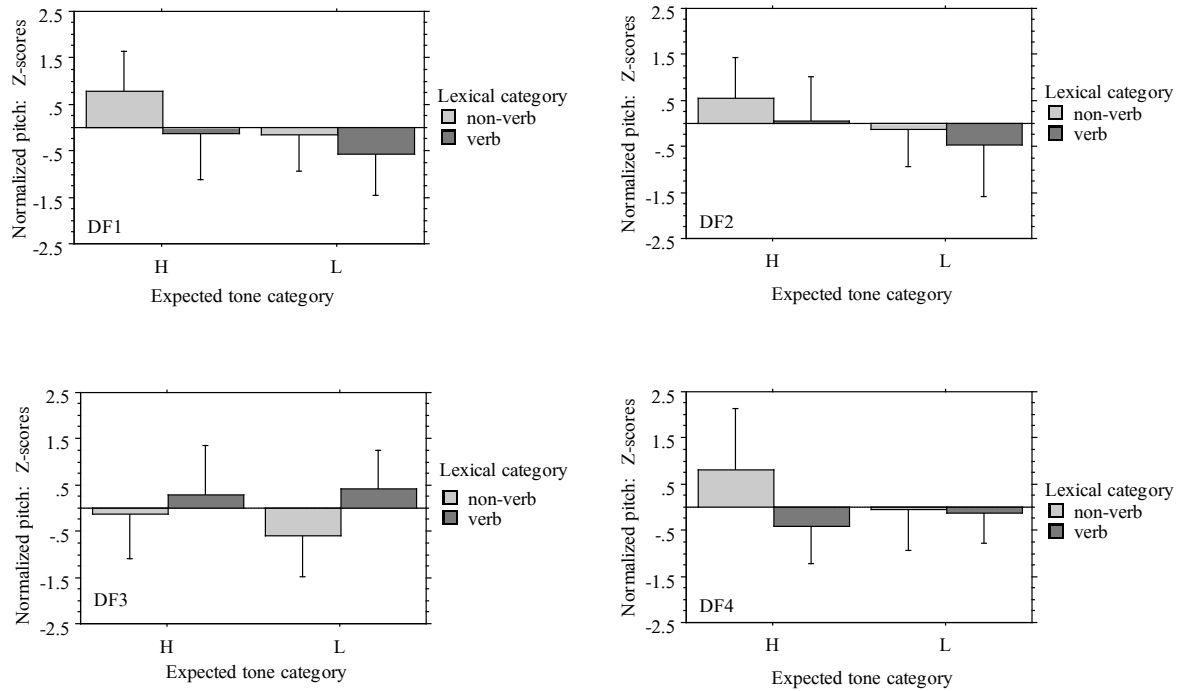


**Figure 100** Bar graphs showing individual results for high-marked Doig male speakers. Results from one-factor ANOVA, independent variable: Tone category (H, L), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

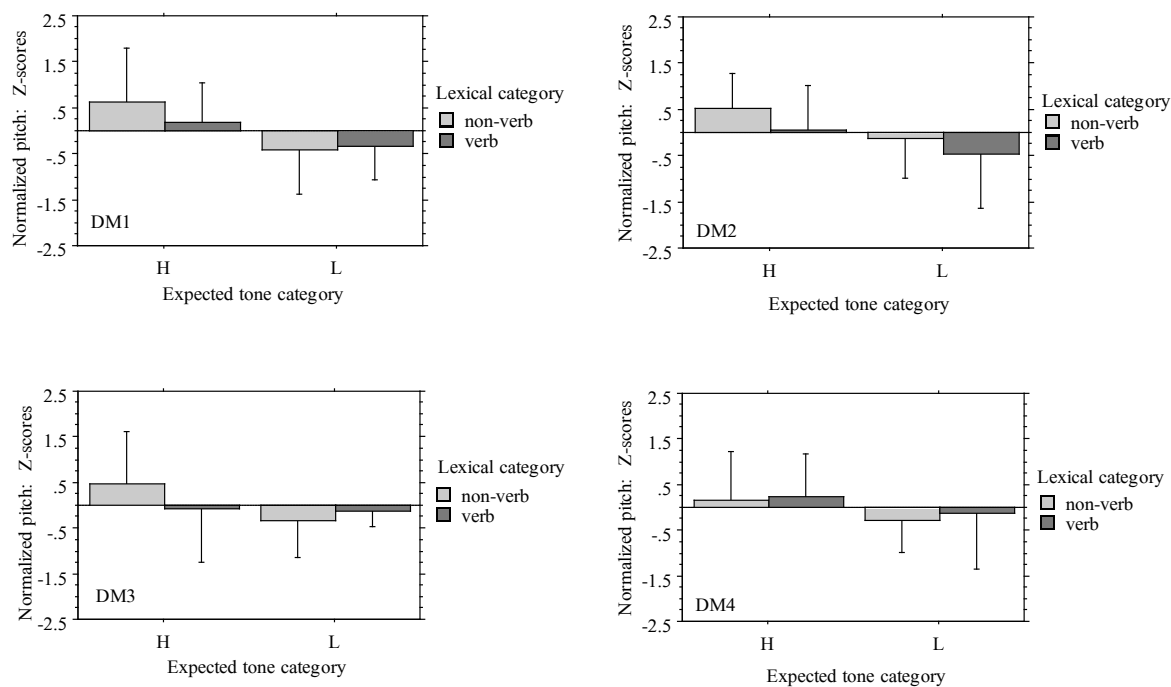


**Figure 101** Bar graphs showing individual results for low-marked Halfway female and male speakers. Results from one-factor ANOVA, independent variable: Tone category (H, L), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

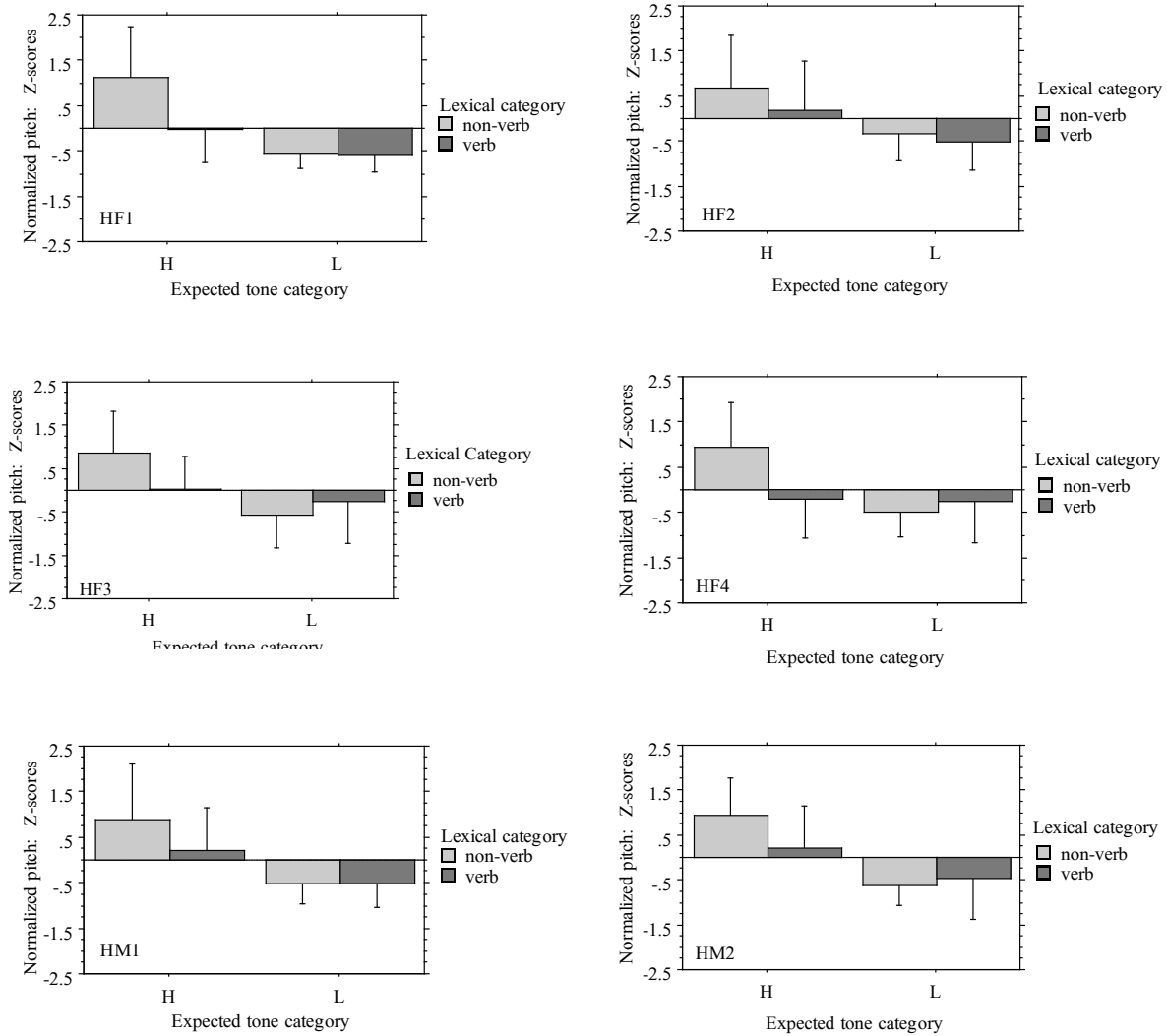
**Appendix 2 Factorial analysis individual means: Tone category x Lexical category x Normalized pitch**



**Figure 102** Bar graphs showing individual results for high-marked Doig female speakers. Results from one-factor ANOVA, independent variable: Lexical category (Non-verb, Verb), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

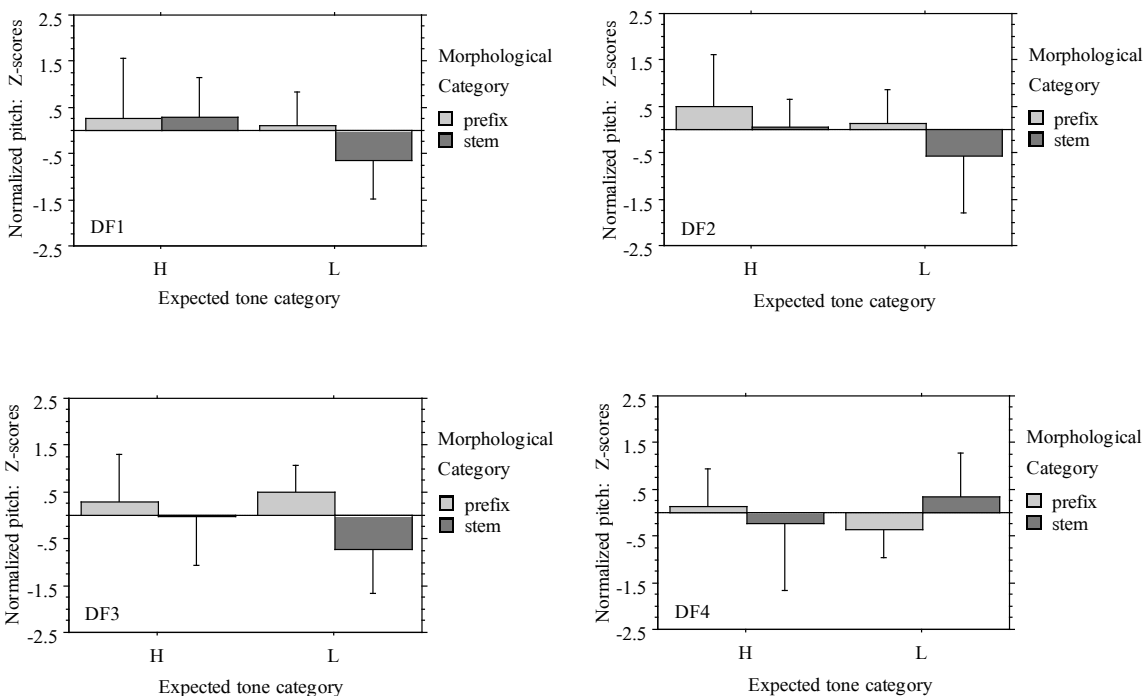


**Figure 103** Bar graphs showing individual results for high-marked Doig male speakers. Results from one-factor ANOVA, independent variable: Lexical category (Non-verb, Verb), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

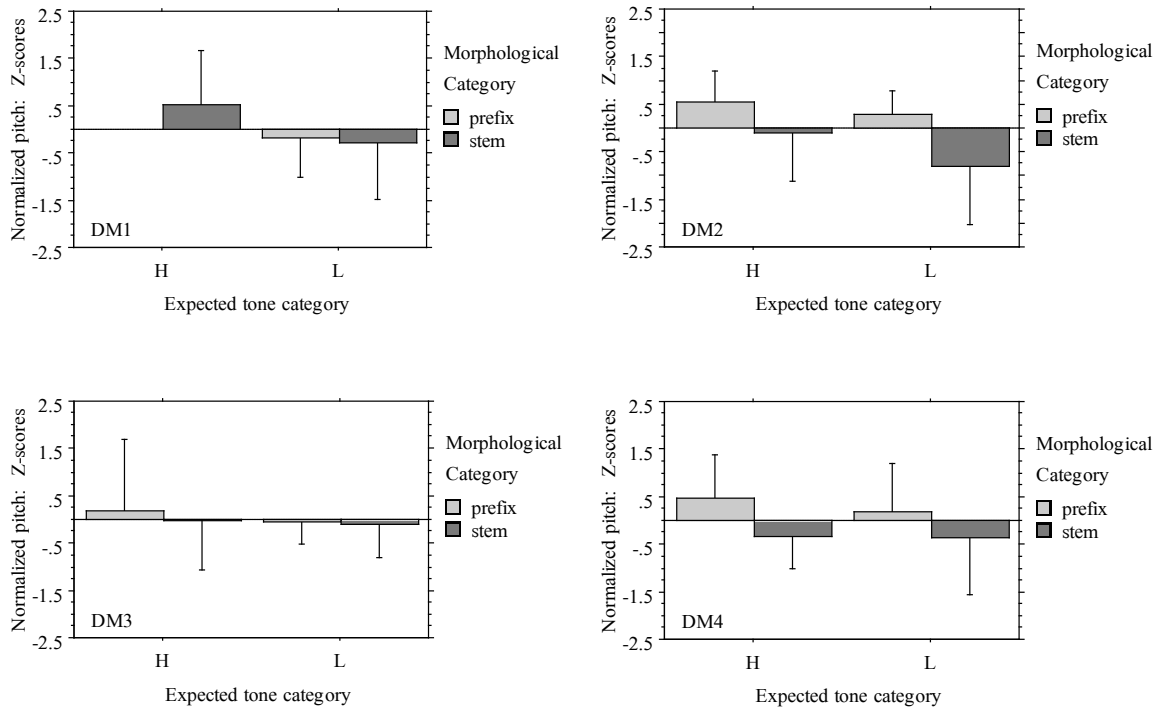


**Figure 104** Bar graphs showing individual results for high-marked Halfway female and male speakers. Results from one-factor ANOVA, independent variable: Lexical category (Non-verb, Verb), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

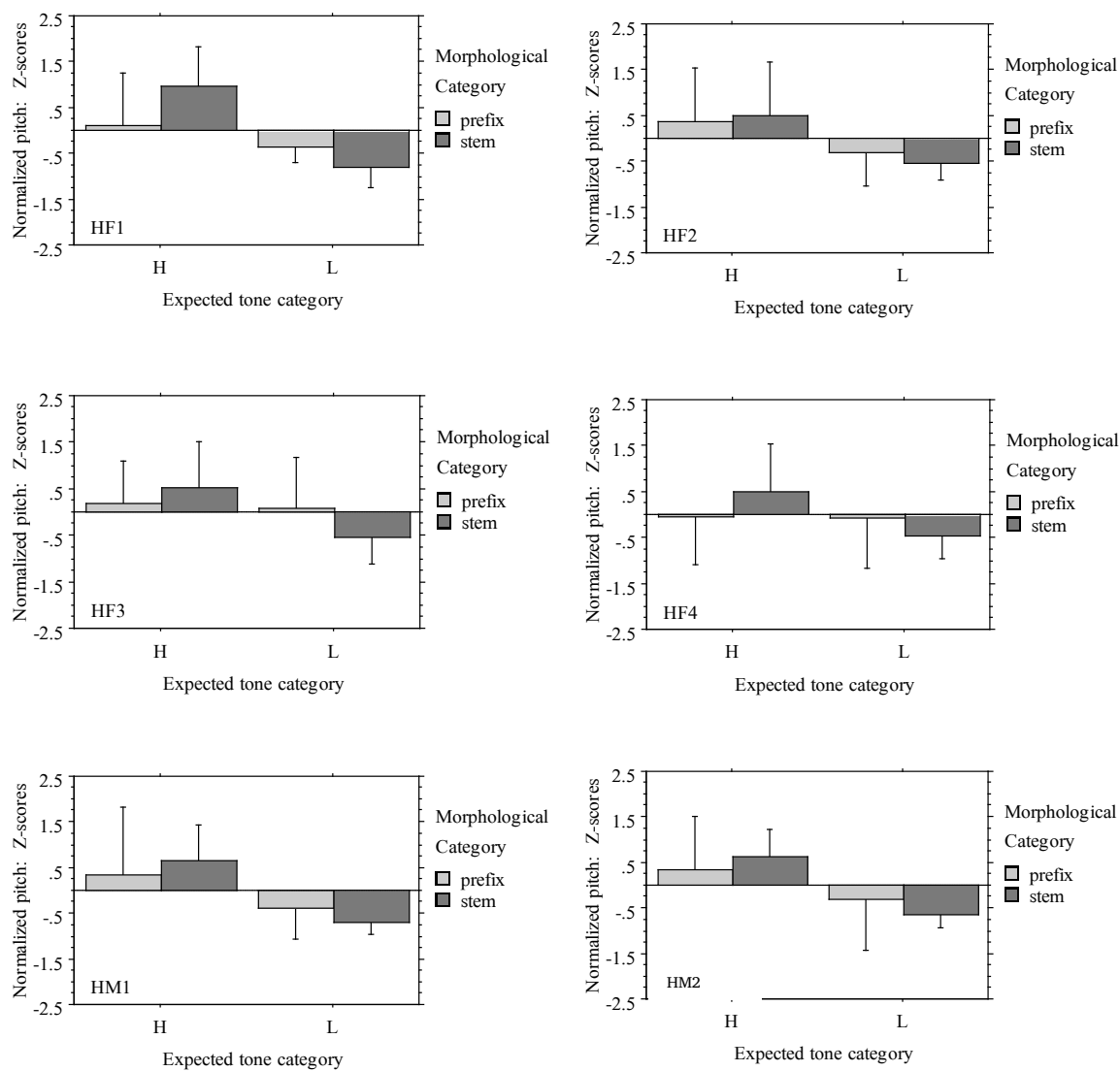
**Appendix 3 Factorial analysis individual means: Tone category x Morphological category x Normalized pitch**



**Figure 105** Bar graphs showing individual results for high-marked Doig female speakers. Results from one-factor ANOVA, independent variable: Morphological category (Prefix, Stem), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.



**Figure 106** Bar graphs showing individual results for high-marked Doig male speakers. Results from one-factor ANOVA, independent variable: Morphological category (Prefix, Stem), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.



**Figure 107** Bar graphs showing individual results for high-marked Doig female speakers. Results from one-factor ANOVA, independent variable: Morphological category (Prefix, Stem), dependent variable normalized pitch. Means for H and L tones shown. Error bars represent  $\pm 1$  standard deviation(s). Speaker code in lower-left corner of graphics.

**Appendix 4 Text DM3: Snare Hill and the Man Who Turned Into a Moose****sh-001 Adzəḡḡ tǫhch'ii dǫ? jii Madááhts'atl'ǫch'e dane yéhjii.**

adzəḡḡ tǫhch'ii dǫ? jii Madááhts'atl'ǫch'e dane yéhjii  
 long.ago far past this 1pS.set snares.around.O people3pS.call.3sO

*A long time ago, they called this Madááhts'atl'ǫch'e [Snare Hill].***sh-002 Dane yet'ááhdzé? háágháághəḡdáá?**

dane yet'ááhdzé? háágháághəḡdáá?  
 people because.of 3pS.lived

*People lived because of this place.***sh-003 Dane yet'ááhdzé? dáánejiitl.**

dane yet'ááhdzé? dáánejiitl  
 people because.of 3pS.survived

*People survived because of this place.***sh-004 E ii laa háák'aa juudzenéh, sadanéḡ háák'aa juudzenéh ghats'adaah, aht'e júúne dane k'ǫḡdiineḡ.**

eh ii laa háák'aa juudzenéh sa-dané-ḡ háák'aa  
 and that ASSERT still today my-people-hum.pl still

juudzenéh ghats'adaah aht'e júú-ne dane k'ǫḡdii-ḡ  
 today 1pS.be.alive all these-hum.pl people young-hum.pl

*And that is why even today, my people, we are still living, and all these young people, as well.*

**sh-005 Gwaadáádó, ajuu hááwóhch'e de wóle, ajuu- ajuu hanaajúúnuu dáánejiitl dé dóghwe dane ghwegho.**

gwaadáádó ajuu hááwóhch'e de wóle ajuu ajuu hanaa-júúnuu  
back.then neg. like.that temp.part it.is neg. neg. our-ancestors

dáánejiitl dé dóghwe dane ghwegho  
3pS.survived loc.part starvation people 3sS.killed

*Back then some of our ancestors did not survive; many people died from starvation.*

**sh-006 Gwaadáádó kénéjit yí wak'ats juu énejit adzedo.**

gwaadáádó kénéjit yí wak'ats juu énejit adzedo  
back.then powerful there cold(weather) also powerful long.ago

*It was tough back then and it was fiercely cold long ago.*

**sh-007 Ii tl'qh yas natl'q.**

ii tl'qh yas natl'q  
and.then snow lots

*There was lots of snow.*

**sh-008 Hááwóhch'e edáádlah dé?**

hááwóhch'e edáádlah dé?  
like.that be.difficult temp.part

*It was like that, sometimes it was hard.*

**sh-009 Jii Madááhts'atl'qch'e giyéjhii ts'é? náághadehdézhaa.**

jii Madááhts'atl'qch'e giyéjhii ts'é? náághadehdézhaa  
this 1pS.set snares 3pS.call.3sO to.there 3pS.return

*They called that place Madááhts'atl'qch'e [Snare Hill] and they returned to that place to survive.*

**sh-010 Giighadaah dáánaa?atl'qch'e.**

giighadaah dáánaa?atl'qch'e  
 around.base.of.O 3pS.set snares

*They put snares around it.*

**sh-011 Ii wats'ę hadaa giits'ę daayúút ęhhááde.**

ii wats'ę hadaa giits'ę daayúút ęhhááde  
 from.here moose 3pS.toward 3pS.chased.3sO side-by-side

*Then they chased the moose to him (another hunter), walking side-by-side.*

**sh-012 Ęhhááde ghaadélhe hadaa giits'ę daayúút dé.**

ęhhááde ghaadélhe hadaa giits'ę daayúút dé  
 side-by-side 3pS.walked moose 3pS.toward.them 3pS.chased loc.part

*They walked side-by-side to chase the moose off the hill.*

**sh-013 Hadaa daaghelúút dé ii waa- ii wat'áádze laa ii ghędaah.**

hadaa daaghelúút dé ii wat'áádze laa ii ghędaah  
 moose 3pS.snared loc.part that because.of ASSERT that 3pS.eat

*Every one of them snared moose, and because of that, they were able to eat.*

**sh-014 Gwaagii laa adzędọ jii dane yak'ih ghadaah.**

gwaagii laa adzędọ jii dane yak'ih ghadaah  
 that.way ASSERT long.ago these people on.it 3pS.lived

*This is how, a long time ago, people lived on that.*

**sh-015** Guu éh laa, tá<sub>s</sub> éh dane ghadaah dó gwaadáádó wó<sub>l</sub>ę.

guu éh laa tá<sub>s</sub> éh dane ghadaah dó  
 those with *ASSERT* arrows with people 3pS.lived past

gwaadáádó wó<sub>l</sub>ę  
 long.ago it.was

*At that time, people survived by using bow and arrows, long ago.*

**sh-016** Eh, lhígé ah jii sô ah, dane yagáe náách'ę?  
 and one.time (hes.) this must.be (hes.) peopleclose-by.it 3pS.lived

eh lhígé ah jii sô ah dane yagáe náách'ę?  
 and one.time (hes.) this must.be (hes.) peopleclose-by.it 3pS.lived  
*One time, some of the people must have been living nearby.*

**sh-017** Dane yagáe náách'ę? hōhch'e háá yaşk'iih.

Dane yagáe náách'ę? hōhch'e háá yaşk'iih  
 people close-by 3pS.lived like.that *EMPH* winter

*Some people camped nearby, in the winter.*

**sh-018** Yaşk'iih wó<sub>l</sub>ę.

yaşk'iih wó<sub>l</sub>ę  
 winter it.was

*It was wintertime.*

**sh-019** ędáádlah ę juu ajuu kéh hadaa ghazēhhélh hēda wó<sub>l</sub>ii?é.

ędáádlah ę juu ajuu kéh hadaa ghazēhhélh hēda wó<sub>l</sub>ii?é  
 hard.times hum. also neg. for moose 3pS.kill nothing existed

*Times were hard; they could not kill any moose, there was a shortage.*

**sh-020 Jii Madááhts'atl'qch'e giits'é tsédéhjiitl.**

jii	Madááhts'atl'qch'e	giits'é	tsé?	déhjiitl
this	Madááhts'atl'qch'e	3pS.toward.it	to.there	3pS.went

*They went to Madááhts'atl'qch'e [Snare Hill].*

**sh-021 Giits'é tsé? déhjiitl de daqlhíge dane aské alẹ.**

giits'é	tsé?	déhjiitl	de	daqlhíge
3pS.toward.it	to.there	3pS.went	loc.nom	one.person

dane	aské	alẹ
person	young.man	3pS.be

*When they went towards it there was one person, a young man.*

**sh-022 Aské alẹ, újọ adaadaah.**

aské	alẹ	újọ	adaadaah
young.man	he.was	well	3sS.looks.after.himself

*The young man took good care of himself.*

**sh-023 Ajúúlii daah ts'éguu ẹhchúút de sọ mak'eh wọle.**

ajúúlii.daah	ts'éguu	ẹhchúút	de	sọ	mak'eh
nowhere	woman	3sS.hold	this.person	must.be	on.him

wọle
it.exists

*He did not touch women, so there was no mark on him (he was pure).*

**sh-024 Hach'e ii mawaach'ẹh kéch'ẹh, hẹhch'e dane.**

hach'e	ii	mawaach'ẹh	kéch'ẹh	hẹhch'e	dane
even	that	3sS.be.pure	3sS.look.like	like.that	person

*How pure he was, that man!*

**sh-025 Dane k'ódii dane táách'é?**

dane k'ódii dane táách'é?  
 person young people 3sS.lived.among  
*The young man lived among them.*

**sh-026 Ẹ juu sô dane k'áǵédézhāa hōhch'e ọ?**

ẹ juu sô dane k'áǵédézhāa hōhch'e ọ  
 this.person also must.be people3sS.walk.around like.that y/nQ  
*That man must have travelled with them, didn't he?*

**sh-027 Dąę lhígé-- ąą-- dane mejíí? ajuu úújọ.**

dąę lhígé ąą dane mejíí? ajuu úújọ  
 one.person (hesitation) person his.mind neg. good  
*There was another person whose mind was not good.*

**sh-028 Dane sô ẹ juu dane k'ódii alẹ hach'é lọ sô;**

dane sô ẹ juu dane k'ódii alẹ hach'é lọ sô  
 person.must.be hum. also person.young 3sS.be even EVID.SURPRISE must.be

**sh-029 dats'éǵé? dzé? núúyúúlh.**

dats'éǵé? dzé? núúyúúlh  
 his.wife to 3sS.accuse.3sO  
*That man must have accused the young man [of touching] his wife.*

**sh-030 Jii deǵíí? éh.**

jii deǵíí? éh  
 this his.mind with  
*It was all in his head.*

**sh-031 E ẹ dane, adaaʔaach'ẹ hỏhch'e aské alẹ hỏhch'e esẹ.**

e ẹ dane adaaʔaach'ẹ hỏhch'e  
and that person 3sS.keeps.himself like.that

aské alẹ hỏhch'e esẹ  
young.man 3sS.be like.that I.said

*That person, he kept himself clean like that, that young man, as I have mentioned.*

**sh-032 Jii dats'ets'ané? nááne?ẹ.**

jii dats'ets'ané? nááne?ẹ  
this his.chest 3sS.hid.3sO

*He was hiding his chest.*

**sh-033 Dats'ets'ané? nááne?ẹ zỏh hỏhch'e éh.**

dats'ets'ané? nááne?ẹ zỏh hỏhch'e éh  
his.chest 3sS.hid.3sO only like.that with

*He just kept his chest hidden like that.*

**sh-034 Hỏhch'e éh ah, ajuu dane yats'ets'ané? áá?ẹh.**

hỏhch'e éh ah ajuu dane yats'ets'ané? áá?ẹh  
like.that with *hesitation* neg. person his.chest see

*That way, no one saw his chest.*

**sh-035 Jwe matsets'ané? k'e lọ hadaa dzisgíí?**

jwe matsets'ané? k'e lọ hadaa dzisgíí?  
there his.chest on *EVID-SURPRISE* moose.mane.hair

*On his chest he had the mane of a moose!*

**sh-036 Hadaa gháá? náá?íi dane ajuu adaayejíh.**

hadaa gháá? náá?íi dane ajuu adaayejíh  
 moose.hair hanging.down peopleneg. 3sS.know

*People did not know about the moose hair hanging from his chest.*

**sh-037 Guu hadaa mawajíi ii sô adaajíh he, de dane k'ódii.**

guu hadaa mawajíi ii sô adaajíh he de  
 those moose respected that must.be 3sS.knows really this

dane k'ódii

man young

*He must have known those clean (spiritual) moose, this young man.*

**sh-038 Hóhch'e laa úújô adaadah, ajuu ts'éguu juu gáe dayaa ę hóhch'e alę.**

hóhch'e laa úújô adaadah ajuu ts'éguu juu  
 like.that ASSERT well 3sS.took.care.of.himself neg. women too

gáe dayaa ę hóhch'e alę  
 near he.goes hum. like.that 3sS.be

*He took care of himself, and didn't go near women.*

**sh-039 Eh...eh jii ạạ Madááhts'atl'qch'e, sô gííghadaah satl'q ghétl'q aht'e gwe nę náádzat.**

eh eh jii ạạ Madááhts'atl'qch'e sô gííghadaah  
 and and this (hesitation) Madááhts'atl'qch'e must.be 3pS.around.it

satl'q ghétl'q aht'e gwe-nę náádzat  
 3pS.set snares there.were.lots all those-hum.pl. 3sS.hunt

*And here at, Madááhts'atl'qch'e, they must have set lots of snares around here, all those hunters.*

**sh-040** Gííghadaah satl'q h́hch'e ẹ.

giighadaah            satl'q                    h́hch'e            ẹ  
 3pS.around.it        3pS.set snares            like.that        *hum.pl.*

*They set snares around it like that.*

**sh-041** Háá gq k'qh ghadéhk'ún ts'eh s̄ aht'e ẹhlh̄qhaajiitl ii s̄ yí.

háá    gq    k'qh    ghadéhk'ún            ts'eh    s̄            aht'e  
*EMPH* there camp 3pS.started.fire        there must.be        all

ẹhlh̄qhaajiitl        ii        s̄            yí  
 3pS.came.together that must.be there

*Right there they made camp together and started a fire*

**sh-042** Náághetsatl wawe náághadaakwan ii kwagááh.

náághetsatl wawe            náághadaakwan            ii        kwagááh  
 3pS.got.wet ??            3pS.are.drying.themselves that        beside.fire

*They were wet and they were drying themselves beside the fire.*

**sh-043** Aht'e lhenaaghesjiitl háá hadaa ii ghaduujieitl dah w̄lẹ.

aht'e lhenaaghesjiitl        háá    hadaa ii        ghaduujieitl            dah    w̄lẹ  
 all    3pS.came.together *EMPH* moose those 3pS.will.go.toward about it.was

*They all came together again preparing to go toward the moose.*

**sh-044** Ii deh yí, ẹ dane hach'é lq dats'égé? ts'ẹ? ajúúlii kaanúyúúlẹ!

ii    deh            yí    ẹ        dane hach'é        lq  
 this *nom.loc*        there *hum.* man even            *EVID.SURPRISE*

dats'égé?        ts'ẹ?        ajúúlii kaa-núyúúlẹ  
 his.wife        to        *neg.* for-3sS.is.thinking

*Right there that man must have wrongfully accused him of fooling around with his wife!*

**sh-045** Ẹ s̄ò yíí.

ẹ            s̄ò            yíí  
*hum.*    must.be    there  
*It must have been him there.*

**sh-046** Jii dats'ets'ané? j̄o-- dats'ets'ané? úúj̄o ii gúúh ii- yíí.

jii    dats'ets'ané? j̄o    dats'ets'ané?            úúj̄o    ii    gúúh  
 that   his.chest    there   his.chest            well   that   way

ii    yíí  
 that   there

*That young man hid his chest well that way.*

**sh-047** Ii náánẹ?ẹ h̄ohch'e ii- ii aja- ajuu dak'wisje ajuu lhéchojé háále, ajuu dane yúú?ẹ.

ii    náánẹ?ẹ    h̄ohch'e    ii    ajuu    dak'wisje    ajuu    lhéchojé  
 that   3sS.hid    like.that    that   *neg.*    his.jacket    *neg.*    apart

háále            ajuu    dane    yúú?ẹ  
 3sS.does.like *neg.*    people3sS.see.3sO

*He hid it that way and did not pull his jacket apart, so people wouldn't see it.*

**sh-048 Hóhch'e ẹ gwadze sô, jííge ts'égúúh, ii yats'ets'an ii yak'wisjé? lhéch'ò ts'ẹh hóláá?**

hóhch'e	ẹ	gwadze	sô	jííge ts'égúúh	ii
like.that	hum.	then	must.be	going.upwards	that

yats'ets'an	ii	yak'wisjé?	lhéch'ò	ts'ẹh	hóláa?
his.chest	that	his.jacket	apart	from	3sS.did.like.that

*It must have happened like this: the one who accused him exposed his chest by ripping open his jacket.*

**sh-049 Dẹ, “Dóch'ẹ hach'é lọ dats'ets'ané? náánẹ?ẹ?” yéhjii, ẹ juu, jwe mats'ets'ané? k'e ts'ẹh hadaa dzisgí? náá?ij.**

dẹ	dóch'ẹ	hach'é lọ	dats'ets'ané?	náánẹ?ẹ	yéhjii
there	why	even	<i>EVID.SURPRISE</i> his.chest	3sS.hid.3sO	3sS.said

ẹ	juu	jwe	mats'ets'ané? k'e	ts'ẹ?	hadaa-dzisgí?	náá?ij
that	also	here	his.chest	on	from moose-mane	3sS.hang.from

*"Why is this guy hiding his chest?" he said. And right there, his chest had moose-hump hair hanging down!*

**sh-050 Hadaa dzisgí? laa jii ąą , hadaa ẹ nawóné? kéhdzẹ? ii magháá? nachéze náá?ij.**

hadaa-dzisgí?	laa	jii	ąą	hadaa ẹ	nawóné?
moose-mane	<i>ASSERT</i> this	(hesitation)	moose it	hump	

kéhdzẹ?	ii	magháá?	nachéze	náá?ij
the.same.as	that	his.hair	3sS.be.long	3sS.hang.down

*This moose mane was just like the hair on a moose's hump; his hair was long and hanging down.*

**sh-051** *Ii laa hadaa dzisgíí? úúzhe.*

ii laa hadaa-dzisgíí? úúzhe  
 that ASSERT moose-mane 3sS.is.called  
*That's called 'hadaa dzisgíí?', moose mane.*

**sh-052** *Hadaa ẹ nawqóné? kéhdzé?*

hadaa ẹ nawqóné? kéhdzé?  
 moose that hump the.same.as  
*It's just like the hair on a moose's hump.*

**sh-053** *Eh ii wats'ẹh sô ajuu mawúújọ k'éhch'ẹ.*

eh ii wats'ẹh sô ajuu mawúújọ k'éhch'ẹ  
 and from.there must.be neg. 3sS.is.happy 3sS.be.like  
*After that, he was not very happy.*

**sh-054** *Háá hadaa eghaduujitl dẹ wóle.*

háá hadaa eghaduujitl dẹ wóle  
 EMPH moose 3pS.were.going.to.chase nom.loc it.was  
*They were going to surround the moose.*

**sh-055** *Ii gwaadáádó wawqyọ dẹ guunẹ dane.*

ii gwaadáádó wawqyọ dẹ guunẹ dane  
 that back.then 3sS.is.smart temp.loc those people  
*Back then those people were wise.*

**sh-056** *Juudzenéh wadeh dane woyọ naaghẹh.*

juudzenéh wadeh dane woyọ naaghẹh  
 today more.than people 3sS.is.smart 3pS.be  
*They were wiser than people today.*

**sh-057 Gwaadáá dane, yíjii dó Dane-zaa,**

gwaadáá dane yíjii dó Dane-zaa  
back.then peoplelong.ago Dane- zaa.people

*Those people back then, our Dane-zaa ancestors.*

**sh-058 Hóhch'e laa juudzenéh háák'aa ghats'edaah.**

hóhch'e laa juudzenéh háák'aa ghats'edaah  
like.that ASSERT today still 1pS.be.alive

*They were resourceful, that's why we are still here today.*

**sh-059 Ẹ ah sò ehts'ezòh giyéhlhígé dajii dane hadaa edéhjiitl, "Dóch'ii ajuu mawúújò kéch'èh?"**

ẹ ah sò ehts'ezòh giyéhlhígé dajii dane hadaa  
and must.be suddenly his.brother 3sS.told people moose

edéhjiitl dóch'ii ajuu mawúújò kéch'èh  
3pS.chase why neg. 3sS.is.happy 3sS.look.like

*When they were chasing the moose, someone said to the older brother of the pure young man, "Why does he look so unhappy?"*

**sh-060 "Ajuu kelii, dọtsiit méh zòh hááwòch'e, ajuu dọtsiit," sò yéhjii.**

ajuu kelii dọtsiit méh zòh hááwòch'e  
neg. easy 2sS.let.3sO.go with.him only 2sS.stay

ajuu dọtsiit sò yéhjii  
neg. 2sS.let.3sO.go must.be 3sS.tell.3sO

*"Whatever you do, stay right with him, don't let him go off by himself", this person told him.*

**sh-061 Hóhch'e eh, háá ii wats'ẹ hadaa eghadéhjiitl ẹ h́hch'e ẹ wats'ẹ yéhech'e h́hch'e.**

h́hch'e eh háá ii wats'ẹ hadaa eghadéhjiitl  
like.that and *EMPH* that from moose 3pS.went.towards

ẹ h́hch'e ẹ wats'ẹ yéhech'e h́hch'e  
then like.that *nom.temp* from close.together like.that

*It must have happened that way, when they started chasing the moose; he stayed close to his brother.*

**sh-062 Yéhech'e h́hch'e ajuu yadatsiit h́hch'e.**

yéhech'e h́hch'e ajuu yadatsiit h́hch'e  
close.together like.that *neg.* 3sS.let.him.go like.that

*He was right with him; he never let him go.*

**sh-063 Háá jọẹ tsezọh guu naade sọ, hadaa taawadéhsat ẹ jii.**

háá jọẹ tsezọh guu-naade sọ hadaa taawadéhsat  
*EMPH* here suddenly pl-in.front must.be moose 3pS.ran.away

ẹ jii  
*nom.loc* this

*All of a sudden, right in front of them, the moose all ran off.*

**sh-064 Jii lhígé ẹhchaage guts'égúh hadaa taawaadéhsat dé.**

jii lhígé ẹhchaage guts'égúh hadaa taawaadéhsat dé  
this one separate ways moose 3s.ran.away *nom.loc*

*One moose separated from the rest of the herd and started to run away.*

**sh-065** “Jii naadeḡ ustleḡ, júúde jii naadeḡ neḡleh,” yéhjii júúde sô yaanewó?qh.

jii	naadeḡ	ustleḡ	júúde	jii	naadeḡ	neḡleh
this	in.front	1sS.will.go	quickly	this	in.front	2sS.run

*"I'm going to go this way, you quickly go around that way [and turn the moose around],"*

yéhjii	júúde	sô	yaanewó?qh
3sS.said.to.3sO.	quickly	must.be	3sS.fooled.3sO

*he said [the younger brother to his older brother]; everything happened so quickly,*

**sh-066** Neḡwaneh júúde... júúde yanáe?aaḡ.

neḡwaneh	júúde	júúde	yanáe?aaḡ.
3sS.mixed.3sO.up	quickly	quickly	3sS.fooled.3sO

*The young man was able to fool his brother who was trying to stay close to him.*

**sh-067** Júúde yanáe?aaḡ hōhch'e.

júúde	yanáe?aaḡ	hōhch'e.
quickly	3sS.fooled.3sO	like.that

*He quickly fooled him that way.*

**sh-068** Jii lhíge déhsq adeḡ lhíge déhsq deḡ.

jii	lhíge	déhsq	adeḡ-lhíge	déhsq	deḡ
this	one	3sS.chased.O	3sO-brother	3sS.chased.O	nom.loc

*The younger brother chased one (moose) and the other brother chased another.*

**sh-069** Ii wats'eḡ zqh najwé.

ii	wats'eḡ	zqh	najwé
that	from	only	3sS.is.gone

*Then he was gone.*

**sh-070** *Ii wats'əh aht'e hadaa eghaajiitl laa hōhch'e.*

ii wats'əh aht'e hadaa eghaajiitl laa hōhch'e  
 that from all moose 3sS.were.chasing ASSERT like.that  
*Everyone was chasing the moose.*

**sh-071** *Aht'e giyedéhjiitl laa ɛ juu ajúúlii.*

aht'e giyedéhjiitl laa ɛ juu ajúúlii  
 all 3pS.went.toward.3pO ASSERT hum. also neg.  
*Then when they went toward them, there weren't any moose.*

**sh-072** *“Dááwqoch'əa?” ghajii.*

dááwqoch'əa ghajii  
 what.happened 3pS.said  
*"What happened?" they asked.*

**sh-073** *Ajúúlii hadaa ajúúleneḡ hadaa ṣalúút.*

ajúúlii hadaa ajúúleneḡ hadaa ṣalúút  
 neg. moose no.one moose 3sS.snared  
*No one had snared any moose.*

**sh-074** *E ah-- ii wats'ə gɔ aht'e ɛlhónaghajiitl de hōch'ə júú méhlhígé? ɛ.*

e ah ii wats'ə gɔ aht'e ɛlhónaghajiitl de  
*hesitation* that from there all they.came.together *nom.loc*

hōch'ə júú méhlhígé? ɛ  
 like.that but his.younger.brother *hum.*

*And, then they all got together, all of them except for the younger brother.*

**sh-075 Ii ɛ najwé.**

ii ɛ najwé  
that hum. gone

*He was gone.*

**sh-076 Ii wats'ɛ, ii wats'ɛ k'ajuu naaghadésjiitl ii wats'ɛ ɛ nɛ-**

ii wats'ɛ ii wats'ɛ k'ajuu naaghadésjiitl ii wats'ɛ  
from.there from again 3pS.went.back from.there

*From there-- from there, they went back again.*

**sh-077 ɛ déhlhígé ech'qh déhtl'aa ɛhde dadó dage.**

ɛ déhlhígé ech'qh déhtl'aa ɛhde dadó dage  
hum. his.younger.brother away.from 3sS.went there his.older.brother

*That's where he took off from his older brother.*

**sh-078 Ii wokaa ghanehtaah hōhch'e yéhdzihgúúh ii hadaa déhsq ɛ gq.**

ii wokaa ghanehtaah hōhch'e yéhdzihgúúh ii hadaa  
there 3pS.were.looking like.that that.way that moose

déhsq ɛ gq

3sS.chased.O hum. there

*They were looking over there, where he had chased that moose.*

**sh-079** Gq zqh yíi, uh-- giik'éh wakaataah ɛ juu manadané? zqh ɣalaa hadaa zqh wójit sô naatl'aah.

gq zqh yíi giik'éh wakaataah ɛ juu manadané?  
there only there follow.3pO 3pS.were.looking hum. then his.clothes

zqh ɣalaa hadaa zqh wójit sô naatl'aah  
only 3sS.lies moose only 3sS.be.afraid must.be 3sS.took.off

*Over there they followed his tracks to where his clothes were lying on the ground, and then all of a sudden, a moose took off.*

**sh-080** Hé ii hadaa aajíi aht'e júúde.

hé ii hadaa aajíi aht'e júúde  
*EMPH* that moose 3sS.became all quickly

*He quickly became a moose!*

**sh-081** Guu hadaa lqh ts'é? déhtl'aa aht'e hadaa yéh wadéhɣade gq.

guu hadaa lqh ts'é? déhtl'aa aht'e hadaa yéh  
those moose edge to 3sS.went all moose with

wadéhɣade gq  
3pS.went.with there

*He went around to the edge of where all the other moose were and they went with him.*

**sh-082 Lhááhts'é? juukaats'eh ii a-- ii mélh eyaanédlade aht'e hadaa hááwqsat.**

lhááhts'é? juukaats'eh ii a ii mélh eyaanédlade  
 somewhere opening that (*hesitation*) that snares where.3sS.hit

aht'e hadaa hááwqsat

all moose 3pS.went.through

*Somewhere where there was an opening he ran through the snares, pushing them out of the way, all the moose followed.*

**sh-083 Gwilaa hááwejaa jii, jii ah- jii wajich.**

gwilaa hááwejaa jii wajich  
 maybe it.happened.like.this this story

*That's what happened in this story.*

**sh-084 Jii sadáádzíi Madááts'atl'qch'e dak'esa?uu.**

jii sadáádzíi Madááts'atl'qch'e dak'esa?uu  
 this behind.me snares.set.around.it in.the.picture

*Right behind me in the picture [video] is Madááhts'atl'qch'e [Snare Hill].*

**sh-085 Ii wajich háá ii zqh méyehch'e.**

ii wajich háá ii zqh méyehch'e  
 this story *EMPH* this only 3sS.fits.it

*This is the only story that fits this area.*

**sh-086 Eh, juudze aht'e gwe k'élhéhwats'ajich hōhch'e dah.**

eh juudze aht'e gwe k'élhéhwats'ajich hōhch'e dah  
 and today all.of.us there 1pS.talk.to.each.other like.that about

*Today, people tell stories about this area when they get together.*

**sh-087 Háá jii zoh wajich méhjii ch'ò sò dane aghajii.**

háá jii zoh wajich méhjii ch'ò sò dane aghajii  
*EMPH* this only story like.it here must.be people3pS.call.it  
*This story must be about this place.*

**sh-088 Jò laa dane yek'ii hadaa aajaá?, juudzenéh kuuts'ajíh háá gwii- gwiilaa wóle enúúdle.**

Jò laa dane yek'ii hadaa aajaá? juudzenéh kuuts'ajíh  
 here *ASSERT* person.on.it moose became today 1pS.think

háá gwiilaa wóle enuudlii  
*EMPH* that.is.how 3sS.be probably

*Right here, a man turned into a moose that day; today we believe that's how it was.*

**sh-089 È jii, jii mawajijé? jii hadaa aaje.**

è jii jii mawajijé? jii hadaa aaje  
 and this this his.story this moose 3sS.became  
*And this, this is his story, about that man who became a moose.*

**sh-090 Nadzeze lò.**

nadzeze lò  
 long *EVID.SURPRISE*  
*It's long.*

**sh-091 Méh nahewasjiché hōhch'e chedaa lhōlaade dah hōhch'e.**

méh	nahewasjiché	hōhch'e	chedaa	lhōlaade
about it	1sS.will.tell.you	like.that	alone	one.after.another

dah hōhch'e  
about like.that

*I'm going to talk to you guys about these stories, like this, one after another.*

**sh-092 Taahdaa jwe ẹ da mōdage nááyecheṣe hōhch'e lhōlaade.**

taahdaa	jwe	ẹ	da-mōdage	nááyecheṣe	hōhch'e
sometimes	there	hum.	his.own-older.brother	3sS.sees.3sO	like.that

lhōlaade  
one.after.the.other

*Once in a while, his brother would see him like that, now and again.*

**sh-093 Méh wajich naad̲zeṣ sō hōhch'e.**

méh	wajichnaad̲zeṣ	sō	hōhch'e
about.it	story long	must.be	like.that

*His story is really long.*

**sh-094 Lhéló waloh ts'ẹ? ajuu wọ de nááyaache, gwadzé lhéló gwadzé wats'ẹ méhwajich wólẹ hadaa.**

lhéló	waloh	ts'ẹ?	ajuu	wọ	de	nááyaache
finally	its.ending	toward	neg.	for	this.(hum.)	3sS.saw.3sO

gwadzé	lhéló	gwadzé	wats'ẹ	méhwajich	wólẹ	hadaa
there	finally	there	toward	his.story	it.is	moose

*In the end, he didn't see his brother anymore, towards the end of story of the moose.*

**sh-095 Hqch'ii laa juudzénéh dane yataah néhyah eh jii hadaa nahagááh néhyaa ajuu dane yaaghadaaghq.**

h'qch'ii      laa      juudzénéh      dane yataah      néhyah      eh      jii  
like.that      ASSERT today      peopleamong.them      3sS.standing and      this

hadaa nahagááh      néhyaa      ajuu      dane      yaaghadaaghq  
moose beside.us      3sS.went      neg.      people3pS.kill.them.all

*Because of that man who joined the moose and showed them man's ways, people today are not able to kill off all the moose*

**sh-096 Ii tl'qh, dane yekáédaa h'qhch'e de juudzénéh hadaa.**

ii tl'qh      dane yekáédaa      h'qhch'e      de      juudzénéh  
and.then      people3pS.hunt.them      like.that      nom.temp      today

hadaa  
moose

*And since then, people are still able to hunt moose.*

**sh-097 Ehts'ii, k'éh ts'é? dane wehtsan haa k'éh k'éádach h'qhch'e.**

ehts'ii      k'éh      ts'é?      dane wehtsan      haa      k'éh  
wind.blows      path      toward      people3sS.smell.O      EMPH      path

k'éádach      h'qhch'e  
3sS.walk [upwind]      like.that

*The wind blows, if you are following a moose out in the bush, don't approach from upwind because it circles back on its trail and will smell you.*

**Appendix 5 Text DM5: Sweeney Creek and the Dreamer Makéts'awéswą****sc-001 Juudzénéh jwe dane atl'q haaje wazuugé k'é wqhch'e.**

juudzénéh jwe dane atl'q haaje wazuugé k'é wqhch'e  
 today around.here peopleafter just.like empty way like.that

*Today is seems empty here, after the people have gone.*

**sc-002 Wats'ę adáawats'ajiih dę úújọ.**

wats'ę adáawats'ajiih dę úújọ  
 from.there 1pS.remember nom.temp well

*From the time [we were small], we remember well.*

**sc-003 Jọ tlę ezélé? juu aajii tl'węą.**

jọ tlę ezélé? juu aajii tl'węą  
 here horse bells also 3sS.make(sound) after

*There were horse bells sounding.*

**sc-004 Gwaadó wólę jejó two days dane nédaa jejuu.**

gwaadó wólę jejó two days dane nédaa jejuu  
 back.then it.was here two.days people3sS.stay now

*Back then, people camped there for two days.*

**sc-005 Tlę awadanáátise aadzę.**

tlę awadanáátise aadzę  
 horse big.area before

*Long ago there were horses in that big area.*

**sc-006 Tlę ezélé? aajii.**

tlę ezélé? aajii

horse bells 3sS.make(sound)

*You could hear the horse bells.***sc-007 Askégáe lháádzé? tlę éh k'éhwesats éh.**

askégáe lháádzé? tlę éh k'éhwesats éh

boys somewhere horse with 3pS.travelled.around with

*The boys would travel various places with horses.***sc-008 Ajúúlii gúúh wólę úh jejúúye ajúúlii dane éje.**

ajúúlii gúúh wólę úh jejúúye ajúúlii dane

nothing those.times it.was and friendly nothing people

éje

3sS.bother

*The animals that existed at that time were friendly and didn't bother people.***sc-009 Gúú háák'e.**

gúú háák'e

those.(times) way

*That's the way it was.***sc-010 Saę tsaę- tsaę- ts'idáá? aslę kénasjii úújọ**

saę tsaę- tsaę- ts'idáá? aslę kénasjii hé úújọ

me [stutter] child 1sS.be 1sS.remember *EMPH* good*I remember when I was a child, things were really good.*

**sc-011 Háá wagon éh dane k'ejizde wats'ę laa úújọ.**

háá wagonéh dane k'ejizde wats'ę laa úújọ  
*EMPH* wagonwith people3sS.camp.around from.there *ASSERT* good  
*When people started camping around with wagons, times were good.*

**sc-012 Hóhch'e ęhdáátl'aa gwaadó ęhdáátl'aa dane éhjii ọ adak'ę? ęhdétl'aane nááwat ęhdétl'aane.**

hóhch'e ęhdáátl'aa gwaadó ęhdáátl'aa dane éhjii  
 really difficult long.ago difficult people 3sS.say

ọ adak'ę? ęhdétl'aane nááwat ęhdétl'aane  
 but strongly hard.workers 3sS.work hard.workers

*Life was really difficult long ago, people say that even though many people were hard workers, they still had to work really hard.*

**sc-013 Guune dzę laa háák'aa juu ghats'ędaah.**

guune dzę laa háák'aa juu ghats'ędaah  
 those.people temp.loc *ASSERT* still now 1pS.be.alive

*Because of those people, we are still alive today.*

**sc-014 Hé machọh naadégaane juu chęhsane ghajii.**

hé machọh naadégaane juu chęhsa-ne ghajii  
*EMPH* his.sleep daylight those 3pS.be.poor-hum.pl 3pS.say

*People who still sleep after daylight comes are poor, they said.*

**sc-015 Háágwii.**

háágwii  
 that's.all

*That's the way it is.*

**sc-016** **Ii juu ɛlhɔ gwenaawadéts'at éjé? ajuu aahade uh- ajuu aahade aduuyaa.**

ii juu ɛlhɔ gwenaawadéts'at éjé? ajuu aahade  
 this now suddenly it.happens.again then neg. ahead

uh- ajuu aahade aduuyaa  
 [false start?] neg. ahead many

*If this were to suddenly happen again (famine) in the future, there won't be much for us.*

**sc-017** **Háák'aa juu k'ehdzenaa sɛnekii zet'óh.**

háák'aa juu k'ehdzenaa sɛnekii zet'óh  
 still now 1pS.return.to ?? before

*[There may be hard times] before we can get back to living the way we were before.*

**sc-018** **Juu ghadii úú matsíí?é? wólede ajuu úúséjuuh.**

juu ghadii úú matsíí?é? wólede ajuu úúséjuuh  
 now animals and its.offspring 3sS.exist neg. 2sS.shoot.3sO

*Now, we don't shoot the animals that have young ones.*

**sc-019** **Háá?iijuu haalaadii sô háágwii haaseje.**

háá?iijuu haalaadii sô háágwii haaseje  
 even.though accidentally must.be that.way the.way.we.are

*Even though it is not how it was meant to be, that is how it is.*

**sc-020** **Háá ii sô wóle.**

háá ii sô wóle  
 EMPH this must.be it.is

*I guess that must be it.*

**sc-021 Jíjjuu lhígé nááchę.**

jíjjuu lhígé nááchę  
 this one dreamer  
*There was a dreamer.*

**sc-022 Makéts'awéswaą laa úúye.**

Makéts'awéswaą laa úúye  
 Makéts'awéswaą. ('That's the way it is') ASSERT 3sS.be.called  
*He was called Makéts'awéswaą ('That's the way it is').*

**sc-023 Dane sô, dane mats'égéwé gaah wọ daaghętl'ọ sô.**

dane	sô	dane	mats'égé-wé gaah	wọ
person	must.be	person	his.wife-with rabbits	for

daaghętl'ọ sô  
 3pS.set snares must.be

*This man, I think, this man was setting snares for rabbits with his wife.*

**sc-024 Dane sô yúúnet'úúk éh, eht'uuh ya?óts'é? déhtl'aah, magwisje ghaawọkọ, eht'úúh ya?óts'é? déhtl'aah.**

dane	sô	yúúnet'úúk	éh	eht'uuh	ya?óts'é?	déhtl'aah
person	must.be	3sS.shoot.3sSwith	bullet		to.other.side	3sS.go.through

magwisje	ghaawọkọ	eht'uuh	ya?óts'é?	déhtl'aah
his.jacket	3sS.has.hole	bullet	to.other.side	3sS.go.through

*Someone must have shot him, the bullet went right through him, making a hole in his jacket, the bullet went right through him.*

**sc-025** Waʔonéts'éʔ mats'egéʔ gaah wọ daanaaghatl'ọ ẹhlhẹh.

waʔonéts'éʔ mats'egéʔ gaah wọ daanaaghatl'ọ ẹhlhẹh  
 on.other.side his.wife rabbits for 3sS.reset snares instead

*His wife who was sitting on the other side of him, resetting rabbit snares was killed instead of him.*

**sc-026** Ẹ zéhkhé.

ẹ zéhkhé  
 hum.sg 3sS.kill.3sO

*That man killed her.*

**sc-027** Eh wats'ẹ sọ ẹ dane káánaataah hōhch'e.

eh wats'ẹ sọ ẹ dane káánaataah hōhch'e  
 and then must.be hum.sg person 3sS.look.for like.that

*From then on he was looking for that man.*

**sc-028** Eh hōhch'e zọh walọh ts'éʔ.

eh hōhch'e zọh walọh ts'éʔ  
 and like.that only its.end to

*He kept on like that until the end.*

**sc-029** Né̄s̄chẹ kọh náásachẹ, mats'égéʔ aadzẹ yé̄lẹnááʔ.

né̄s̄chẹ kọh náásachẹ mats'égéʔ aadzẹ  
 3sS.fall.asleep there 3sS.dream.about.it his.wife before

yé̄lẹnááʔ

s3S.be.previously

*He went to sleep and dreamed that his wife was that other guy's wife.*

**sc-030** “Naghazékhii? ii tl’q, yéhnúújéle naawqghane?q laa sô yéhjii.

naghazékhii? ii tl’q yéhnúújéle naawqghane?q laa sô  
 3pS.kill.2sO and.then 3sS.go.back 3pS.plan ASSERT must.be

yéhjii

3sS.tell.3sO

*“They were going to kill you; afterward, they planned for that woman to return to that guy”,  
 he was told.*

**sc-031** Dane yéhjii.

dane yéhjii  
 person 3sS.tell.3sO

Someone told him that [in his dream].

**sc-032** Eh mats’égé? kaa méwanaatl’áá; aadzé mats’égé? yelhe laa.

eh nats’égé? kaa méwanaatl’áá aadzé mats’égé? yelhe  
 and your.wife for 2sS.do.similar.to.3sO before his.wife 3sS.be

laa

ASSERT

*“What she had planned for you happened to her”. She was his wife before.*

**sc-033** Nəlaa naaghe?óláa, ajuu laa naghəlaa laa sô,” dane yéhjii.

nəlaa naaghe?óláa ajuu laa naghəlaa laa sô  
 for.you 3sS.be.meant.for neg. ASSERT for.you ASSERT must.be

dane yéhjii

person 3sS.tell.3sO

*That bullet was meant for you, but they did not hurt you,” somebody told him (in his  
 dream).*

**sc-034** Ẹ wats'ẹ sọ náádadéschẹ.

ẹ	wats'ẹ	sọ	náádadéschẹ
hum.sg	from.there	must.be	3sS.start.to.dream

*From that point, he started dreaming.*

**sc-035** Lhígé sọ néschẹ.

lhígé	sọ	néschẹ
one.time	must.be	3sS.fall.asleep

*One time, he fell asleep.*

**sc-036** Lhígé sọ néschẹh, lhédó zọh.

lhígé	sọ	néschẹh	lhédó zọh
one.time	must.be	3sS.fall.asleep	dying only

*One time he fell into a really deep sleep.*

**sc-037** Haaje sọ dazọh wawadaah.

haaje	sọ	dazọh	wawadaah
just	must.be	his.chest	3sS.be.alive

*His chest was only moving slightly.*

**sc-038** Ajuu aajich úújọ.

ajuu	aajich	úújọ
neg.	3sS.breathe	well

*He was not breathing very well.*

**sc-039** Kemaahse sọ giyéhdaahge ye?ẹhjiighadaa.

kemaahse	sọ	giyéhdaahge	ye?ẹhjiighadaa
in.a.clean.place	must.be	3pS.keep.3sO	3pS.look.after.3sO

*They cleaned a place in the bush and looked after him there.*

**sc-040 Gwaadó wawoyó dẹ.**

gwaadó wawoyó dẹ  
 back.then 3sS.be.wise nom.temp  
*They were wise long ago.*

**sc-041 “Háá aajii kaa juu tlezaa ajuu wúújii éh.”**

háá aajii kaa juu tlezaa ajuu wúújii éh  
 EMPH 3sS.make.sound for these dogs neg. 3sS.make.noise with  
*“Let’s see what happens, make sure the dogs don’t make any noise,” they said.*

**sc-042 Tlezaa gwe juu sô natluu naaghadésti’q.**

tl’ezaa gwe juu sô natluu naaghadésti’q  
 dogs there also must.be many 3pS.tie.mouths.up  
*They muzzled the many dogs that they had.*

**sc-043 Chédahts’é giyéhdaa ts’é? giyaa?ẹ.**

chédahts’é giyéhdaa ts’é? giyaa?ẹ  
 alone 3pS.keep.3sO to 3pS.watch.3sO  
*They kept him alone, watching him.*

**sc-044 Ẹhgáe giyaa?ẹ jii ghadaa zqh.**

ẹhgáe giyaa?ẹjiiighadaa zqh  
 one.after.another 3pS.look.after.3sO only  
*One after another, they watched over him.*

**sc-045 Háá méh ọkeghe ghetl’áá lhélọh.**

háá méh ọkeghe ghetl’áá lhélọh  
 EMPH with.him twice becoming.dark finally  
*They spent two nights with him.*

**sc-046 5 days méh aawejaa, hōhch'e zōh.**

5 days méh            aawejaa            hōhch'e            zōh  
 5.days with.him    3pS.pass.(time)    like.that            only  
*They spent 5 days with him, and that's what happened.*

**sc-047 Eh wōdzeze sadeh chegeh ajuu háák'e náágiyehchiish.**

eh    wōdzeze    sadeh            chegeh            ajuu    háák'e  
 and    a.long.time    3sS.be.positioned    carefully            neg.    way

náágiyehchiish

3pS.put.3sO.in.position

*He laid there for a long time, and carefully they would roll him into a different position.*

**sc-048 Hōhch'e zōh sō giyejiighadaa.**

hōhch'e    zōh    sō            giyejiighadaa  
 like.that    only    must.be            spS.watch.3sO  
*They watched over him like that.*

**sc-049 Háá ii deh jō zōh wawadaah aht'e hōhch'e.**

háá    ii    deh    jō    zōh    wawadaah    aht'e    hōhch'e  
*EMPH* there then here only 3sS.be.alive all like.that  
*He was barely alive all that time.*

**sc-050 Háá lhéloh eight days aawejaa.**

háá    lhéloh            8 days            aawejaa  
*EMPH* finally            8.days            3pS.pass.(time)  
*Finally it had been eight days.*

**sc-051 Úújɔ kemaah̄ts'ę guune.**

úújɔ kemaah̄ts'ę guu-neḡ  
 good clean.place those-hum.pl  
*They put him in a good clean place.*

**sc-052 Dane woyɔne dane chish alęne sô.**

dane	wóyɔneḡ	dane	chish	alę-neḡ	sô
person	wise	person	elder	3sS.be-hum.pl	must.be

*There was an old wise man there with them.*

**sc-053 Lhets'edaa giigááh déhts'ii giyyuu- giigeyaahdah.**

lhets'edaa	giigááh	déhts'ii	giyyuu
once.in.a.while	3pS.beside	pl.sit	(false start)

giigeyááhdah

3pS.look.after.3sO

*Once in a while, they would sit beside him and look after him.*

**sc-054 Háá hōhch'e zɔh nine days aawejaa de.**

háá	hōhch'e	zɔh	9 days aawejaa	de
EMPH	like.that	only	9.days 3sS.pass.(time)	then

*9 days had passed like that.*

**sc-055 Giigááh déhts'ii éh ę ts'ęzo, wōhch'e aajich aadaachilh.**

giigááh	déhts'ii	éh	ę	ts'ęzo	wōhch'e
3pS.beside	pl.sit	with	hum.sg	suddenly	strong

aajich aadaachilh

3sS.breathe 3sS.become

*They were sitting there with him when suddenly he started to breathe more strongly.*

**sc-056 Eh s̥ giikahtaah ɛ juu, aajich aanaajaa.**

eh	s̥	giikahtaah	ɛ	juu	aajich
and	must.be	3pSwatch3sO	hum.sg	also	3sS.breathe

aanaajaa

3sS.become

*As they watched him, he started breathing strongly again.***sc-057 Háá ɛ d̥ wats'ɛ s̥ ɛ giigááh déhts'ii z̥h.**

háá	ɛ	d̥	wats'ɛ	s̥	ɛ	giigááh
EMPH	hum.sg.	there	from	must.be	hum.sg.	3pS.beside

déhts'ii z̥h

3pS.sit only

*They continued to sit beside him.***sc-058 Háá guugááh s̥ jiiigé náánesdaah.**

háá	guugááh	s̥	jiiigé	náánesdaah.
EMPH	beside.them	must.be	up	3sS.sit.back.up

*Then he sat up again.***sc-059 Ii d̥ s̥, guutaah wakaadaanétaah úúj̥n̥ s̥ kaahtaah.**

ii	d̥	s̥	guutaah	wakaadaanétaah	úúj̥n̥
that	nom.loc	must.be	among.those	3sS.look.at.3sO	good-hum.pl

s̥ kaahtaah

must.be 3sS.looks.at

*As he was looking at them, he saw who the good people were.*

**sc-060** **Wats'ẹ sọ chuu giyẹkọh.**

wats'ẹ            sọ                    chuu   giyẹkọh  
 from            must.be            water 3pS.give.3sO

*They gave him water to drink.*

**sc-061** **Juu giidé? yéhdadzaat éhjii hých'e.**

juu    giidé?                                    yéhdadzaat                    éhjii                    hých'e  
 also 3pS.acting.on.his.eyes            3pS.massage.3pO            3sS.said                    like.that

*They also were massaging his eyes [to wake him].*

**sc-062** **Háá nááyadéch'ẹ hých'e.**

háá    nááyadéch'ẹ                    hých'e  
 EMPH 3sS.open.eyes                    like.that

*He opened his eyes.*

**sc-063** **"Guugááh jiijigé naanesdaa desọ.**

guugááh            jiijigé                    naanesdaa            desọ  
 beside.them there                    3sS.sat.up            I.wonder

*"I must have sat up again with them then".*

**sc-064** **"Gọ wọlẹ laa," ii sọ gwiyéhjii.**

gọ    wọlẹ    laa    sọ                    gwiyéhjii  
 there it.is    ASSERT must.be            3sS.tell.3pO

*"It must have been over there," he told them.*

**sc-065** **"Jọdẹ we tsaaghaadaah k'alaak'ech'ii dzéné, dahjii.**

jọdẹ            we    tsaaghaadaah                    k'alaak'ech'ii                    dzéné dahjii  
 right.there there 2sS.live.badly                    nine                    days 2pS.say

*"You were barely alive for 9 days,' you said.*

**sc-066 Jọ wats'ẹ dəsʔat dẹ gọ.**

jọ wats'ẹ dəsʔat dẹ gọ  
 here from 1sS.float over.there

*From here I floated over there.*

**sc-067 Haaje gọ níyaa.**

haaje gọ níyaa  
 just there 1sS.arrive

*I must have just gotten there.*

**sc-068 Haaje lhígé nááchus laa ghasdlẹ.**

haaje lhígé nááchus laa ghasdlẹ  
 just one dreamer ASSERT 1sS.see

*I saw one dreamer.*

**sc-069 "Nẹ tóch'ẹ sọ wadezat", dane séhjii'.**

nẹ tóch'ẹ sọ wadezat dane séhjii  
*hum.pl.* long must.be time person3sS.tell.1sO

*"A long time has gone by", someone told me.'*

**sc-070 Haaje ii delaah k'ajuu t'aahnaadézhaa.**

haaje ii delaah k'ajuu t'aanaadézhaa  
 just there right.then again 1sS.return.back

*And right then, I started back.*

**sc-071 "9 days," sadáhjii'.**

9 days sadáhjii  
 9.days 2pS.tell.1sO

*"Nine days," you told me.'*

**sc-072** Ẹ Makéts'awéswąą , ii juu, ii juu nááchij.

ẹ	Makéts'awéswąą	ii juu	ii juu	nááchij
<i>hum.sg</i>	Makéts'awéswąą	him.too	him.too	3sS.dream

*That Makéts'awéswąą, him too, he was a dreamer, too.*

**sc-073** Nine days ajuu ghaadaah.

nine days	ajuu	ghaadaah
nine.days	neg	3sS.be.alive

*He was dead for 9 days.*

**sc-074** Ẹ laa juu mayiiné? natluu juudzénéh ii ts'ajin.

ẹ	laa	juu	mayiiné?	natluu	juudzénéh	ii	ts'ajin
<i>hum.sg</i>	ASSERT	also	his.songs	many	today	those	1Ps.sing

*We sing many of his songs today.*