4pSCb38. An investigation of the three tone system in Tsuut'in (Dene)

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This study is part of the documentation and conservation of Tsuut'in (Sarcee, Sarsi; ISO 639-3: srs), a northern Dene (Athabascan) language by a collaboration of academic and community members. Tsuut'in is a tone language, but contrary to Dene tonogenesis theory and unlike reports on all other Dene tone languages, Tsuut'in is reported to have three tones, H, L, M. The tonal system in Dene family has been argued to arise from the loss of laryngealized sonorants in the monosyllabic stem codas and the incorporation of laryngealization into the nucleus of the stem, resulting in H and L tonal contrasts. The Dene languages additionally exhibit ‘tonal reversal’, a tendency for the Dene tone languages to show ‘reversed’ tonal patterns that postdate the original tonogenesis. In this study we investigate the tonal distribution, realization patterns in data collected from fluent speakers reciting prepared wordlists and short discourses. Preliminary investigation indicates that, as reported, three tonal patterns emerge, with distinct distribution patterns arguably related to morphological factors. Furthermore M tone is more highly variable. The distribution patterns and interactions with morphology and the statistical analyses associated with the data are laid out.

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INTRODUCTION

This study is part of the documentation and conservation of Tsuut’ina (formerly Sarcee, Sarsi; ISO 639-3: srs), a northern Dene (Athabascan) language, by a collaboration of academic and Tsuut’ina community members. Tsuut’ina is a tone language, but unlike other Dene tone languages, and problematic for Dene tonogenesis theory, Tsuut’ina is reported to have three tones, H, L, M (LI, 1949; Cook, 1971). The Dene tonal system has been argued to arise from the loss of laryngealized sonorants in the monosyllabic stem codas and the incorporation of laryngealization into the nucleus of the stem, resulting in H and L tonal contrasts across a large group of Dene languages spoken in the Mackenzie Basin, and the American Southwest (Navajo, Apache).

The Dene languages also exhibit a phenomena called ‘tonal reversal’, tonal patterns that switch H→L, L→H in these languages. In a landmark study, Krauss (2005) classified and explicited these changes across different syllable types, showing a striking systematic development of the tonal patterns among Dene tone languages. Kingston (2005, in the same volume) has pointed out that though the development of both H or L tone from the loss of laryngealized sonorants in stem codas, as a theory of tonogenesis in Dene, is valid, the pattern of ‘reversals’ must postdate the original development of tone in at least some of the languages i.e. the process is likely ongoing thus not inherently tied to Dene tonogenesis. No explanation for this ongoing process or its relationship to Krauss’s tonogenesis hypothesis has been put forward. The data and analysis of tone in Tsuut’ina may shed light on the development of the tonal systems in the Dene tone languages, and provide impetus for studies of the variation and change in those systems.

Tsuut’ina is unlike other Dene tone languages because it has been reported to have three tonal contrasts, H, M, L. Krauss’s tonogenesis theory can not accommodate the development of a third tonal contrast. Furthermore, until recently, very few phonetic investigations of tone in Dene have been performed. In this study we investigate the distribution of the tones in Tsuut’ina, focusing in this study on the distribution of tone in data. The distribution of tone, and its relationship to the morphology, are laid out. We find evidence for three tone patterns and contour tones, and find that the distribution of these tones is tied to morphological structure, unsurprisingly in this morphologically complex language.

METHODS

The data for this study is from elicited word list which consists of minimal pairs constructed for tonal contrasts. The word list was recorded in a sound-treated booth at the University of Alberta in March 2012, using a Countryman E6i omnidirectional earset microphone and a Sound Devices 702 solid-state audio recorder, recording 48KHz 24-bit WAV audio. For the recordings, the speakers were provided with the list of English items to be translated into Tsuut’ina, alongside orthographic Tsuut’ina forms without any tone marking. The tone marking was drawn in part from published materials on Tsuut’ina, and in part added during transcription for items whose tone marking needed confirmation. For the first word list, the speaker was asked to read each item three times, twice in isolation and once in the carrier sentence ʔawə ʔísni-la “and s/he said __” For the second word list, the speaker opted to provide one repetition of each item, offering additional forms in cases where dialectal variants were noted. The data from in this study is from a single male speaker. A first transcription was done at the University of Alberta in ELAN; the data was further transcribed and segmented in Praat at the University of Rochester.

To investigate tone, the Praat script ProsodyPro (Xu 2005-2012) was run on the vowel data. Measurements of vowel durations were taken., Vowels were coded in Excel for vowel length, long- short; their position in the word, initial, final and medial; and their morphological affiliation, Stem, prestem and Aux. Vowels in the medial position were all syllables in neither initial nor final position, and were not stems. Syllables that were in the final position in the word were coded as final. In general final position in a verb is the position of the lexical stem (Lex). However, suffixes such as the nominalizer relativizer -i may be added to verbs (kàáádá “liar, lawyer”). Thus vowels were marked for the morphological category Stem (Lex); these were a subset of the syllables in final position. Similarly, the syllable before the stem is the position of person and aspect conjugation marking; this syllable was identified as the Aux. The Aux and Lex stems are thus the last two syllables in a morphological verb and comprise the core or minimal verb. A strong morphological boundary between them has been identified in other Dene languages (McDonough, 1999, 2003; McDonough & Wood, 2008). The Aux was in initial position in words in some forms and medial in those with prefixes to Aux. Thus the syllables were marked for both position in word and morphological category. The statistical package R was used for statistical analysis which was run at the
University of Alberta. In this study we report on the distribution of tone, and the duration of vowel length contrasts and the stem versus pre-stem morphemes.

**RESULTS**

**Vowel Durations**

As excepted, the long and short vowels show significant differences in duration (Figure 1.) The duration differences between long and short vowels also held of the stem vs pre-stem domains. Vowels in Tsuut’ina have greater mean durations in stems than in non-stems, regardless of phonemic vowel length, with stem vowels having greater mean durations (mean: 106.6483 ms., n = 192) than non-stem vowels (mean: 96.1208 ms., n = 314). A two-sided Wilcox test confirms that this difference in durations is significant (p = 0.0037). When vowel length is factored in, the same trends in duration still apply: stem short vowels, which have greater mean durations (88.1345 ms., n = 165) than non-stem short vowels (78.0074 ms., n = 254). A two-sided Wilcox test shows that the means of short vowels in stem and non-stem conditions differ significantly (p = 4.4342 × 10⁻⁶). Likewise, long stem vowels also have a greater mean duration (250.8212 ms., n = 17) than long non-stem vowels (174.5659 ms., n = 58).

![Figure 1](image.png)

*Figure 1. The mean durations of short and long vowels in Tsuut’ina.*

In our data set of 585 vowels, short vowels were more common than long vowels, with short vowels occurring in 86% of the syllables. In the Lex stem, short vowels made up 92% of the vowels (n=190, n=17).

**Tone Distributions**

Three level tones, high (H), mid (M), and low (L), and three falling contour tones (HL, HM, ML) occur in the Tsuut’ina data. Most contour tones arise due to tone sandhi. One instance of rising tone (MH) occurred in the data, all other contour tones were falling. The contour tones only occur on long vowels; there are no contour tones on short vowels. Contour tones made up 8% of the database. Among the three contour tones, ML was by far the most common, occurring in 37 of the 52 (71%) contour tones in the dataset. Only one contour tone occurred on the vowels in the Lex Stem, ML, the once instance in the dataset of a rising tone. Table 1 is the distribution of the three level tones in the database for both long and short syllables. There are more than twice as many H tones and M tones than L tones in the database. H tones occurred in stems more than other level tones, making up about 45% of the stems tones. Of the 235 syllables marked as M tones in the database (39% of the tonal contrasts), 107 were in initial position in the word; this is about half the tones in initial position, independent of their morphemic category. Of the remaining M tone syllables, 53 were in medial (23%) and 58 in stem position (25%). Thus M tones occurred in initial position in about half their occurrence in the data. Finally, of the 90 L tone syllables in the database, 20 or (23%) were in initial position, 19 (22%) in medial, and 47 (55%) occur in stem position. Thus L tones, which accounted for only 17% of the tones in the database, occurred almost half the time (52%) in stem morphemes. Thus H and L tones tend to appear more frequently affiliated to stem morphemes.
than in other morphemes, and M tones tend to appear affiliated to a position in word, in initial position in the word. Thus, for the distribution of level tones in the database, the H and L tones are more closely associated to morphemes (Stem morphemes), and M tone to position in word (initial position).

**TABLE 1.** The distribution figures for the short and long level tones in the database

<table>
<thead>
<tr>
<th>Tone</th>
<th>Tokens</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>197</td>
<td>33%</td>
</tr>
<tr>
<td>M</td>
<td>235</td>
<td>39%</td>
</tr>
<tr>
<td>L</td>
<td>90</td>
<td>15%</td>
</tr>
</tbody>
</table>

Table 2 is the distribution of the three level tones by morpheme type stem vs non-stem morphemes. H tone is the most common tone appearing in about half the stems, followed by M (32%) and L (24%). In the Lex Stems, which account for about 35% of the level tones, nearly half of them are H tones.

**TABLE 2.** The distribution of the long and short level and contour tones by morpheme type

<table>
<thead>
<tr>
<th>Stem</th>
<th>Tokens</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>92</td>
<td>45%</td>
</tr>
<tr>
<td>M</td>
<td>65</td>
<td>32%</td>
</tr>
<tr>
<td>L</td>
<td>49</td>
<td>24%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Contour</th>
<th>Tokens</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>HL</td>
<td>0</td>
<td>1 2%</td>
</tr>
<tr>
<td>HM</td>
<td>0</td>
<td>6 12%</td>
</tr>
<tr>
<td>MH</td>
<td>1 2%</td>
<td>2 4%</td>
</tr>
<tr>
<td>ML</td>
<td>0</td>
<td>36 69%</td>
</tr>
</tbody>
</table>

With respect to contour tones, which only occur in long vowels, to account for the distribution, we include one other morphological category, the Aux stem. The Aux stem is the syllable before the Lex Sem, the Aux+Lex is the core verb, as noted. Other prefixes may appear to the left of Aux. Thus the Aux may be in initial position or in medial, but it will always adjoin the Lex Stem. The Aux marks person, number and aspectual conjugation. In other Dene languages, tone is a conjugation marker (perfectives in Navajo). This type data is not available for Tsuut’ina. However, thirty-five of the 37 instances of ML contour tone in the dataset appear in the Aux. The ML contour is associated with the 1st person plural (1Pl) person marking. In (1) are examples from the dataset of this contour. The Aux Stem is the penultimate syllable in these examples, the Lex Stem is final.

```
(1) ʔásiìt'i / ʔásaàt'i
     "we're staying"
ʔidítöy / ʔídaátöy
     "let's count"
ʔisíli / ʔisálí
     "we are"
midíikid / mídaákid
     "let's ask him/her"
síltááz / saátááz
     "we (pl.) are sleeping"
```

The examples in (1) are instances of the morphological effect of inflectional or grammatical tone on tone distribution in morphologically complex languages. In (2) a verb is glossed for the Aux stem and Lex stem for demonstration. The verb in (2) has a prefix /mi/ on the Aux stem /díi/. The Aux stem contains both an aspectual marker and a person and number specification, the contour tone is associated to the person/number.

```
(2) midíikid
    "let's ask him/her"
mi-diíₐux kid_lex
```

Because of the richness of morphology of the Dene verb, many of the tonal contrasts are associated with inflectional and/or conjugational specification. As such, they are unlike lexical tone in that they are associated to grammatical meaning. While not an uncommon phenomena, there are many ways to consider this type tonal variation and contrast, however the role of tone in grammatical and inflectional versus lexical contrast is not taken up in this study. Noted only is the fact that the tones may be tied to morpho-syntactic specification, in this case the ML contour tone associated to the 1Pl marker /ii(h)/.
Tone Distributions in Short Vowels

No contour tones occur on short vowels in Tsuut’ina. Three level tones occur: High (H), Mid (M), and Low (L), with a total inventory of 490 tones on the short vowels. Of this number, 186 (33%) are H tones, 218 (39%) are M tones, and 86 (15%) are L tones. Thus L tones make up in only 15% of the tones among the short vowels. This distribution is not symmetric. L tone vowels make up a quarter of the tones in the Lex Stems, but only 8% of the tones in the non-stem domain. (There are no long L toned vowels in Aux.) Of the H tones in short vowels, 35% appear in initial position (67 of 193), 34 (18%) in medial, and 85 (44%) in stems. Almost half the H tone syllables in the database occurred in Lex Stem morphemes, though Lex Stem morphemes make up 35% of the database. Thus the distribution of the H and L tones appear to be more constrained by morpheme types than position in word, both tend to appear in Lex Stems more than elsewhere in the verb.

TABLE 3. The distribution of the level tones in short vowels by morpheme type

<table>
<thead>
<tr>
<th>Stems</th>
<th>Non-stems</th>
</tr>
</thead>
<tbody>
<tr>
<td>H</td>
<td>85</td>
</tr>
<tr>
<td>M</td>
<td>58</td>
</tr>
<tr>
<td>L</td>
<td>47</td>
</tr>
</tbody>
</table>

Level and Contour Tone Distributions in Long Vowels

Long vowels make up only 14% (n=80) of the vowels in the database. The three level tones (HH, MM, and LL) and contour tones (HL, HM, ML, and MH) appear on long vowels. There are no rising LM or LH contour tones in the data. Of 80 total tonal tokens on long vowels, 28 (35%) were level tones (HH=10, MM=16, LL=2), while 52 (65%) were contour tones (HL=1, HM=7, ML=37). However this is a skewed distribution. ML is the most commonly contour tone in long vowels occurring in 47% (n=37) of the cases. Among all the contour tones, 71% were mid falling (ML) tones, with only a single instance of a HL tone. Thus, while contour tones appear in 65% of the long vowels, 47% of those are the ML, which associated with the 1st person Plural marker in the Aux stem. This is not surprising since many occurrence of contour tones arise through tone sandhi, which occurs when prefixes are adjoined to vowel initial items. Otherwise contour tones are not lexically contrastive. Because we have not morphologically glossed the dataset for this study, we do not report on tone sandhi.

TABLE 4. The distribution of the level and contour tones in long vowels by position

<table>
<thead>
<tr>
<th>Position</th>
<th>Count</th>
<th>Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td>28</td>
<td>33%</td>
</tr>
<tr>
<td>Medial</td>
<td>33</td>
<td>39%</td>
</tr>
<tr>
<td>Stem</td>
<td>17</td>
<td>20%</td>
</tr>
</tbody>
</table>

By morphological category, only 25% of the long vowels appears in stems (n=17). As noted, only one contour tone appeared in the stem morphemes, the single instance of a mid rising (MH) tone in the dataset. Of the 52 long vowels coded as Aux, 82% of them are contour tones. Most of the long vowels, associated to the ML are in Aux position, at the boundary between the Aux and the stem morphemes.

DISCUSSION

The distribution of the tones in Tsuut’ina is an important first step in understanding its tonal system. Three observations on the tonal patterns emerge from this data: First, although three level tones appear in the data, the tonal distribution is asymmetric. This asymmetry may be important in understanding the role of tone in inflectional categories. Two, L tone is a highly marked tone with low frequency across the dataset. However, it appears in Lex Stems in a quarter of the stem tokens, far more often than it appears outside the Lex Stem. This distribution implicates its role in lexical contrasts as opposed to grammatical functions. Concomitantly, H tone is the most common tone in Lex Stem and M in pre-stem domain. M tone is most often found in initial position in the word, more independent of morphological affiliation than other tones. Three, while tonal contours are most often
associated to sandhi effects, a mid falling contour tone, ML, has emerged as a mark of an inflectional category, 1st person plural. There are no other falling tones associated to boundaries in this dataset. Since the distribution of this tone seems likely confined to this morpheme, the existence of this pattern implicates the role of both the morphology and internal boundaries on the development of tone in the Dene languages. Finally, a study of the development of tonal contrasts in the Dene languages will benefit from careful phonetic investigations and attention to morphological structure and from a focus on investigating the difference between lexical and grammatical or inflectional tone.

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REFERENCES