THE REALIZATION OF VOICELESS NASAL CONSONANTS IN UPPER TANANA (DENE)

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ABSTRACT

This study describes a rather rare nasal voicing contrast in Upper Tanana (Dene/Athabascan). The language has a rich inventory of nasal segments, distinguishing oral and nasal vowels and three phonemic consonants /m/, /n/, /n̥/. The voicing status of the coronal nasal (/n/ vs. /n̥/) is morphologically conditioned and surfaces as marking the contrast between light (unsuffixed) vs. heavy (suffixed) stems. We use the Earbuds Method [1] to analyze nasal events acoustically in order to better understand the processes involved in this contrast. Data come from two female speakers (both in their 80s). The results of this analysis suggest that, acoustically, the contrast between /n/ vs. /n̥/ may be more precisely described as a timing contrast rather than a voicing contrast. Additionally, there is evidence that the entire nasal gesture may be shifting leftward into the vowel in the light stem variant, mirroring other developments in the Upper Tanana stem syllable.

Keywords: Upper Tanana, Nasality, Earbuds, Dene/Athabascan, Timing Gestures

1. INTRODUCTION

Upper Tanana is a Dene (Athabascan) language spoken by fewer than 50, mostly elderly, individuals in eastern interior Alaska (USA) and the Yukon Territory (Canada). It has a large phoneme inventory distinguishing nasal and oral vowels as well as three nasal consonants /m/, /n/, /n̥/ [2, p. 43]. Nasal vowels can be reconstructed as sequences of vowels followed by nasal coda consonants [3]. Stem vowel nasalization has affected all long vowels (e.g., /nãː/ ‘mother’, /t͡sʰõː/ ‘grandmother’, /xĩː/ ‘melt (pfv.)’) but is less regularly found in stems with short vowels. Thus we find /ʔĩh/ ‘see (ipfv.)’ and /tʰãj/ ‘trail’, but also forms such as /tit͡ʃʰin̥/ ‘stick’ or /tonʔ/ ‘knock (pfv.)’.

The voicing contrast between /n/ and /n̥/ has a morphological origin between light (unsuffixed) and heavy (suffixed) stems. Voiceless /n̥/ occurs only word-finally in the absence of anysuffixes. Voiced /n/ occurs in syllables containing a historically vocalic suffix which has been absorbed into the stem. This morphological alternation has evolved into a surface contrast between word-final nasal phones, e.g., /nelt^{h}ʌn̥/ ‘it is frozen’ vs. /nelt^{h}ʌn/ ‘the frozen one’; /t͡θ’an̥/ ‘bone’ vs. /ʃt͡θ’anʔ/ ‘my bone’; or /tit͡ʃʰin̥/ ‘stick’ vs. /ʃtit͡ʃʰinʔ/ ‘my stick’. This contrast exists only for stems with short vowels. For long stem vowels, the contrast is between long nasal vowels and long oral vowels followed by voiced /n/, e.g., /tiht͡sʰĩː/ ‘I am hungry’ vs. /tiht͡sʰiːn/ ‘I, being hungry’. Verbal suffixes include the (productive) nominalizing suffix -v, the negative suffix -v́, and the imperative suffix -v. The only productive nominal suffix has the shape -v̀ʔ, but several non-productive suffixes with the shape -v are also attested ([2] chap. 11).

In this paper, we show that contemporary /n̥/ represents a transitional stage between a Vn sequence and suprasegmentalization of nasality on the preceding vowel Ṽ.

2. EARBUDS METHOD

While numerous techniques and methods exist for analyzing nasality in human speech nearly all share a common problem—they are not practical outside of a clinical setting, especially when working with Elders. Therefore, we opted for the Earbuds Method [1], which is specifically designed for collecting nasal data from the field using a non-invasive technique with minimal equipment. The Earbuds Method is based on the principle of nasalance, a nasal to oral amplitude output ratio ([4]), but instead of collecting amplitude (intensity) readings from a nasometer (see [5]), a pair of low impedance earbuds are used. This technique involves placing one earbud directly under a nostril with the silicon tip facing upward, channeling air from the nostril directly toward the earbud diaphragm ([1, p. 50]). The other earbud is held in place by the consultant at the corner of the mouth. After normalization of the intensity (dB) contours from each track, the resulting data can be quantified using the nasalance ratio (a proportion of nasal to oral energy within the signal) ([1, p. 59]). This information provides accurate details about the amplitude, timing, and duration of nasal gestures (e.g., pre & post-nasalization, nasal leakage, & coarticulation effects), which is what we seek to

better understand in the nasal voicing contrast in Upper Tanana.

When assessing figures made using the Earbuds Method, purely nasal sounds (e.g., [n]) are correlated with greater amplitude in both the wave form and intensity curves in the nasal tracks (displayed in red) compared to the oral tracks (displayed in blue). Purely oral sounds (e.g., [s]) show the opposite trend. Conversely, nasal vowels (e.g., [ã]) show similar degrees of amplitude in both the nasal and oral tracks given that air escapes from both tracts during the production of nasal vowels. Transitions between nasal and oral sounds are correlated with gradual increases in amplitude in the respective track as the velum lowers and raises.

3. METHOD

3.1. Participants

Given that Upper Tanana is a highly endangered language, we could only gather data from two participants, both women in their 80's.

3.2. Data

In total, 127 tokens were collected: 78 from one speaker and 49 from the other. An elicited wordlist was used, and tokens were produced in isolation. The data were then annotated into individual segments using Praat [6].

3.3 Procedure

Following the recommendations in [1], a pair of low impedance earbuds were connected to the microphone jack of a Marantz Professional Solid State Recorder PMD 671 and the device was set to record in stereo. The participants were asked to hold one earbud just beneath their nostril with the silicon tip facing upward while the second earbud was placed at the corner of the mouth. Participants were asked to hold the earbuds still and produce each word twice at a normal speech rate.

3.4 Acoustic analysis

Each token containing /n/ and /ŋ̍/ in coda position was extracted using Praat [6]. Next, each channel from each token was independently extracted and converted to intensity. The wave forms from both channels were then drawn with the nasal track placed above the oral track. Below the wave forms, the intensity curve from the nasal track (red) was transposed on the intensity curve from the oral track (blue). Finally, a TextGrid with each phoneme segmented was drawn over the images. This allowed for the analysis of nasal events in and across phoneme boundaries using two amplitude metrics (Decibels for the intensity contours & Pascals for the wave forms) to identify timing gestures associated with /n/ and /ŋ̍/.

4. RESULTS

4.1. Heavy stems

When a nasal coda appears in a heavy (suffixed) stem, the segment is traditionally described as voiced /n/ [2, p. 133]. With respect to timing, the nasal gesture frequently begins midway through the vowel and continues throughout the duration of the coda. Heavy stems with this archetype are observed in word-final position in Figures 1 and 2 where the amplitude in the nasal tracks substantially increases midway through the vowel and is maintained until the coda concludes. The coda in Figure 1 lasts 108 milliseconds (ms) while the entire nasal gesture, including the vowel, totals 185 ms. Likewise, the coda in Figure 2 totals 176 ms, while the entire nasal gesture, including the vowel, totals 247 ms.

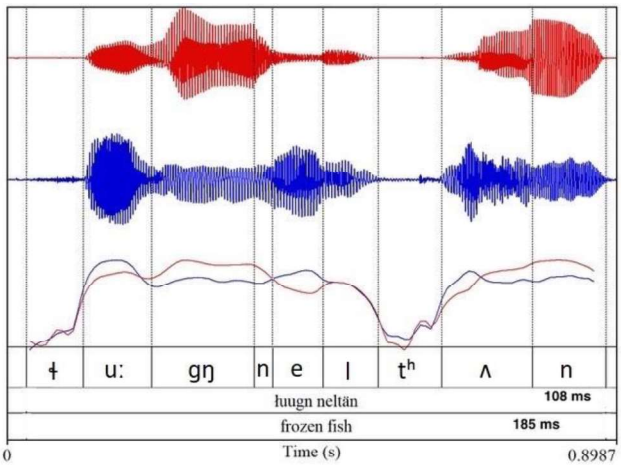

Figure 1: Word-final heavy stem with nasal coda in the word /ɬu:gŋ neltʰʌn/ *w*'frozen fish'

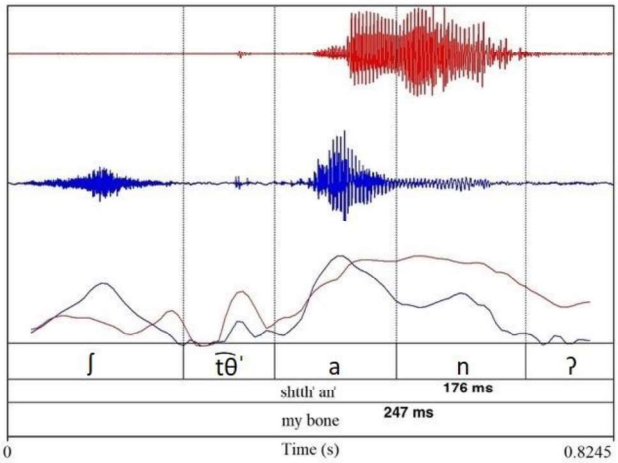

Figure 2: Word-final heavy stem with nasal coda in the word /ʃtθ'anʔ/ 'my bone'

4.2. Light stems

When a nasal coda appears in a light (unsuffixed) stem, the segment is traditionally described as voiceless /n̥/ [2, p. 133]. Yet the periodic wave cycles throughout the codas in Figures 3 and 4 suggest the segment may in fact be voiced. Instead, we observe that the contrast between heavy and light stem coda [n] might be better described as a difference in the timing of the nasal gesture. In light stems ending with coda [n] (as observed in Figures 3 & 4), the entire nasal gesture is shifted leftward into the vowel compared to the nasal gesture in heavy stems. This nasalizes a greater portion of the vowel yet shortens the duration of nasality in the coda. Consequentially, the nasal gesture concludes before the coda completes resulting in partial oralization of coda [n] ([n] → [ñ]).

In Figure 3, the nasalized portion of the coda only lasts 42 ms; substantially less than coda [n] in heavy stems. Yet two-thirds of the vowel in the light stem form is nasalized compared to roughly half the vowels in the heavy stem forms.

After the nasal gesture concludes, 24 ms of periodic wave cycles in the oral track wave form are observed throughout the remainder of the coda. Additionally, unlike in the heavy stem examples, both intensity curves drop sharply during the final phase, suggesting the latter half of the coda may be perceived as quieter. This could be the source of impressionistic observations of voiceless /n̥/ described in the literature.

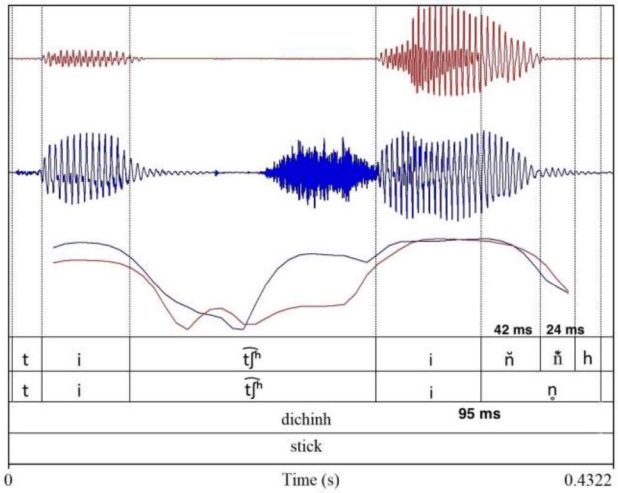

Figure 3: Word-final light stem with nasal coda in the word /titʃʰin̥/ 'stick'

In Figure 4, the nasal gesture nasalizes the entire vowel and concludes halfway through the coda. The nasalized portion of the coda lasts just 55 ms after which lower amplitude periodic cycles (seen in the blue wave form) continue for an additional 55 ms until the coda concludes.

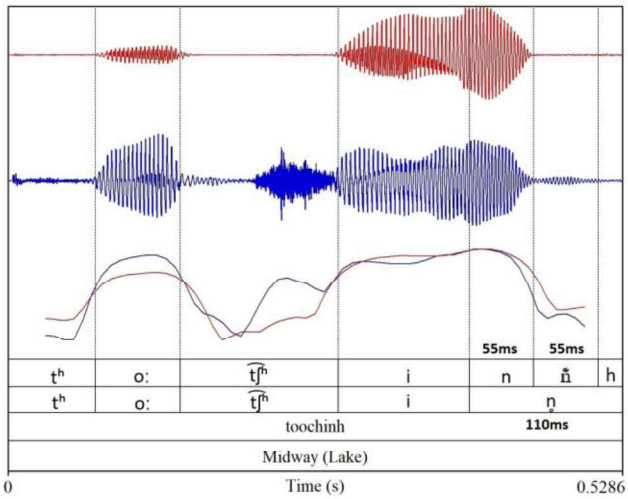

Figure 4: Word-final light stem with nasal coda in the word /tʰo:tʃʰin̥/ 'Midway Lake'

4.3. Quantifying Nasality in Upper Tanana Stems

To quantify these findings, we use the nasalance ratio, described in [1] as a proportion of nasal to oral energy throughout the signal. Nasalance is provided in Figures 5 & 6 as a line that fluctuates temporally between nasal (green) and oral (orange), which corresponds to the nasalance line crossing the 50% mark. Figures 5 and 6 with the nasalance lines were created in R (4.1.1) using the script provided in [1] and are formatted with the nasal and oral wave forms transposed to better illustrate the nasal gesture shifting leftward in the light stem example (Figure 6).

Figure 5 presents an example of a heavy stem form with a nasal coda in the word *dindeh etshyin* 'shaman'. As with Figures 1 and 2, the nasal gesture in the final syllable begins halfway through the vowel and concludes at the end of the coda. This observation is confirmed by the nasalance line crossing above the 50% mark 53% of the way through the vowel ((56 ms *crossing point* / 106 ms *total vowel duration*) *100) and dropping below the 50% mark upon conclusion of the coda. The entire nasal gesture is 139 ms with 56 ms positioned within the vowel and 83 ms positioned in the coda.

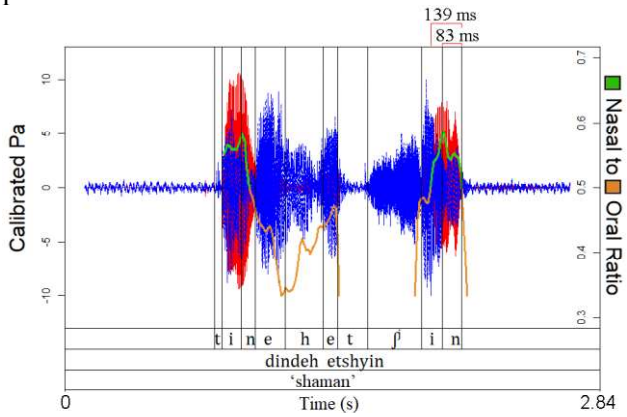

Figure 5: Word-final heavy stem with nasal coda in the word /tineh etʃin/ 'shaman'.

Figure 6 presents an example of a word-final light stem form with a nasal coda in the word *etshyinh* 'he's making magic'. As with Figures 3 and 4, the nasal gesture in the final syllable begins just after the onset of the vowel and concludes roughly halfway through the coda. This observation is confirmed by the nasalance line crossing above the 50% mark 18% of the way through the vowel ((21 ms *crossing point* / 95 ms *total vowel duration*) *100) and dropping below the 50% mark just 34% of the way through the coda leaving 66% of the coda with no nasality ((17 ms *until crossing point* / 50 ms *total coda duration*) *100).

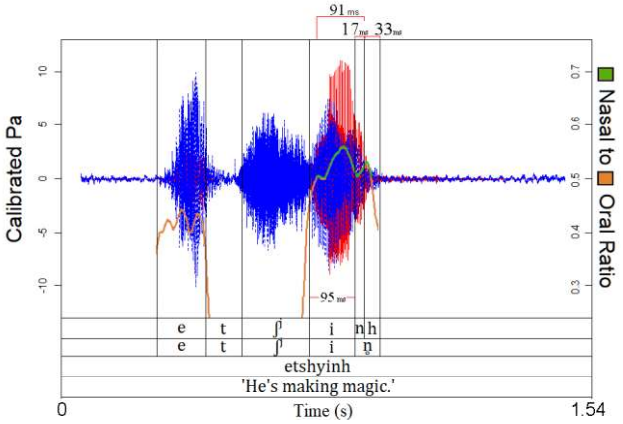

Figure 6: Word-final light stem with nasal coda in the word /etʃiŋ̊/ 'he's making magic'

As observed in Figures 1-6, the overall duration of the nasal gesture is variable, yet the proportions of the gesture that overlap the vowel and coda remain consistent. In heavy stem forms with a nasal coda, approximately half the vowel is nasalized and the entire coda is nasalized. In light stem forms with a nasal coda, the majority of the vowel is nasalized while the coda is only partially nasalized.

5. DISCUSSION

Results from this analysis suggest that the previously described nasal voicing contrast that alternates between heavy and light stems in coda position may be more accurately described as a timing contrast. Acoustic evidence presented in Figures 1–6 suggest that in the light stem forms, the gesture is shifting leftward into the vowel and out of the coda compared to heavy stem forms where the gesture occupies approximately half the vowel and the entire coda. These results are further supported by comparison with other Dene languages such as Ahtna [7] and Slave [8]. Ahtna has not developed phonemic nasal vowels. /n/ in codas is fully voiced, e.g., [tʰɛn] 'ice' (cf. Upper Tanana [tʰʌŋ̊]). This suggests that in Ahtna the nasal gesture minimally overlaps with the entire coda. Contrarily in Slave, which has lost most coda consonants, the nasal gesture has shifted completely leftward and initiates with the onset of the vowel leaving no overlap for a would-be coda (e.g., [tʰɛ̃] 'ice' [8, p. 42]). Upper Tanana light forms with nasal codas demonstrate a transitional system between languages like Ahtna and like Slave where the nasal gesture has shifted leftward but not to the point where it no longer overlaps with the coda. If the nasal gesture were to continue shifting leftward, we might predict a fully nasalized vowel along with an oral coda, similar to the development of /ʔĩh/ 'see (ipfv.)' and /tʰãj/ 'trail' mentioned above, and to the loss of stem-final nasal consonants in syllables with long stem vowels. This trend, then, is yet another instance of coda consonant loss in Upper Tanana ([9], [10]). It is important to note that the timing of the nasal gesture in Upper Tanana light stems is not necessarily precise and might result in different sound combinations in the coda; especially during the transition phase between the nasal and oral segments while the tongue repositions to allow air to escape the mouth.

While the contrast between heavy and light stem [n] might be more accurately described as a timing contrast involving the nasal gesture, it may not be the best way to describe the contrast for language learners. Pedagogically, learners are already familiar with other voicing contrasts in Upper Tanana, specifically in the stop series. Therefore, applying this concept to nasal [n] is not new. However, explaining and understanding a timing gesture involving varying degrees of nasalization on both the verb and coda would be considerably more complicated for both instructors and learners alike. Additionally, the degree of endangerment of Upper Tanana makes it unlikely that the leftward shift of the nasal gesture will continue to the point where the entire vowel is nasalized and no nasal consonant remains. In that case, educators would have to make a decision as to whether they want to maintain a conservative orthography or make adjustments to the spelling system to reflect pronunciation.

6. CONCLUSION

Using the earbuds method, we have shown that what has been described as a voicing contrast between nasal consonants is acoustically a timing contrast, with the nasal gesture shifting leftwards. These findings provide yet another salient example of the multifaceted nature of phonetic cues that are described generically as 'voiceless nasals' (see e.g., [11], [12]). Future studies exploring the acoustic correlates of nasality in Ahtna and Slave will help to provide a more complete picture of these complexities in Dene languages.

7. ACKNOWLEDGMENTS

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