# ACOUSTIC CHARACTERISTICS OF PREASPIRATED STOPS IN PLAINS CREE

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## 1 Introduction

In this paper, I investigate the acoustic characteristics of preaspirated stops in Plains Cree, an Algonquian language of Canada. Plains Cree is the westernmost member of the Cree-Montagnais-Naskapi dialect continuum that stretches from Alberta to Quebec. Existing descriptions of Plains Cree focus on standard and often archaic phonetic variants and rarely contain phonetic analysis. Similarly, teaching materials put little emphasis on Cree pronunciation beyond individual characters. Here, I focus on a small set of data drawn from Plains Cree spoken in Maskwacîs, Alberta and describe the occurrence of preaspiration, its durational properties, and durational properties of preceding vowels.

### 1.1 Plains Cree sound system

The consonants and vowels of Plains Cree are given in Table 1; the Standard Roman Orthography is used herein. Stops are unaspirated and *c* is an affricate which can range from [t͡s] to [t͡ʃ]. All consonants occur in onsets and codas. In onsets, stop/nasal-*w* clusters occur. For vowels, a length distinction is conventionally described; long vowels are tense while short vowels are lax, e.g., *î* [iː] and *i* [ɪ]; *ô* [oː (~ uː)] and *o* [ʊ] [1], [2]. In *VhC* sequences these distinctions may be lost (e.g., both *īhc* and *ihc* occur as [ih͡ts]) [1], [3].

**Table 1**: The sounds of Plains Cree

| Consonants | | | | | | Vowels | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| p | t | | | k | | | | | | | |
| | | c | | | | î | i | | | | |
| | | s | | | h | ê | | | | ô | o |
| m | n | | | | | | | â | a | | |
| w | | | y | | | | | | | | |

#### Preaspiration in Cree

In Cree, *h* occurs in onsets and codas and in codas before any other consonant, though *hs* and *h*-nasal sequences occur only across morpheme boundaries. "Preaspirated" is used to refer to sounds which *h* can precede word-finally: *p*, *t*, *k*, and *c*. The affricate *c* is included as a stop due to this patterning [1]. Changes in preaspiration in Plains Cree are not well-documented, though ongoing changes in Woods Cree in northern Saskatchewan have been investigated. Woods Cree speakers tend to simplify *hk* and *hp* to *h* word-finally but not word-internally, with little change in *ht* and *hc* clusters [4]. In Plains Cree, word-final *hk* may simplify to *h* in some areas (A. Wolvengrey, pers. comm.).

### 1.2 Cross-linguistic preaspiration

Preaspiration is rare among the world's languages and may be used in different ways [5]. For example, Scottish Gaelic uses non-phonemic preaspiration to indicate voiceless rather than voiced stops. This has influenced nearby English dialects, where voiceless consonants are preaspirated [6].

Icelandic distinguishes between plain, postaspirated, and preaspirated stops. Experiments have found that preaspiration can be cued by voice offset time (VOffT), a syllable-final counterpart of VOT. Unlike Cree, Icelandic preaspiration only follows short vowels; longer vowel durations require longer VOffT [7]. VOffT, vowel duration, and vowel length considered in the following analyses.

## 2 Method

Data used herein was drawn from recordings collected in an ongoing collaboration between the Alberta Language Technology Lab at University of Alberta and Miyo Wahkohtowin Education in Maskwacîs, Alberta.

### 2.1 Recordings

Careful pronunciations of Cree words were collected using Countryman E6 unidirectional head-mounted microphones and a Roland OCTA-CAPTURE external sound card at a sampling rate of 44.1kHz and bit depth of 16 onto a computer using either Audacity or Adobe Audition. The files were stored in an uncompressed .wav format. Data from 8 native speakers Plains Cree (6 female), aged 50 to 80 years, were used in this study. Fluency levels (1 to 3) were assessed by the author on the basis of fieldwork sessions and speaker self-assessments.

### 2.2 Data collection

Words containing phonemic preaspirated stops, determined on the basis of the Standard Roman Orthography [3], were extracted for each of the stops (*p*, *t*, *k*, *c*) preceded by each vowel, as available. For each word, recordings from three speakers were included. Word-internal preaspirated stops were the focus of this study, though some word-final instances were included due to a small data set. Stress, speech rate, and position were not analysed at this time. Table 2 gives counts for available sequences ($N = 144$).

**Table 2**: Counts for *VhC* sequences

| | â | a | ê | î | i | ô | o |
|---|---|---|---|---|---|---|---|
| hp | 3 | 0 | 0 | 0 | 6 | 0 | 0 |
| ht | 9 | 6 | 6 | 6 | 6 | 0 | 3 |
| hk | 15 | 12 | 6 | 0 | 12 | 6 | 12 |
| hc | 0 | 12 | 6 | 0 | 12 | 0 | 6 |

### 2.3 Measurements

Praat was used for acoustic measurements [8]. Preaspiration was measured as VOffT (ms), a devoiced period of the

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vowel before the stop closure [7]. The consonant and the non-occurrence of phonemic preaspiration were included, for comparison to ongoing changes in Woods Cree [4]. Vowel duration and phonemic length were also included.

## 3 Results and discussion

Due to the small data set, the regression models were kept simple. Further research will allow for more in-depth analyses. For logistic regression models, *īhC* and *Vhp* sequences were removed as they occurred categorically with expected preaspiration. Analyses were performed in R using the package lme4 [9], [10].

### 3.1 Preaspiration

Preaspiration, measured by the presence of VOffT, occurred in 87% of tokens. All instances of *hp* ($n$ = 9) occurred with VOffT, consistent with Woods Cree findings [4]. For *ht*, *hk*, and *hc*, there were no reliable predictors for the occurrence of VOffT. Fixed effects included in logistic regression models were consonant, vowel, vowel length, and fluency, with word and speaker as random effects. No significant effects were found. However, the 87% occurrence rate of preaspiration suggests a higher degree of retention in this Plains dialect compared to Woods Cree [4]. This 87% of the data was used for the following analyses of VOffT.

The mean duration of VOffT was 74.82 ms ($SD$ = 26.56). Table 3 gives the descriptive statistics for the VOffT (ms) by phonemic vowel length.

**Table 3**: Preaspiration duration by phonemic vowel length

| Vowel Length | Mean | SD | Min | Max |
|---|---|---|---|---|
| long | 67.55 | 26.86 | 24.41 | 136.82 |
| short | 79.35 | 25.50 | 33.34 | 147.32 |

A linear mixed effects regression model was fit with VOffT as the response variable, word as a random effect, and vowel duration and length as fixed effects, with an interaction between them. Vowel length was a significant predictor ($b$ = 43.07, $t(118)$ = 2.41, $p$ = .0177). Long vowels occur with shorter VOffTs and short vowels with longer VOffTs. The interaction was also significant ($b$ = -.298, $t(121)$ = -2.03, $p$ = .0449); as long vowels became longer, the VOffT period became longer, while as short vowels became longer, the VOffT period became shorter. This may suggest a preferred *Vh* duration relative to vowel length, perhaps to maintain the length distinction. This is similar to Icelandic findings, where longer *Vh* durations required longer VOffTs for preaspiration to be perceived [7]. However, Plains Cree allows preaspiration after long and short vowels which is further reflected in the significant vowel duration/length interaction. An analysis of the *h*/*Vh* ratio may clarify this, following Pind [7] for Icelandic. Comparisons to other *hs* and *h*-sonorant clusters will also allow for more detailed description.

### 3.2 Vowel duration

A linear mixed effects regression model was fit with vowel duration as the response variable, word and speaker as random effects, and the occurrence of VOffT and vowel length as fixed effects. Phonemic vowel length was a significant predictor ($b$ = -36.64, $t(69)$ = -4.62, $p$ < .001); long vowels occurred with a mean duration of 136.60 ms ($SD$ = 46.17) and short vowels with a mean duration of 103.49 ms ($SD$ = 28.43). These results align with previous phonological and phonetic descriptions of Cree, e.g. [1], [2]. However, there was no significant effect for the occurrence of preaspiration. Thus, the previously-described vowel length neutralisation in *VhC* sequence is not seen in these Maskwacîs Cree data, though further data collection and analysis is necessary to confirm this. Detailed comparison with vowels followed by plain consonants, and between different vowel qualities, may also offer insight.

## 4 Conclusion

The Plains Cree speakers in this pilot study have shown relatively little loss of preaspiration compared to Woods Cree findings. The data analysed here have suggested some important predictors for VOffT and the duration of the preceding vowel in Plains Cree, though the data for more in-depth analyses are not yet available.

Additional data collection in different regions and communities, and the inclusion of speech rate, stress, and medial/final position in analyses, will allow for fuller descriptions of Plains Cree preaspiration and variation across dialects. Detailed descriptions of modern Cree use may benefit researchers, teachers, and students alike, and in turn facilitate the development of pedagogical materials.

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