Sandhi in Plains Cree

(final submitted draft)

Kevin Russell

University of Manitoba

Kevin_Russell@umanitoba.ca

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Abstract

Recent phonetic studies of external sandhi across languages have found some cases to be categorical and others to be gradient, as well as considerable inter-speaker variation. This study examines sandhi in Plains Cree, using acoustic analysis of natural speech from the narratives of two speakers. One type of sandhi, involving the apparent deletion of the first vowel and compensatory lengthening of the second (e.g., /a#o/ → [oː]), is shown to be gradient and probably resulting from gestural overlap. Another more specialized type, the (possibly morphosyntactically governed) coalescence of /a+i/ or /aː+i/ to [eː], appears to be categorical. Implications for practical orthography are discussed.

Keywords: sandhi, categorialness, gradience, Cree

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1 Introduction

Traditionally in many schools of phonology, processes affecting vowels that meet across a word boundary were usually assumed to be categorical phonological rules of exactly the same sort as word-internal rules, except perhaps for applying in a different level of the phonology. There have some remarkable successes in describing patterns of external sandhi using various versions of phonological theory, such as Hayes' (1986) autosegmental analysis of vowel sandhi in Toba Batak.

In the 1990s, however, careful phonetic studies showed in case after case that apparently categorical sandhi phenomena were actually gradient, depending on factors such as speech rate. Nolan, Holst, and Kühnert (1996) using electropalatography and Zsiga (1994) using spectral analysis showed that the modification of English /s/ to apparent [ʃ] in sequences like *miss you* was gradient and remained distinct from underlying /ʃ/, such as in *issue*. Nolan et al. (1996) argued that the intermediate results were best explained by gestural overlap rather than a categorical rule changing phonological features. Similarly, Zsiga (1997) showed that, while word-internal vowel harmony in Igbo was indeed a categorical rule, the changes undergone by vowels in external sandhi were gradient and best explained by gesture overlap. Such findings seemed to suggest that all sandhi processes between words might turn out to be gradient.

The picture became more complicated with later findings. Ladd and Scobbie (2003) found some cases of categorical external sandhi in the consonant gemination and lenition of three speakers of Sardinian. Ellis and Hardcastle (2002), using electropalatography to study inter-word place assimilation in English nasals, found a surprising amount of speaker variability: some speakers never assimilated at all, some always did so categorically, some alternated between no assimilation and complete assimilation, and some showed the gradient pattern found in earlier studies like Nolan et al. (1996). Tserdanelis (2005), building on a rich body of earlier phonological and phonetic work on Greek external sandhi, found different patterns of categoriality for different sandhi processes and, once again, considerable speaker variability.

This paper offers data on external sandhi from another language, Plains Cree. The processes of vowel deletion and coalescence were first noted by Bloomfield (1930), who clearly described it as being optional, but without any hint that it may be a gradient process resulting in intermediate states. Using acoustic analysis of natural monologic speech from two Plains Cree speakers, we will find another example of a split between processes: one type of sandhi is categorical, others are gradient and seem to result from gestural overlap.

2 Plains Cree and external sandhi

Plains Cree (an Algonquian language spoken in much of western Canada) has an essentially triangular vowel system with a length distinction. There are three short vowels, conventionally written *i*, *a*, and *o*, though *o* in fact ranges between mid and high. Each short vowel has a long counterpart, conventionally written with a circumflex accent in the standard roman orthography. There is in addition a long *ê* with no short counterpart.[1]

short	i		o	*long*	î		ô
						ê	
		a				â	

Plains Cree has optional processes that affect vowels that meet across a phonological word boundary. Although it is the phonological reality of these processes that is at issue in this paper, for conciseness I will describe them in this section as if they were absolute and unquestionable, without constantly appending the word “apparently”.

There are in general three possible outcomes when two vowels meet across a phonological word boundary (plus one special case to be discussed later):

- At one extreme, the juncture between the vowels may be exaggerated by partially devoicing the first vowel: *êkwa anima* → [eːgwaḁ anɪma] ‘and that.one’.[2]
- The hiatus may simply be tolerated and the two vowels pronounced in sequence with nothing consonantal and no period of devoicing separating them.
- Finally, at the opposite extreme from devoicing, if the final vowel of the first word is short, it may be deleted. Alternately, a word-final short *o* may be turned into the glide *w*. If the initial vowel of the second word is also short, it will undergo compensatory lengthening.[3] This is the outcome that will be referred to as *sandhi* throughout this paper.

The examples in Table 1 illustrate some of the possible combinations and the results of external sandhi applying to them. In each, the first column gives the canonical form of the string, the form the word would

[1] The consonants in the standard roman orthography are relatively straightforward. *s* varies between [s] and [ʃ]; *c* is an affricate varying between [ts] and [tʃ]. *hp, ht, hk* are pre-aspirated stops (often pronounced as fricatives).

[2] In glossing strings of Cree words, a period is used in cases where two or more words of English are needed to gloss a single Cree word adequately.

[3] There are scattered exceptions to compensatory lengthening throughout the Bloomfield texts from the 1920s and the more recent texts edited by H.C. Wolfart and Freda Ahenakew. For example, in the sentence *nêpêwisiw aw oskinîkiw* ‘This youth was ashamed’ (Bloomfield, 1930, p. 197), the final vowel of *awa* ‘this’ has deleted without lengthening the initial vowel of *oskinîkiw* ‘youth’.

Table 1: Examples of the most widespread pattern of Plains Cree external sandhi — deletion of the first vowel with compensatory lengthening of the second.

canonical	*after sandhi*	*gloss*
piko ana	pikw âna	just that.one
nama awiyak	nam âwiyak	no one
ôma ita	ôm îtah	this here (here it is)
êkosi anima	êkos ânima	thus that.one
êkosi êtokwê	êkos êtokwê	thus I.think
anihi oskinîkiwa	anih ôskinîkiwa	these youths

have in isolation. The second column is the sequence as actually transcribed in its source, showing the effects of external sandhi.

Non-copular sentences in Cree contain a verbal complex, which consists of the core verb-word (the stem and all its suffixes) and zero or more *preverbs* — particles which mark grammatical properties such as mood and aspect, control predicates ('want', 'try', etc.), clausal complementizers, and a wide range of adverbial meanings ('in vain', 'while moving around', 'secretly', 'jointly', etc.). By all phonological criteria, the preverbs are independent phonological words (Russell, 1999). One of the ways that preverbs pattern with independent words that they participate in all three of the above options for dealing with vowel hiatus. Together, the elements of the verbal complex form a phonological phrase.

Although currently little is firmly established about Cree prosody, as a first approximation it can be said that this kind of sandhi appears to occur freely across phonological phrase boundaries but rarely, if ever, across intonation phrase boundaries. Further work is needed to confirm these informal observations, as well as to determine if the level of prosodic hierarchy has an effect on the frequency of sandhi or on the gradience that will be established in this paper.

In addition to the normal sandhi combinations, there is a special case that applies within a verbal complex, between the first preverb and the following preverb or verb stem. A preverb-final *a* or *â* can coalesce with a following short *i* to produce a single long *ê*. For example, the complementizer *kâ-* will often coalesce with the initial *i* of the core verb-word *itwêt* '(s)he says' to form [keːtweːt], usually transcribed *k-êtwêt* in published texts. This type of sandhi is restricted to the first preverb of the verbal complex. Between two independent words outside the verbal complex or elsewhere within the verbal complex, the only possibility to resolve /a#i/ hiatus through sandhi is the usual deletion of the first vowel with compensatory lengthening of the second, resulting in a long [iː]; and there is no way at all of resolving /â#i/ through sandhi, since /â/ is long.

There are two traditions of orthography for Cree, which treat sandhi differently. The first uses the syllabary originally devised for Cree, variants of which have since come to be used for Ojibwe, Inuktitut, Chipwyan, and other aboriginal languages of Canada. A second tradition, beginning with the texts published by Leonard Bloomfield (1930, 1934), uses a mostly phonemic transcription with symbols of the roman alphabet. Variants of this system are used in most textbooks of Cree and in most work by linguists, for example the extensive collection of texts published by H.C. Wolfart and Freda Ahenakew over the years, including the two sets of texts analyzed in this paper (Minde, 1997; Ahenakew, 2000). In the syllabic orthography as used by native speakers, the coalescence type of sandhi is frequently marked, for example using ᑫ ⟨kê⟩ instead of ᑲᐃ ⟨ka.i⟩, but the results of the other types of sandhi are rarely if ever recorded. Works that use the roman orthography, on the other hand, are much more likely to record the results of sandhi rather than simply the canonical surface forms of each individual word. Bloomfield consistently marked sandhi and several other non-phonemic details whenever he heard them. A few of the Wolfart and Ahenakew texts do not mark sandhi (e.g., Whitecalf, 1993), but most do. These texts are idealized away from raw phonetics in most other respects: while hesitations and self-corrections are usually included, most other low-level phonetic details are not recorded, such as word-internal vowel syncope. The following study will help determine whether the syllabic tradition as practised by many native speakers or the roman tradition as practised by linguists is a more accurate reflection of native speakers' phonological systems.[4]

3 Method

3.1 Speakers and materials

The analyses in this paper were based on recordings of autobiographical and other oral narratives by two speakers of Plains Cree, who were in their late seventies and early eighties at the times of the recordings:

- Emma Minde (EM) grew up in *onihcikiskwapiwinihk* (Saddle Lake, Alberta) and spent her adult life in *maskwacîsihk* (Hobbema, Alberta).
- Alice Ahenakew (AA) grew up and lived in Cree-speaking communities in north-central Saskatchewan,

[4]Another relevant difference between the two orthographic systems is in the treatment of the verbal complex. In roman orthography as written by linguists, strings of preverbs and the verb stem have traditionally been joined together with hyphens, a practice which is followed in this paper. In syllabic orthography, and even in roman orthography as written by many native speakers, preverbs and the verb stem are almost always separated by spaces, consistent with their status as independent phonological words.

including *pakitahwân-sâkahikanihk* (Sturgeon Lake) and *yêkawiskâwikamâhk* (Sandy Lake).

The narratives were recorded, transcribed, and edited by linguists H.C. Wolfart and Freda Ahenakew (also a native speaker of Plains Cree), and have been published as Minde (1997) and Ahenakew (2000). Fuller details on the recordings are available in the two volumes.

Using the transcriptions of the recordings, two types of tokens were identified as candidates for analysis: sequences of words where an underlying word-final vowel was followed by a word-initial vowel (whether or not these were transcribed by Wolfart and Ahenakew as having a deleted word-final vowel) and, for comparison, other tokens of the second words of the earlier sequences where the preceding word ended in a consonant. Vowel tokens were identified as candidates for analysis only if the flanking consonants were stops or fricatives, not approximants or [h].

The various environments where sandhi can take place will be discussed in the Results section in three broad categories:

- /a#ê/: where a word-final /a/ comes into contact with *ê-*, a complementizer preverb that is an independent phonological word but is morphosyntactically bound to the following verbal complex. When these sequences undergo sandhi, the /a/ appears to delete; the /ê/, already a phonologically long vowel, does not undergo compensatory lengthening. These tokens will be compared to tokens of the complementizer *ê-* that occur after a consonant-final word. If the /a/-deletion characteristic of this type of sandhi is done by a categorical phonological rule, we should find no difference between the two sets of tokens.

- other "deletion with compensatory lengthening" sandhi: involving a number of combinations of word-final /i/ or /a/ with word-initial /ê/, /o/, /ô/, and /a/. The second word in each sequence can be any word beginning with the right vowel, rather than being restricted to a single word, such as the complementizer *ê-* of the /a#ê/ category. These sandhi tokens will be compared to tokens of the corresponding word-initial long vowels following a word-final consonant (the predicted result of a categorical sandhi rule).

- /kê/: where the complementizer preverb *kâ-* or the future preverb *ka-* coalesces with an initial /i/ of a following preverb or verb stem, resulting in [keː]. These tokens will be compared to tokens of the complementizer *ê-* which follow a final /k/ or pre-aspirated /hk/ in the preceding word.[5]

[5]It would have been preferable to use underlying word-initial /kê/ sequences for the comparison. Unfortunately, there are only

3.2 Procedures

The recordings of the oral narratives were digitized at 22 kHz with 16-bit resolution using a SoundBlaster Audigy Platinum external sound module. Segmentation and acoustic analysis was conducted using the Windows version of Praat 4.1 (Boersma, 2001).

Tokens that had been identified in the first phase as candidates for analysis were segmented if they met the following conditions: they were free from background noise or overlapping talking; they were long enough and loud enough to allow a reliable formant analysis; they had clear boundaries (e.g., some /k/s that had been weakened to [ɣ] were unuseable); and they were at least one syllable away from nearest pause or clear intonational boundary, in order to minimize boundary effects.

For tokens that met the criteria, interval boundaries were placed using Praat at the beginning and the end of regular vowel periodicity in the waveform, with some ambiguous cases checked against the spectrogram. Vowel tokens were excised into individual sound files. Formant tracks were computed for each sound file, using Praat's "Formant (burg)" command, with a window length of .01 s and a time step of .002 s. All formant analyses were initially performed with the maximum number of formants found set to 5, but this was adjusted for some vowels in order to get a better match between the automatic formant track and clearly visible formants in the spectrogram — to 6 for a few vowels (mostly tokens of /o/ and /ô/) and to 4 for even fewer vowels. All formant analyses were visually inspected and a few vowels had their formant tracks edited semi-manually with a graphical program: clearly spurious formant tracks were deleted manually; for regions where a single formant split into two formant tracks (and which could not be corrected by changing the maximum number of formants in Praat), the program automatically selected in each frame the formant with the lowest bandwidth.

The following measurements were made on the resulting segmented vowels and their formant tracks:

- length
- F1 and F2 at start of vowel: average of the first three frames of the formant analysis
- F1 and F2 at end of vowel: average of the last three frames of the formant analysis
- change in F1 and F2: the difference between the previous two measures

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a small handful of words with initial /kê/ in Plains Cree, and all those used by EM and AA are lexical variants of words usually beginning with /kî/, e.g., *kîkwây* ∼ *kêkwây* 'what?'.

Another future preverb *ta-* appears to act just like the future preverb *ka-*, with, for example, *ta-isi-* coalescing to *t-êsi-*. There were, however, not enough tokens of sandhi with *ta-* in either speaker's narratives for reliable statistics, so it will not be discussed further.

After these measurements, a preliminary descriptive statistical analysis was conducted and any vowel token that was an outlier in its category on any of the measures was examined further. If there was a clear acoustic problem with the token that could compromise the formant measurements (background noise, extreme nasalization, irregular voice quality), the token was excluded from further statistical analysis; in the absence of any of these problems, the outlier remained in the analysis. Fewer than 2% of all tokens were excluded in this way.

4 Results and discussion

In the first three subsections, we will focus on cases where word-final /a/ appears to delete before the complementizer *ê*-, examining speaker EM in 4.1 and AA in 4.2, and in 4.3 showing the main findings of 4.1 and 4.2 are unlikely to result from factors such as consonantal and prosodic context. Section 4.4 will look at other cases of apparent deletion and compensatory lengthening, involving vowel combinations other than /a#ê/. Section 4.5 will look at coalescence of /kâ+i/ and /ka+i/ into [keː].

In the tokens from EM, the distinction between sandhi context /Ca#ê/ and comparison context /C#ê/ is highly confounded with the identity of the consonant. This is because the majority of sandhi-context tokens involve just two initial words, *mîna* 'also' and *mâna* 'used to', with only a minority of words having a preceding oral consonant, such as *êkota* 'there' or *mâka* 'but'. In contrast, /n/ is no more likely than other consonants to be a word-final consonant, so /n#ê/ tokens represent a minority of the comparison class. In order to tease apart the effects on formant frequency of a sandhi vs. non-sandhi context from the (quite large) effect of a preceding [n], the results for EM will be reported separately for those tokens where the preceding consonant is oral (henceforth, /Ca#ê/ and /C#ê/) and those where the preceding consonant is [n] (henceforth /na#ê/ and /n#ê/). The issue does not arise for AA, since only tokens after an oral consonant were measured.

The lopsided distribution of final consonants between the conditions also results in highly unequal sample sizes in some of the comparisons, which negates the robustness of the t-test against some obviously unequal variances. For this reason, all of the following statistical comparisons will be made using the (usually more conservative) non-parametric Wilcoxon rank sum test with continuity correction. Statistical analyses were performed using R 2.2.0.

Table 2: Measurements for EM's /a#ê/ tokens and comparison /C#ê/ and /a#C/ tokens

A. Including all /a#ê/ tokens

	F1 start		F1 change		F2 start		F2 change		n
Ca#ê	550.5	(87.4)	−57.5	(87.7)	1932.6	(222.3)	250.1	(263.2)	28
C#ê	474.8	(37.8)	0.2	(42.6)	2090.1	(142.3)	45.6	(91.5)	65
na#ê	562.4	(53.3)	−64.1	(60.7)	2091.7	(107.2)	108.9	(132.3)	100
n#ê	521.7	(43.5)	−30.4	(31.9)	2128.4	(102.0)	62.6	(85.4)	15
a#	677.9	(70.3)	–	–	1640.6	(185.4)	–	–	70

B. Including only those /a#ê/ tokens that were uninterrupted and transcribed as having undergone sandhi

	F1 start		F1 change		F2 start		F2 change		n
Ca#ê	505.5	(48.4)	−11.2	(55.8)	2064.3	(113.4)	111.3	(73.2)	16
C#ê	474.8	(37.8)	0.2	(42.6)	2090.1	(142.3)	45.6	(91.5)	65
na#ê	557.4	(48.4)	−57.1	(48.1)	2101.1	(99.1)	95.1	(107.5)	86
n#ê	521.7	(43.5)	−30.4	(31.9)	2128.4	(102.0)	62.6	(85.4)	15

4.1 /a#ê/ sandhi – EM

Part A of table 2 compares all vowel tokens in the context where sandhi could apply with tokens in a post-consonantal context, showing the mean F1 and F2 at the start of the vowel and the mean change in F1 and F2 between the start and end of the vowel.

Considering first those deletion environments where the preceding consonant is oral, we can see that F1 begins significantly higher after a word with an underlying final /a/ than it does after a consonant-final word (W=1441, p<.0001) and F2 begins significantly lower (W=533, p=.0016). Tokens of /a#ê/ are also considerably more diphthongal than the comparison tokens. While F1 is flat in [eː] after a word-final consonant, after word-final /a/ it falls almost 60 Hz — the difference in amount of F1 change between the two contexts being significant (W=499, p=.0006). F2 of the [eː] rises in both contexts, but significantly more so after a word-final /a/ than after a word-final consonant (W=1478, p <.0001).

A similar pattern is evident when we compare those contexts where the preceding consonant is nasal [n]. The starting frequency of F1 is significantly higher after word-final /na/ than after a word-final /n/ (W=389, p=.0028), as is the change in F1 frequency during the vowel (W=1029, p=.0208). F2 is again lower after a word-final /na/ than after a word-final /n/, and again rises more during the vowel, but these differences are no longer significant (W=583, ns, for F2 start; W=927, ns, for F2 change).

The differences between contexts just reported are not surprising, since the comparison included *all* tokens in the environment for /a/-deletion to apply, whether or not /a/ actually did (at least appear to) delete. While one of the conclusions of this paper will be that there is no meaningful distinction between the set of tokens with an apparently deleted /a/ and the set with a non-deleted /a/, for now we still have to rule out an alternative analysis where an optional categorical rule has fully deleted the /a/ in just a subset of the cases that were eligible for deletion.

To this end, part B of table 2 reports the same measurements for just the subset of tokens which the transcribers judged to have a deleted /a/. The subset is further restricted to tokens where the waveform and spectrogram show voicing throughout, thus excluding the small number of tokens which could possibly be interepreted [aheː] or [aʔeː].

Looking first at those cases where the preceding consonant is oral, we can see that the "deleted" /a/ still makes its presence felt. F1 is still signicantly higher after a word-final "deleted" /a/ than after an underlying word-final consonant (W=716, p=.02), though the much smaller fall of 11 Hz during the [eː] is no longer significantly from the flat F1 found after a word-final consonant (W=409, p=.19). Somewhat paradoxically, there is no statistically significant difference in the *starting* frequency of F2 (W=474, p=.59), but F2 *rises* significantly more sharply during [eː] after a "deleted" /a/ than after an underlying word-final consonant.

Turning to those cases where the preceding consonant is [n], we still find evidence for the continuing presence of the "deleted" /a/. F1 starting frequency is higher after "deleted" /a/ than after an underlying word-final /n/ (W=943, p=.0045). The F1 fall of 57 Hz after a "deleted" /a/ is greater than the fall of 30 Hz after a word-final /n/, and, unlike what we found after oral consonants, this difference is significant (W=1029, p=.02). Neither F2 starting frequency nor F2 change is significantly different between these two contexts.

Summing up so far, in every comparison we have conducted in every context, at least two of four measures (starting F1 and F2, amount of change in F1 and F2) are significantly different for /ê/s that follow an underlying /a/ compared to /ê/s that follow an underlying consonant, in the direction that would be expected if the underlying /a/ had not really been deleted. Even in the subset of tokens that is most heavily biased against finding a difference (those tokens without any interruption which were judged by the transcribers, including a native speaker, to have a deleted /a/), we still found a difference.

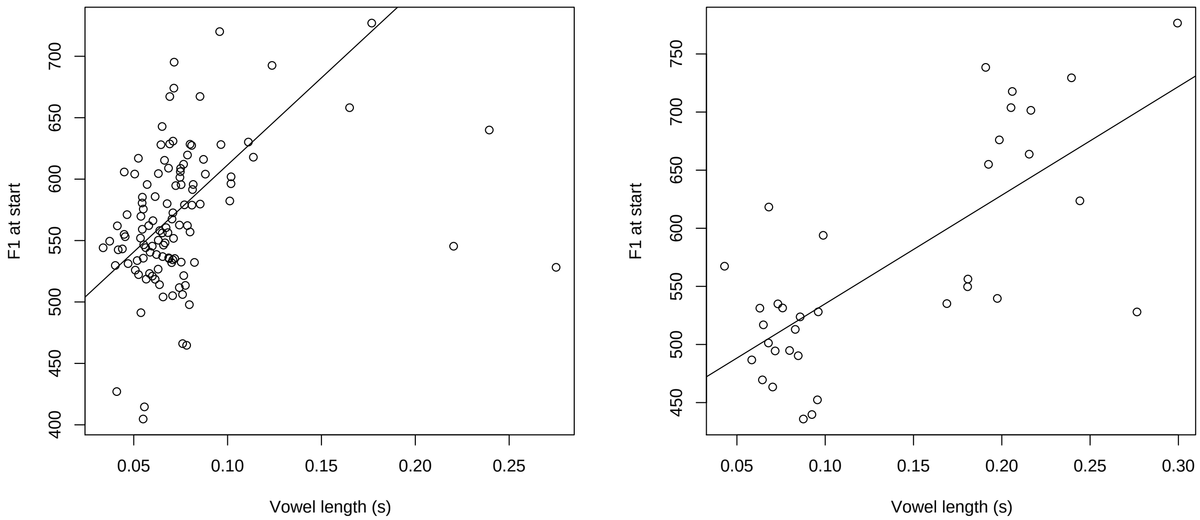

Figure 1: Plots of starting F1 by vowel length for all EM's /a#ê/ tokens after a nasal consonant (left) and after an oral consonant (right). The regression line in the left plot is fitted to only those vowels shorter than 150 ms.

The length of the vowel tokens also seems to point to the /a/ not really being deleted. Again, for the strictest test, we will consider only those /a#ê/ tokens which the transcribers judged to have a deleted /a/. The length of these tokens is still significantly longer than the length of word-initial /ê/s after a word-final consonant (73.0 ms vs. 64.2 ms, W=5390, p=.043). (One might want to compare the additional 8.8 ms in the length of /a#ê/ with the mean length of 36.4 ms for pre-consonantal word-final /a/s, but this number is probably an overestimate, since the /a/ tokens measured for this study excluded many that were too short to get reliable formant tracks from.)

Since it seems highly unlikely that we are dealing with a optional categorical rule that sometimes produces [aeː] for /a#ê/ and sometimes just [eː], what else might contribute to the range of variation that we find in /a#ê/ tokens? It turns out there is a strong relationship between the starting frequencies of the formants and the length of the token. Figure 1 shows the starting F1 plotted against vowel length for all of EM's /a#ê/ tokens, whether they were transcribed as having undergone /a/ deletion or not. For tokens after a nasal consonant (shown in the left panel of Figure 1, the correlation between length and starting F1 is significant (adjusted r^2=.082, p=.0012). The correlation is even stronger (adjusted r^2=.176, p <.0001) if we exclude the handful of outliers longer than 150 ms, most of which are interrupted sequences, [ahê] or [aʔê], and which we might plausibly conclude are not participating in the sandhi process at all. After an oral conso-

Table 3: Measurements for all AA's uninterrupted /a#ê/ tokens and comparison /C#ê/ and /a#C/ tokens.

	F1 start		F1 change		F2 start		F2 change		n
Ca#ê	507.8	(53.4)	−25.4	(56.1)	2259.6	(171.5)	126.1	(168.7)	25
C#ê	470.9	(40.3)	0.8	(38.0)	2371.5	(193.9)	52.9	(190.6)	42
a#C	682.7	(62.1)	–	–	1675.8	(219.5)	–	–	28

nant, the correlation between length and F1 is stronger still (adjusted r^2=.518, p <.0001).[6] For comparison, ordinary [eː] tokens in C#ê contexts show absolutely no relationship between their length and their starting F1 (after a word-final nasal: adjusted r^2=−.031, ns; after a word-final oral consonant: adjusted r^2=−.006, ns).

In summary, the sequences with an underying /a#ê/ do seem to begin with a more /a/-like tongue position than a true underlying /ê/ does and are longer as well. Furthermore, the longer the /a#ê/ sequence, the more /a/-like its beginning is.

4.2 /a#ê/ sandhi — AA

Table 3 shows the same four measurements for AA's potential /a#ê/ tokens and comparison /C#ê/ tokens. All of the potential /a#ê/ tokens in AA's text which met the criteria for measurement were in fact transcribed with a deleted /a/ by the editors. So the following comparison for AA corresponds to the strictest comparison for EM in the first two lines of part B of Table 2. A categorical deletion process would predict no difference between [eː] in the two contexts, but once again we do find a difference.

In AA's speech, as in EM's, F1 of [eː] begins significantly higher after a "deleted" word-final /a/ than after an underlying word-final consonant (W=751, p=.003), and F2 begins significantly lower (W=336, p=.014). While F1 is flat throughout [eː] after a word-final consonant, after a "deleted" /a/ it falls 25 Hz — the difference between contexts being significant (W=357, p=.029). Though F2 after a "deleted" /a/ does rise more than after a word-final consonant, this difference is not significant (W=628, ns).

Again as with EM, the length of AA's tokens suggests that /a/ is not really deleted. The mean length of the /a#ê/ tokens is significantly longer than that of comparison /ê/ (75.2 ms vs. 63.2 ms, W=681, p=.043). For comparison, the mean length of the pre-consonantal word-final /a/s that were measured is 49.0 ms but,

[6] At first glance, it may appear that the post-oral tokens offer evidence for a categorical rule that has applied to the cluster of tokens shorter than 150 ms and perhaps not to those tokens longer than 150 ms, an analysis which is made stronger by the absence of any correlation between length and starting F1 within the shorter cluster (adjusted r^2=−.006, ns). But this is probably due to the sparsity of data in this condition. We have just seen that EM *does* show such a correlation for her short post-nasal tokens. The next speaker, AA, will also show a correlation for her tokens (all shorter than 150 ms) in the post-oral context.

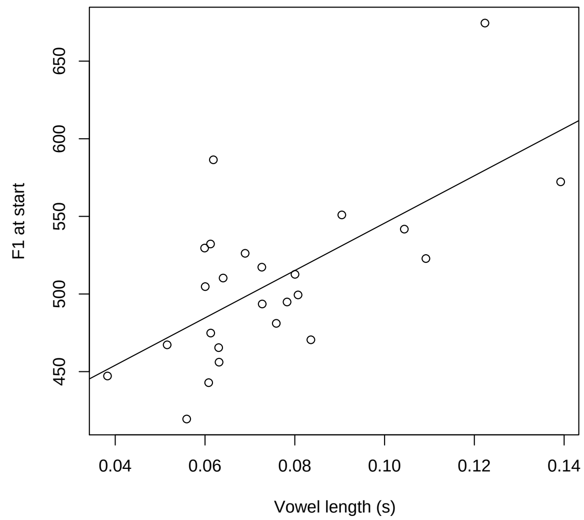

Figure 2: Plot of starting F1 by vowel length for all AA's /a#ê/ tokens (all are after oral consonants).

as with EM, this is probably an overestimate.

So, for AA as for EM, we find no support for a categorical deletion rule and, once again, the variation in /a#ê/ sequences seems to be best explained as a result of the length of the sequence. Figure 2 shows a close correlation in AA's tokens between length and F1 start (adjusted r^2=.408, p=.0004). The longer the /a#ê/ sequence, the more /a/-like its beginning.

4.3 Other possible influences on /a#ê/ sandhi

Given that the current data come from natural discourse, rather than from materials carefully controlled by an experimenter, the different classes that have been statistically compared are not perfectly balanced in terms of the surrounding consonants or their prosody. In this section, I show that the central results of sections 4.1 and 4.2 still hold after statistically controlling for consonantal context. Specifically, using hierarchical regression, we will see that generalized linear models that take into account the effects of both consonantal context and sandhi status (whether or not the token contains an underlying /a/) predict significantly more variance in F1 and length than models based on only consonantal context. Finally, some observations on the prosodic consistency of the sandhi classes are made.

For AA's /Ca#ê/ and /C#ê/ classes, the C can be any of /t, s, c, k/. Pooling these two classes together, a model that predicts starting F1 based on the preceding consonant's place of articulation (coronal vs. velar) and manner of articulation (fricative/affricate vs. plosive) manages only a non-significant adjusted r^2 of .003. Adding sandhi status as a variable results in a model with an adjusted r^2 of .101 (p=.021). The difference between the two models is significant ($F(1, 65)$=7.95, p=.006).

For EM's /na#ê/ and /n#ê/ classes, the consonant preceding the token is always [n], so the effects we found in section 4.1 of a "deleted" /a/ on starting F1 cannot be due to the consonantal context. It is harder to demonstrate this for EM's /Ca#ê/ class. The strongest test, analogous to the one we just used for AA, would require us to restrict our attention to just the 17 /Ca#ê/ tokens that the transcribers judged to have a deleted /a/, all but one of which have a preceding coronal. Indeed, numerically, the starting F1 of the 16 post-coronal /Ca#ê/ tokens is 22 Hz higher than that of the 24 post-coronal /C#ê/ tokens, as we would predict, but this difference fails to reach significance (W=249, p=.12). Broadening our focus to all /Ca#ê/ and /C#ê/ tokens, regardless of how they were transcribed, clearly but unsurprisingly shows an effect sandhi status over and above consonantal context: adding it as a variable improves the model's adjusted r^2 from .238 ($p <$.0001) to .364 ($p <$.0001), the improvement being significant ($F(1, 96)$=20.2, $p <$.0001).

To summarize so far, every subset of tokens for both speakers shows at least a numerically higher starting F1 for tokens with an "deleted" /a/, even after controlling for the preceding consonant's place of articulation. For all subsets with more than 20 underlying /a/ tokens (AA's /Ca#ê/, EM's /na#ê/, and the unrestricted set of EM's /Ca#ê/), this difference in starting F1 is statistically significant after controlling for both the place and manner of the preceding consonant. Knowing whether the vowel token starts with a underlying /a/ allows us to predict an additional 10% or more of the variance in starting F1, over and above the best prediction that can be made from the identity of the preceding consonant. We can thus be reasonably confident that the main findings of sections 4.1 and 4.2 concerning F1 reflect real differences and are not just artefacts of unbalanced consonantal environments.

In contrast to F1, the F2 effects found in sections 4.1 and 4.2 were less consistent. Starting F2 was lower in EM's /Ca#ê/, but only when considering the full class, not when considering just the subset judged by the transcribers to have deleted /a/. This pattern persists after controlling for the effects of the preceding context: adding sandhi status significantly improves the model from an adjusted r^2 of .080 to .205 ($F(1, 96)$=16.3, p=.0001) for the whole set of tokens, but there is no improvement at all for just the subset with "deleted" /a/. For AA's /Ca#ê/, the significantly lower starting F2 found earlier disappears after controlling for the effects of preceding consonant. So, unlike F1, F2 fails to show consistent differences in the strictest tests that would eliminate a categorical analysis.[7]

Turning to vowel length, here too sandhi status has an effect over and above any effect of consonantal context.[8] First looking at EM (grouping together all of /Ca#ê/, /C#ê/, /na#ê/, and /n#ê/), the best model predicting length from the surrounding consonantal context uses the following consonant's place of articulation (labial vs. coronal vs. dorsal) and nasality and the preceding consonant's nasality. This model has an adjusted r^2 of .038 (p=.013), its success being almost entirely due to the preceding consonant's nasality, which as mentioned earlier is confounded with sandhi status in EM's data. Adding sandhi status as a variable results in a model with an adjusted r^2 of .204 (p<.0001). The difference between the two models is significant ($F(1, 225)$=48.1, p <.0001). For AA's vowel length, the model with place of articulation (labial vs. coronal vs. dorsal) and manner (nasal vs. plosive) has an adjusted r^2 of .193 (p=.0009), with vowels being significantly longer before nasals and a trend for them to be shorter before labials. Even so, adding sandhi status results in an improved model with an adjusted r^2 of .250 (p=.0002), the improvement being significant ($F(1, 62)$=5.8, p=.019). In sum, for both speakers, the extra length contributed by the "deleted" /a/ in /a#ê/ tokens appears to be real and not an artefact of consonantal environment.

Ideally, it would also be desirable to control for or to factor out the effects of stress and prosodic context. Unfortunately, extremely little is certain about the prosody of Plains Cree — there is not even agreement over such basic questions as which syllable of a word stress falls on or whether Cree even has a stress system as such. (For some preliminary findings on prosody, based on data from the same two speakers as this study, see Cook (2006) and Mühlbauer (2006).) For the present study, the only practicable means of minimizing prosodic variation was to avoid tokens in syllables adjacent to a pause or a clear intonational phrase boundary.

The /a#ê/ classes, however, have a fair degree of prosodic consistency. Since the complementizer *ê-* begins a verbal complex and thus a phonological phrase, all tokens of these classes occur across a phonological phrase boundary, as do the consonant and /ê/ of the corresponding comparison classes. EM's /na#ê/ class has even more internal consistency, since, as mentioned earlier, almost all tokens involve either *mîna* or *mâna* as the first word of the pair. Both *mîna* 'also' and *mâna* 'used to' have a strong tendency to be a second-position

[7]This is not to say that there are no F2 effects. One conclusion of this paper is that the beginnings of /a#ê/ tokens form a single continuous range from [a]-like to [eː]-like, determined primarily by the physical length of the sequence. Any division of this continuum into two groups can only be arbitrary, though this is essentially what the transcribers' practice amounted to. The range of this continuum differs from simple /ê/ in both F1 and F2. The F1 differences were usually large enough to survive an arbitrary selection of just the most [eː]-like tokens. The F2 differences were not.

[8]The following consonants in these classes for both speakers were /p, t, k, m, n/, making nasality the only reasonable manner of articulation variable. EM additionally had one /s/, which was grouped with the plosives as non-nasal.

Table 4: Summary of results for other types of "deletion" sandhi

		sandhi			comparison			p-values	
speaker	type	F1	F2	n	F1	F2	n	F1	F2
EM	i#ê	509.9	2069.7	52	487.1	2094.5	83	.0007	.18
	i#ô	596.1	1406.1	9	580.2	1209.4	63	.32	.0064
	i#a	668.1	1727.4	33	685.5	1688.3	54	.27	.45
	a#o	677.9	1483.5	36	580.2	1209.4	63	<.0001	<.0001
	a#ô	631.8	1316.5	19	580.2	1209.4	63	.014	.064
	i+o	503.5	1376.4	14	580.2	1209.4	63	.0009	.006
AA	i#ê	518.4	2143.6	69	496.2	2192.5	122	.0024	.08
	i#ô	557.0	1230.1	25	542.4	1141.0	49	.23	.0069
	a#ô	590.0	1288.2	9	542.4	1141.0	49	.074	.28

particle in its clause, typically occurring after a focused word or phrase at the beginning of the sentence. This means that most of the tokens in EM's /na#ê/ class fall specifically at the boundary between the first and second phonological phrases of an intonational phrase (though the same is not necessarily true of the /n#ê/ class, so the comparison between /n#ê/ and /na#ê/ would benefit from a more controlled study). Given the reasonable degree of prosodic consistency within the /Ca#ê/ and especially the /na#ê/ class, we can be fairly confident that the correlation between vowel length and starting F1, illustrated in Figures 1 and 2, is real and not an artefact of other contextual effects.

4.4 Other "deletion" sandhi

We will now briefly consider other types of "deletion with compensatory lengthening" sandhi, similar to the /a#ê/ type just discussed but involving different combinations of vowels. We cannot rely on these results as much as the results for the /a#ê/ class, since sample sizes are usually smaller and, for EM, no attempt at all was made to control for the consonantal context. Furthermore, the tokens are less consistent prosodically: while /a#ê/ sandhi involving the complementizer *ê-* necessarily occurred across a phonological phrase boundary, the tokens reported on in this section may be either between phrases or between phonological words within a phrase. Nevertheless, the results almost unanimously parallel the results for /a#ê/, with the sandhi tokens beginning more like the supposedly deleted vowel than their comparison tokens do.

Table 4 shows the starting F1 and F2 and the sample sizes for all other types of sandhi where both the sandhi class and the comparison class had more than five measured tokens, along the probability values from the Wilcoxon tests comparing the two classes. (For AA, the /i#ê/ type includes tokens of the initial /ê/ of particles such as *êkotê* ‘there’ and *êsa* ‘(evidential)’ as well as the complementizer preverb *ê-* examined earlier, so the /C#ê/ comparison class is larger than it was in section 4.2.)

In every single comparison in table 4 (with the possible exception of the /i#ê/ type, discussed below), there is a numerical difference between the F1 and the F2 of the sandhi class and its comparison class, in the direction that would be expected if the word-final vowel had not been deleted. Many of these differences are also statistically significant — including almost all of those in the dimension (F1 or F2) where the two vowels differ the most.

The most surprising result may be for the /i#ê/ class for both speakers, where the sandhi tokens appear to begin *lower* and *more* centralized than comparison /ê/ tokens. This height and centralization difference is in fact understandable, given that short /i/ covers a wide range, from [ɪ] to [ɨ] to [ə], while /ê/ is rather high and quite front. What is surprising is that any significant difference at all was found, given that the regions of vowel space occupied by /i/ and /ê/ in Plains Cree overlap considerably. In fact, the starting positions of the /i#ê/ tokens appear to be rather tightly clustered in just the region of vowel space where the ranges of /i/ and /ê/ overlap.

The one sandhi type where neither of the two numerical differences comes even close to statistical significance is /i#a/ for EM.[9] This may be related to the fact that /i/, and especially word-final /i/, actually *is* very frequently deleted in Plains Cree, even if the following word begins with a consonant and thus does not provide a sandhi context. One possibility is that EM simply deleted the /i/ in most /i#a/ tokens, leaving a short [a]. Arguing against mere deletion is the fact that EM’s /i#a/ tokens are on average twice as long as comparison word-initial /a/s (101.9 ms vs. 50.7 ms, W=1755, p <.0001, or, comparing only those /i#a/ tokens transcribed as having undergone sandhi, 100.3 ms vs. 50.7 ms, W=1617, p<.0001). So the /i#a/ class, at least for EM, may be the one case where a vowel sequence undergoes a genuine categorical process that deletes the first vowel and makes the second vowel phonologically long.

Token lengths for the other sandhi types show some different patterns. For AA’s and EM’s /i#ô/, the sandhi tokens are actually very slightly but non-significantly shorter than the comparison tokens. For the other classes, the numerical difference is in the expected direction, with the following two being significantly

[9] Due to an error, no comparison tokens of word-initial /a/ were identified and measured for speaker AA. The F1 and F2 slopes show progressive lowering and fronting during AA’s /i#a/ tokens. The mean slopes for /i#a/ are low to moderate in size compared to the slopes in other sandhi classes, though they are understandably (given the sample size of only 12) not statistically different from zero. So there is a chance that, with a larger sample and a set of comparison tokens, AA would have shown significant differences for her /i#a/ class, but it is just as likely that it would have turned out like EM’s.

different: EM's /i#ê/ class (sandhi 74.4 ms vs. comparison 64.2 ms, W=2079, p=.0002) and AA's /i#ê/ class with non-preverbs (sandhi 66.7 ms vs. comparison 59.8 ms, W=2613.5, p=.04).

Comparing the lengths of the EM's /a#o/ and /a#ô/ classes provides an especially telling test. According to the hypothesis that sandhi is a categorical phonological rule, both of these sequences will have been neutralized to long [oː] and we should see no significant difference between the two. Yet we do. The /a#ô/ tokens are significantly longer than the /a#o/ tokens (106.8 ms vs. 82.2 ms, W=67, p=.022). This is further evidence that, at least for most sandhi classes, sandhi is not a categorical phonological rule that deletes a short word-final vowel and lengthens a short word-initial vowel.

Finally, though the numbers are small, EM's /i+o/ class gives us a rare glimpse in the present data at sandhi operating between words within the verbal complex, for example, between the /i/ of the preverb *ati-* 'progressive, inchoative' and the /o/ of *ohpikiw* '(s)he grows up' in *ati-ohpikiw*. Starting F1 and F2 are both significantly different from word-initial /ô/. Sandhi /i+o/ is also significantly shorter than word-initial /ô/ (69.9 vs. 93.6 ms, W=196.5, p=.001). Finding evidence of gradience at the smallest prosodic level at which sandhi can apply, between words within a phonological phrase, suggests that Cree sandhi is not a phenomenon that is gradient only in large domains and categorical in small domains.

4.5 kê- sandhi — EM and AA

We now compare the gradient results just obtained to a type of sandhi that does clearly seem to be categorical, the coalescence of the complementizer preverb *kâ-* or future preverb *ka-* with a following /i/ to form [keː]. Some caution must be taken in interpreting the results in this section. Tokens of *kê*-sandhi tend to occur in clusters in narratives, often with a verb of saying after each sentence of a character's quoted speech. As such, they may violate the independence assumption of statistical tests. Such violations, however, would tend to underestimate the true variance and *increase* the chance of a test finding a significant difference. Despite this, we can find few differences comparable to those of /a#ê/ sandhi.

Table 5 gives formant measurements for both EM's and AA's tokens of [keː] resulting from coalescence. For EM, those tokens resulting from /kâ+i/ and those from /ka+i/ are first reported separately, and then pooled together along with three additional ambiguous tokens where the *kê* could plausibly have resulted from either /kâ+i/ or /ka+i/. For AA, due to the small number of tokens, only the pooled results are reported — 16 of the 18 were /kâ+i/ and two were /ka+i/. The comparison tokens are a subset of the same tokens of post-consonantal complementizer /ê/ used above, those where the final consonant of the preceding word is

Table 5: Measurements for EM's and AA's /#kâ-i/ and /#ka-i/ tokens transcribed by the editors as *kê-*, compared to /k#ê/ sequences.

		F1 start	F1 change	F2 start	F2 change	length	n
EM:	#kê (kâ+i)	469.5 (43.6)	16.2 (48.1)	2043.7 (143.6)	19.2 (128.4)	67.6	27
	#kê (ka+i)	476.3 (58.3)	6.7 (42.8)	2082.2 (179.5)	−8.5 (100.7)	78.7	45
	#kê (all)	477.0 (51.8)	10.4 (45.6)	2065.7 (168.9)	−0.2 (108.2)	74.1	75
	k#ê	466.3 (34.0)	−0.4 (40.4)	2113.0 (162.7)	24.6 (90.1)	66.5	65
AA:	#kê (all)	449.7 (42.9)	−3.5 (31.0)	2447.9 (144.4)	−67.3 (119.0)	84.7	18
	k#ê	472.7 (50.7)	6.4 (46.1)	2446.6 (143.2)	20.1 (118.4)	70.2	19

either /k/ or pre-aspirated /hk/.

EM has no significant difference in any of the measures between the pooled group of [keː] tokens coalesced from /kâ-i/ or /ka-i/ and the [keː] tokens arising from an underlying /k#ê/. AA has no significant difference for F1 start, F1 change, F2 start, or length. AA's F2 does, however, fall 67 Hz during a coalesced [keː], which is significantly different from the slight rise found in the comparison tokens (W=240, p=0.036). The difference may be related to the greater proportion of following [k]s in the comparison condition. It is clearly in the wrong direction for it to be an effect of an underlying /a/.

Comparing the two subgroups of EM's [keː]s suggests that coalescence of /ka+i/ and /kâ+i/ might not give identical results. The two significant differences between the groups are that the starting F2 of /ka+i/ is higher than that of /kâ+i/ (W=430, p=.039) and paradoxically that /ka+i/ is longer than /kâ+i/ (W=368, p=.005). In addition, /ka+i/ (but not /kâ+i/) is significantly longer than the comparison /k#ê/ (W=297.5, p=.004).

We would certainly not expect /ka+i/ to be *longer* than /kâ+i/ if both were cases of gradient sandhi similar to the ones from previous sections. The different grammatical functions of *ka-* and *kâ-* offer one explanation for the length difference (which may in turn explain the more extreme starting F2). Since *kâ-* is a complementizer, it is not surprising that it would have the same moderate level of reduction that *ê-* has (and that complementizers in many languages have); the future marker *ka-*, on the other hand, might be no more reduced than any other preverb in the verbal complex. Another possible factor is that far more of our /kâ+i/ tokens than our /ka+i/ tokens involve verbs of saying and thinking, the most common being *kâ-* 'that' plus *itwêt* '(s)he says'. In Cree discourse, these verbs often occur repeatedly in stretches of discourse and in contexts that encourage severe reduction. (Indeed, the more common non-complementized form *itwêw* '(s)he says' is often reduced to little more than a strongly released [t^h].) If both /kâ+i/ and /ka+i/ result in [keː] by a categorical phonological process, these factors could explain why the [keː] from /kâ+i/ ends up shorter and with a less extreme F2.

In sum, the few differences between *kê-* created by sandhi and /k#ê/ are probably due to a tendency for many *kê-* tokens to be less reduced than the complementizer *ê-* usually is. F2 differences, when they exist, are in the wrong direction to be caused by an underlying /a/. No F1 differences at all were found for either speaker. There is no evidence for gradience of the kind that we consistently found for /a#ê/ sequences.

5 Conclusion

We have looked at naturally produced tokens from narratives told by two native speakers of Plains Cree and found that one type of sandhi (*kê*-coalescence) is apparently a categorical process, but strong evidence that (almost) all other types of sandhi in Plains Cree are gradient and the degree to which the first vowel appears to be present varies continuously with the length of the token.

Figure 3 gives an overview of the general situation in vowel space for /a#ê/ sandhi for EM and AA. It plots F1 and F2 at the start of the vowel, showing the 90% data ellipses and points for the post-consonantal /ê/ tokens, pre-consonantal word-final /a/ tokens, and /a#ê/ tokens. While many of the sandhi-environment tokens (usually the fastest ones) are firmly within the region for ordinary /ê/, the general pattern is for tokens to fall along a range of intermediate positions between /a/ and /ê/. There is no clear cut-off between tokens we might want to say have undergone /a/-deletion and those which have not.

In section 4.4, the pattern found earlier for /a#ê/ sandhi was found again for the other types of "deletion with compensatory lengthening" sandhi, though not always as clearly, due to some smaller sample sizes and less controlled environments. This would suggest that there is, in fact, neither compensatory lengthening nor deletion and that this entire sandhi pattern of is, in general, a gradient, length-sensitive process in Plains Cree. Coupled with the observation from section 2 that other possible options for resolving the V#V sequence are tolerating the hiatus and separating the vowels with an [h]-like period of voicelessness, it would seem that a gestural overlap account similar to that proposed by Zsiga (1997) for Igbo is the most appropriate one for this type of sandhi.

How much overlap there is between vowel gestures will be reflected in the length of the vowel sequence, and is likely influenced by factors such as speech rate, speech style and formality, and the strength of the prosodic boundary separating the two vowels. At one end of the continuum, the (possibly weaker)

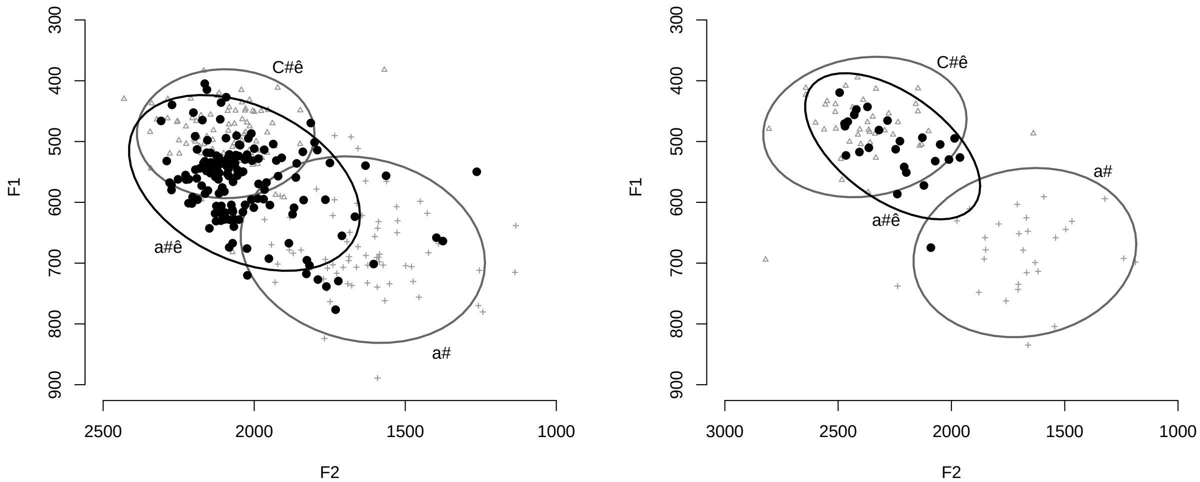

Figure 3: Overview of /a#ê/ sandhi for EM (left) and AA (right), comparing starting frequencies of /a#ê/ sequences with those for comparison /ê/ and word-final /a/. (Black circles represent /a#ê/ tokens.)

target of the word-final vowel and the target of the word-initial vowel may overlap completely, resulting in something no longer than a single vowel, whose quality is determined largely by the second gestural target. As the gestures overlap less and less (for example, with slower or more careful speech or stronger prosodic boundaries), the first gestural target will be less and less undershot and the beginning of the sequence will sound more and more like the first vowel. With minimal overlap, both gestural targets may be fully achieved, resulting in pure hiatus. If the gestures are temporally separated further still, so that they no longer even abut, the result could sound like the words have been separated by an [h].[10]

The sandhi that coalescences the /â/ or /a/ of a preverb with a following /i/ is different from these other types. The same measures that found differences in the other sandhi types found no comparable differences in between sandhi /#kâ+i/ and comparison /k#ê/. So this coalescence does appear to be a genuine categorical phonological rule. Given the considerable inter-speaker variability in sandhi found in other studies (such as

[10]The behavior of word-final /i/ is more difficult to understand. A target for /i/ clearly has an effect on the sandhi token in the /i#ô/ type and surprisingly even the /i#ê/ type, for both speakers. Yet there was no significant difference in vowel quality for EM's /i#a/ class. The /i/ is not simply deleting here — it contributes a full short-vowel's worth of length to the resulting sandhi token, yet its target appears to have very little influence on the position of the tongue body. A reviewer suggests the possibility that /i/ is a targetless vowel in Cree, given its wide range of realizations, including [ə]. This would certainly provide an elegant explanation for the behavior of the /i#a/ class, but it is harder to see how it could account for the /i#ô/ and /i#ê/ classes or for the distribution of /i/ tokens more generally (which is still skewed higher and fronter than [ə]). It remains to be seen whether these results generalize to larger sample sizes and to other speakers. If they do, then /i#a/ could be the one environment where, for some reason, the gradient pattern of other sandhi types has become phonologized into a real categorical rule of deletion and compensatory lengthening.

Ellis & Hardcastle, 2002), it would be wise to replicate this study with more speakers. But for now, based on only two speakers, we appear to have a situation where Plains Cree, like Greek (Tserdanelis, 2005), has some sandhi processes that are categorical and others that are gradient and rate-dependent.

Is there any principled difference between gradient and categorical sandhi types in Cree? One conceivable explanation would take note of the fact that *kê*-coalescence always occurs inside the verbal complex. It may be that, despite the evidence that preverbs are phonologically independent words, there is something special about the prosodic structure of the verbal complex that a categorical rule can target. However, the gradient types of sandhi are also possible between two preverbs and between preverbs and stems within the verbal complex, for example, between the /i/ of *ati-* 'progressive, inchoative' and the /o/ of *ohpikiw* '(s)he grows up' in *ati-ohpikiw*. So the difference between categorical and gradient sandhi cannot be reduced to anything so simple as inside vs. outside the verbal complex.

A more likely explanation is the possibility that *kê*-coalescence is morphosyntactically rather than phonologically governed, much like English *will not* → *won't*. A morphosyntactic analysis is strengthened by Wolfart's observation that the coalescence of complementizer *kâ* with a following /i/ does not seem to be truly optional: it is nearly exceptionless when the verb occurs in a realis clause and is not found at all in irrealis clauses (Wolfart, 1989). In addition, the structure of the Cree verbal complex and lexicon is such that almost every /i/ that occurs after *kâ-* in a potential sandhi context (including every case measured in this study) belongs, at least diachronically, to a single morpheme: *is-*∼*it-* 'thus, to'. According to this hypothesis for *kê*-sandhi, much like the cases of morphologization discussed in Bybee (2004), what would have been a gradient /a+i/ → [eː] sandhi process at some time in the history of Cree became more and more strongly associated with a particular morphosyntactic environment until it was reinterpreted as a categorical phonological realization of a set of morphosyntactic features. It is possible that (but not immediately obvious how) such an analysis might be extended to coalescence involving the future preverb *ka-*. In general, though, Plains Cree adds to the cross-linguistic literature on sandhi phenomena an example of a language where almost all sandhi appear to be gradient and where the one clear example of a categorical sandhi rule occurs in a highly restricted (and possibly morphosyntactically governed) environment.

In closing, we might note an implication of these findings for practical orthographies of Cree. As noted in section 2, the syllabic orthography as used by native speakers rarely if ever reflects the results of any sandhi process except the *kê*-coalescence type. The roman orthography used in publications by linguists, on the other hand, typically has reflected the results of sandhi, including the deletion-with-compensatory-lengthening type. The status of sandhi in Cree therefore has implications for how linguists perform phonemic transcriptions, especially in texts whose audiences will largely consist of native speakers. The instrumental evidence is that most sandhi is a low-level phonetic effect of faster speech. The practice of most native speakers using the syllabic orthography suggests that sandhi is typically not something that speakers are consciously aware of. Recording sandhi may therefore be not just an extraneous and time-consuming detail that can be safely skipped, but a feature that actually makes the transcriptions harder for native speakers to read.

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