The Role of Sonority in Blackfoot Phonotactics*

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Abstract

Contrary to appearance (e.g. *nómohtsstsiinssoka anni iihtáísttsikaahkiaakio'pi* 'she singed me with the iron'), the phonotactics of Blackfoot, an Algonquian language spoken in southern Alberta and northern Montana, are highly restrictive. In this paper, I describe Blackfoot phonotactics and demonstrate that the distribution of Blackfoot phonemes may be explained with reference to sonority. The role of sonority in phonotactics is a concept which has been well-documented phonologically (Sievers 1881 *et seq*) and has been shown to have phonetic motivation (Parker 2002). It has been held accountable for universal preferences in syllable structure (for example, the preference for CV syllables), as well as for the sequencing of segments within and across syllables, as evidenced in generalisations such as the Sonority Sequencing Principle. Cross-linguistic study has revealed the universal applicability of the sonority scale (ibid.), a formal ranking of sound classes according to their relative sonority. In Blackfoot, reference to the traditional sonority hierarchy not only motivates the phonotactic constraints but also provides a possible explanation for several morphophonological processes.

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1. Introduction

This first section provides background information on Blackfoot and sonority.

1.1 Blackfoot

Blackfoot is an Algonquian language spoken in Southern Alberta and North-western Montana. In Canada, Blackfoot is spoken by approximately 4800 native speakers on three reserves, including the Siksiká (Blackfoot) reserve, located about one hundred kilometres East-Southeast of Calgary, the Piikani (Peigan) reserve, located west of Fort MacLeod, and the Kainaa (Blood) reserve, located between Cardston and Lethbridge. In Montana, Blackfoot is spoken by as many as 1000 native speakers on the Pikuni (Blackfeet) reserve.[1]

The data used in this thesis are primarily taken from Frantz and Russell's (1989) Blackfoot dictionary. In addition, information on the morphological and phonological rules of Blackfoot is taken from Frantz' (1991) *Blackfoot Grammar* and additional data from Proulx (1989) and Thomson (1978).

The dialects of Blackfoot as spoken in these four reserves are mutually intelligible (Lowery 1979), with slight differences in such areas as vowel pronunciation and the lexicon. The material used in Frantz and Russell's dictionary was based primarily on the Blood dialect, although dialectal differences were noted by them when available. For the purposes of this thesis, I have not taken dialectal variation into account for the most part. However, the generalisations that I make are supported by a large number of examples and therefore should apply generally to all dialects.

Both the phonological and morphological systems of Blackfoot make interesting topics for study. From a historical viewpoint, Proulx (1989) notes that Blackfoot is said to be the most divergent of the Algonquian languages, having undergone radical and rapid grammatical, lexical and phonological change. It shares few innovations with related languages and clear-cut cognates are rare. This has

[1] Blackfoot: a language of Canada. (n.d.). Retrieved November 1, 2004, from Ethnologue: Website of the Summer Institute of Linguistics, available http://www.ethnologue.com/show_language.asp?code=BLC

resulted in a phonological system which at once appears to both typologically simple (as evidenced by the relatively small consonant inventory and the dominance of CV syllables) and yet fairly complex (as in the presence of “/s/-consonant” clusters such as in /niʔts:ksksínitaks:ini/ ‘one minute’, see section 3.3.4.2).

The phoneme inventory of Blackfoot is relatively simple, containing eighteen consonants (six of which are geminates), five vowels (three of which are additionally distinguished by length), and two diphthongs.[2] These are illustrated below; note, for example, the absence of liquids and voiced obstruents from the consonant inventory:

(1) Blackfoot Consonant Inventory

	Labial	Alveolar	Palatal	Velar	Glottal
Stop	p p:	t t:		k k:	ʔ
Affricate		ts		ks	
Fricative		s s:		x	
Nasal	m m:	n n:			
Glide	w		j		

(2) Blackfoot Vowel Inventory

i i:		
		o o:
ɛ		ɔ
	a a:	

Diphthongs: /aj, oj/

[2] See section 2 for a discussion of the vowel inventory.

One additional point that should be made about Blackfoot is its polysynthetic morphological system. Many of the generalisations to be proposed in this paper relating to the relative sonority of individual segments depend for a large part on the behaviour of these phonemes in word formation. Word compounding, for example, is very productive in Blackfoot. Note the morphological composition of these relatively recent lexical acquisitions:

(3) a. i:xtɛ́pi:ʔpojoʔp — 'telephone', lit. 'what one talks afar with'

i:xt-á-ipi:-iʔpoyi-oʔp

INST-DUR-afar-talk-INST

b. ɛ́ksis:to:matapist:sipatak:ajaji — 'automobile', lit. 'starts running without apparent cause'

á-iksis:to-omatap-ist:sipatak:ajaji

DUR-without.apparent.cause-start-run

The extensive use of affixing results in long, multi-morphemic words. I have relied primarily on Frantz and Russell's (1989) and Frantz' (1991) interpretations of Blackfoot morphology in the analyses of examples used in this paper.

1.2 Sonority

This section briefly introduces the concept of sonority and its role in segment distribution and syllable structure.

1.2.1 The Sonority Sequencing Principle

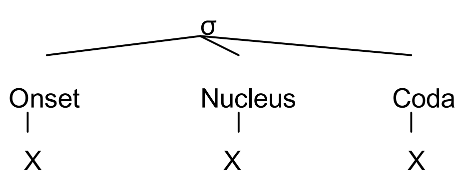
The distribution of phonemes in a language depends largely on their relative sonority. While individual languages differ in their selection of phonemes, it has long been proposed that all syllables preferentially follow a Sonority Sequencing Principle (SSP) (Sievers 1881 *et seq.*), which can be formalised as in Selkirk (1984):

(4) Sonority Sequencing Principle/Generalisation (Selkirk 1984:116)

In any syllable, there is a segment constituting a sonority peak that is preceded and/or followed by a sequence of segments with progressively decreasing sonority values.

From this principle it follows that all languages allow vowels, as the most sonorous segments, to occupy the nucleus of a syllable, while less sonorous segments (i.e., consonants) are more likely to form syllable margins. It is from these observations that a template for syllable structure has been proposed, with a nucleus optionally surrounded by less sonorous segments before the nucleus (the onset) and after the nucleus (the coda). In this paper I will assume a basic hierarchical structure for syllables, as illustrated below.

(5) Hierarchical Representation of Syllable Structure



1.2.2 The Sonority Scale

There is considerable phonological support for the ranking of segments according to their relative sonority from a diverse set of languages allowing a range of syllable types. However, the phonetic correlates for this property of speech sounds have been difficult to determine, and a number of factors have been proposed. Parker (2002) examined several acoustic and aerodynamic characteristics of speech sounds and their correlation with proposed sonority scales. He found that sonority may depend on a number of different physical factors, including intensity, intraoral air pressure, F_1 frequency, air flow and segmental duration, with intensity most strongly correlated with sonority. However, because this paper proposes a sonority scale for Blackfoot based strictly on phonotactics and morphological behaviour, the phonetics of sonority are important only in support of discussing sonority as a concrete phenomenon.

Parker's universal sonority scale, based on phonetic and phonological factors, takes the form represented below. Interestingly, it is virtually identical to the scale proposed by Sievers (1881):

(6) Universal Sonority Scale (Parker 2002:240; slightly simplified; sonority increases with the arrow)

Low Vowels

Mid Vowels (except /ə/)

High Vowels (except /ɨ/)

/ə/

/ɨ/

Glides

Liquids

Nasals

/h/

Voiced Fricatives

Voiced Stops and Affricates/ Voiceless Fricatives

Voiceless Fricatives/ Voiced Stops and Affricates

Voiceless Stops and Affricates

Owing to the phoneme inventory of Blackfoot, as introduced briefly above, a sonority scale proposed for Blackfoot will be less detailed on some points and more detailed on others. For example, Blackfoot lacks liquids, voiced fricatives, and voiced stops; therefore, I will have nothing to say on the relative sonority of these segments. However, Blackfoot additionally contains a phonemic glottal stop, which Parker (2002) found patterned as an obstruent in terms of intensity but as a sonorant on other measures. In addition, Blackfoot distinguishes length for vowels, nasals, fricatives, and stops, a situation which Parker did not take into account. A hypothetical scale for Blackfoot sonority, based on Parker (2002), might take the following form, with the position of geminates undisclosed at this time and glottal stop tentatively placed just below the vowels in terms of sonority:

(7) Proposed Sonority Scale for Blackfoot (again, sonority increases with the arrow):

Low Vowel: /a/

Mid Vowels: /ɛ, ɔ, o/

High Vowel: /i/

Glottal Stop: /ʔ/

Glides: /w, j/

Nasals: /m, n/

Voiceless Fricatives: /s, x/

Voiceless Stops: /p, t, k/

The body of this paper, beginning in section 2, will investigate the presence of a sonority scale as in (7), as manifest in Blackfoot phonotactics and morphology.

1.2.3 Sonority versus Consonantal Strength

The term *consonantal strength* has often been proposed as an alternative to sonority. This theory views phonotactics and syllable structure constraints in terms of the relative strength of the segment rather than their sonority. However, the consonantal strength scales which have been proposed (e.g., Hooper 1976, Vennemann 1988) are essentially identical to those proposed for sonority except that consonantal strength increases as sonority decreases. A consonantal strength version of the sonority scale given in (6) is illustrated below:

(8) Consonantal Strength Scale (Note: consonantal strength increases with the arrow)

↑ Voiceless Stops

Voiced Stops

Voiceless Fricatives

Voiced Fricatives

Nasals

Liquids

Glides

Vowels

I will refer only to sonority in this paper, although descriptions in terms of consonantal strength are equally valuable.

1.2.4 Syllable Preference Laws

Especially relevant to this thesis is a discussion of universal syllable preference laws based on sonority. While syllables preferentially follow the SSP (as discussed above), it has been found that some classes of segments are universally preferred in certain positions of the syllable as opposed to other classes. The relevant syllable structure laws to be discussed here and throughout the remainder of this thesis are based on Vennemann (1988) and have been rephrased in terms of sonority only for simplicity.

1.2.4.1 The Nucleus Law

The first law to be discussed is the Nucleus Law, as stated below:

(9) The Nucleus Law (Vennemann 1988:27; abbreviated)

A nucleus is the more preferred the greater the sonority of its speech sound.

The Nucleus Law implies first of all that vowels are universally preferred as syllable nuclei. This preference is supported by the generalisation that all languages have vowels, and allow them to occupy the nucleus of the syllable. This is also supported by the typological generalisation that if a language allows a class of phonemes to occupy the syllable nucleus, it must also allow more sonorous phonemes to occupy this position. For example, a language that allows syllabic obstruents but not syllabic sonorants is unattested (see Zec 1995).

Recall, however, that the vowels themselves differ in terms of sonority. This indicates that the more sonorous vowels will be more preferred as syllable nuclei as compared to the less sonorous vowels, suggesting that low sonority vowels will be more susceptible to change, such as epenthesis, deletion, and marginalisation as a glide. These types of vowel interactions in Blackfoot will discussed in section 2.

1.2.4.2 The Head Law

This law concerns preferred onsets:

(10)The Head Law (Vennemann 1988:13-14)

A syllable head is the more preferred: (a) the closer the number of speech sounds in the head is to one, (b) the lesser the sonority of its onset, and (c) the more sharply the sonority rises from the onset toward the sonority of the following syllable nucleus.

According to the sonority scales given above, this indicates that segments such as voiceless stops will be universally preferred as onsets as compared to more sonorous segments such as glides. Parts (b) and (c) of the Head Law suggests that this preference is based on contrast between vowels and consonants. If all segments can be placed along the sonority continuum, the claim may be made that stops are the least similar to vowels and will therefore make the greatest contrast between onset and nucleus.

1.2.4.3 The Coda Law

This law concerns preferences for syllable codas:

(11) The Coda Law (Vennemann 1988:21)

A syllable coda is the more preferred: (a) the smaller the number of speech sounds in the coda, (b) the greater the sonority of its offset, and (c) the more sharply the sonority rises from the offset toward the sonority of the preceding syllable nucleus.

Note that preferred syllable codas are not identical to preferred onsets. In terms of the preferred segment, these two syllable structure positions are opposites in their preferences: syllable codas prefer more sonorous segments while syllable onsets prefer less sonorous segments. As well, codas themselves are dispreferred in general, which is attested by the presence of languages with CV syllables but no CVC syllables. This contrasts with onsets, in which an onset with one segment is preferred to an empty onset. In Blackfoot, the consonants that can occur in coda position word-internally are limited in number and occur almost exclusively in this position (see section 3.3.4.1 on /x/ and section 3.3.5 on /ʔ/).[3]

1.2.4.4 The Contact Law

The final preference law to be discussed in this section refers to the point of contact between two syllables:

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[3] However, any segment (except /x/) may occur in word-final position. The appearance of segments in coda position word-finally but not word-internally is fairly common across languages, as in Irish (see Gussmann 2002).

(12) The Contact Law (Vennemann 1988:40)

A syllable contact A$B is the more preferred, the greater the sonority of the offset A and the less the sonority of the onset B.

This preference law has been found to be active both in diachronic phonology (for example, Murray and Vennemann 1983, Vennemann 1988) and in synchronic phonology (for example, Davis and Shin 1999, Rose 2000, Gouskova 2001). It functions as a combination of the Head and Coda Laws by requiring a sequence of two heterosyllabic segments to be of decreasing sonority. This further supports the preference for relatively sonorous syllable codas and relatively less sonorous syllable onsets.

This law, in contrast to the Head and Coda Laws, specifically provides an explanation for the distribution of word-internal segments. This will be important in discussions of affixing and word formation, where two segments are placed in contact over morpheme boundaries.

2. Vowels

This section treats the vowel system of Blackfoot and the relative sonority of Blackfoot vowels as evidenced by the realisation of vowel-vowel sequences.

2.1 Blackfoot Vowel Inventory

The vowel inventory of Blackfoot contains three vowels, /i, a, o/ which are distinguished by length, /iː, aː, oː/. Blackfoot additionally contains two mid lax vowels, /ɛ, ɔ/, which result diachronically from the monophthongisation of sequences of the vowels /a+i/ and /a+o/, respectively, and as is evidenced by synchronic morphophononological combinations (see below). Finally, sequences of /a+j/ and /o+i/ are realised as the diphthongs /aj/ and /oj/. The vowel inventory is summarised below:

(13) Blackfoot Vowel Inventory

i iː		
		o oː
ɛ		ɔ
	a aː	

Diphthongs: /oj/, /aj/

Blackfoot vowels show considerable allophonic variation. This includes tense/lax alternations in closed syllables (as before long consonants), variation between [u] ~ [o] (and [ʊ]), and vowel devoicing, especially at the end of the word. A more complete description of this variation is beyond the scope of this paper, although such differences may play a role in the relative sonority of vowels. For example, if vowel sonority is based on height, an allophonic variation between [u] and [o] may result in different sonority rankings depending on which form is used.

2.2 The Sonority Scale and Blackfoot Vowels

Recall the sonority scale for vowels given above, which is repeated below for convenience:

(14) Proposed Sonority Scale for Blackfoot Vowels

/a/

/o/

/ɛ, ɔ/

/i/

The remainder of this section discusses the realisation of vowel-vowel sequences in Blackfoot as demonstrated by their morphophonological behaviour.

2.3 Vowel-Vowel Sequences

In this section, I will investigate the relative sonority of Blackfoot vowels by examining vowel hiatus. The analysis relies on the assumption that a more sonorous vowel will be preferred as the nucleus of the syllable, and that the less sonorous vowel in a sequence of two vowels will therefore be more prone to deletion or marginalisation (i.e., as transformation into a glide). This analysis follows the explanation given for Spanish vowel sequences in Selkirk (1984), in which the less sonorous vowel in a sequence of two vowels becomes a glide. This is illustrated in the following data for Spanish given in Selkirk (1984:126):

(15) a. /awtor/ *autor*

b. /nwevo/ *nuevo*

Selkirk (1984) writes that the distinction between glides and vowels is often unnecessary, and that the physical realisation of a vowel depends both on its sonority and on the sonority of neighbouring segments. Thus a segment adjacent to a less sonorant segment will form the nucleus, while a less sonorant segment which is adjacent to a more sonorous segment will form either the onset or the coda. Although a proposal that all Blackfoot glides originate from vowel sonority is too abstract, I will provide evidence from phonotactics and morphology that indicates that this analysis is useful in determining the relative sonority of vowels.

In Blackfoot, the realisation of sequences of two unaccented vowels is summarised in the table below:

(16) Realisation of Blackfoot Vowel-Vowel Sequences (unaccented)

	a	i	o
a	aː	ɛ	ɔ
i	ija/a	iː	ijo/o
o	owa/a	oj	oː

As can be seen from the table, Blackfoot avoids sequences of two unaccented vowels, although the method for dealing with this varies. However, these patterns are succinctly explained with reference to sonority. An examination of the table reveals three patterns for vowel-vowel sequences:

(i) A sequence of two vowels with equal sonority (/aa, oo, ii/) is realised as a long vowel (/aː, oː, iː/).

(ii) A sequence of two vowels with decreasing sonority (/ai, ao, oi/) results in a single vocalic element, either a mid lax vowel, whose sonority is assumed to be somewhere between the sonority of the two underlying vowels (/ai/ > /ɛ/; /ao/ > /ɔ/) or a diphthong in which the less sonorous segment has been marginalised (/oi/ > /oj/).

(iii) A sequence of two vowels with increasing sonority (/ia, io, oa/) results in the deletion of the less sonorous vowel (/a, o, a/) or in the insertion of a homorganic glide (/ija, ijo, owa/).

The morphological behaviour of these sequences will be discussed below.

2.3.1 Vowel-vowel sequences with level sonority

In the underlying vowel system of Blackfoot, the only sequences of two vowels with equal sonority are those which occur between two identical vowels. In general, a sequence of two unaccented vowels is realised as a single, long vowel. This is illustrated in the following morphological constructions (data from Frantz and Russell 1989): [4]

(17)	*Output Form*	*Underlying Form*	*Gloss*[5]
	ápɔkomiːksi	ápɔkomi-iksi	'horses with white neck markings'
		horse.with.white.neck.markings-PA	
	isimíːʔpojit	isimí-íʔpojit	'whisper (imp.)'
		secretly-speak-IMP	
	otoːjiʔtakit	oto-ojiʔtakit	'go to mourn (imp.)'
		go.to.do-feel.sad-IMP	
	sóːpaʔtsis	isó-ópiː-aʔtsis	'chair'
		on.horizontal.surface-sit-INST	

I do not have any clear examples of a sequence of two short /a/ vowels at this time. I will therefore not make any conclusions concerning sequences of two short /a/ vowels.

All three vowels seem to pattern equally regularly when either one or both of the vowels is long. In this case, the vowels result in a single long vowel as above. For /a/, Frantz and Russell (1989) sometimes transcribe an extra-long /a/,[6] whose distribution is beyond the scope of this paper. Examples of combinations of short and long vowels of equal sonority are given below:

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[4] All Blackfoot examples, including morphological analysis, are from Frantz and Russell (1989) unless otherwise noted.

[5] The column headings will not be repeated, but the same format will be used for all examples unless otherwise specified.

[6] When required, I will transcribe the extra-long /a/ as /aːː/.

(18)	omí:xka:ʔtsis	omi:xka:-aʔtsis	'fishing pole'
		catch.fish-tool	
	sapíkama:ʔtsis	sapikama:-aʔtsis	'handle of a tool or weapon'
		handle-tool	
	awaxká:ʔtsis	wa:waxka:-aʔtsis	'toy'
		play-tool	
	i:xtέpi:ʔpojoʔp	i:xt-á-ipi:-iʔpoji-oʔp	'telephone'
		INST-DUR-talk-afar-INST	
	a:kí:pas:ka:n	a:ki:-ipas:ka:-n	'women's dance'
		woman-dance-NOM	
	s:pí:pijo:xsit	s:pi:-ipi-oxsi-t	'get into a crisis (imp.)'
		be.high-CAUS -REFL-IMP	
	i:tέso:joʔp	i:t-á-iso-o:ji	'table', lit. 'where one eats upon'
		there-DUR-horizontal.surface-eat	

That long vowels are shortened indicates a maximal syllable size, as predicted by syllable weight and moraic theories (for example, Hayes 1989, Zec 1995, Gordon 1999). However, the issue of syllable weight will not be discussed in detail in this paper.

2.3.2 Vowel-vowel sequences with decreasing sonority

These vowel-vowel sequences consist of a vowel with relatively high sonority followed by a vowel with relatively low sonority. From our inventory of three vowels, these sequences can take three forms: /ai/, /ao/, and /oi/. Provided that the second vowel is not accented, these vowel combinations always result in either a mid lax vowel or a diphthong, where /ai, ao, oi/ are realised as /ɛ, ɔ, oj/, respectively. When the first vowel of the sequence (i.e., the more sonorous vowel) carries a pitch accent, the lax vowel or diphthong is accented. When the second (i.e., the less sonorous vowel) carries the pitch accent, the sequence is pronounced as two separate vowels. These processes are illustrated in the following examples:

(19) Sequences of two unaccented vowels with decreasing sonority:

ákɛ̲tapiː	áka-itapiːji	‘person of the past’
	old-be.a.person	
ipaxksikɛ̲mo	ipaxk-ika-imo	‘stink like feet’
	bad-foot-have.odor.of	
pisːtaːxkɛ̲pokoː	ipsːtaːxkaː-ipokoː	‘pepper’
	tobacco-taste	
otɔ̲jnːɛsːtsiːjit	oto-inːɛsːtsiːji-t	‘go to make a treaty (imp.)’
	go.to.do-make.a.treaty-IMP	
nítsːkoxtɔ̲jtapiːji	nit-sːkoxto-itapiːji	‘I am a spiteful person’
	1SG-spitefully-be.a.person	

(20) Sequences of two vowels with decreasing sonority, where the first (more sonorous) vowel is accented:

akɛ̲́ksimonːiːpokaː	waːká-iksim-onːi-poːkaː	‘illegitimate child’
	many-secret-fathers-child	
iːxtɛ̲́tsiːmoːjɔʔp	iːxt-á-itsiːj-imo-oji-oʔp	‘false Solomon’s seal’
	INST-DUR-sweet-have.odour.of-mouth-INST	
ɛ̲́paxtsíkɛmo	á-ipaxt-ika-imo	‘heliotropes’
	DUR-enclosed-foot-have.odour.of	

akɔ́kiːnaː	aká-okiːn	‘many graves’
	many-bury.in.an.elevated.cache	
ɔ́xpomːɔ́piː	á-oxpomːaː-opiː	‘store keeper’
	DUR-buy.something-sit	
imitɔ́xkat	imitáː-oxkat	‘dogfoot’
	dog-bark.at	
naːmójkin	naːmóː-ikin	‘lilly’
	bee-tooth	

(21) Sequences of two vowels with decreasing sonority, where the second (less sonorous) vowel is accented:

sɛ́sːksiːmokowínaːtːsi	‘green’

In terms of sonority, it is clear that some compromise is made in each case to avoid vowel hiatus. The two cases which result in a mid lax vowel illustrate this “compromise” most clearly; if sonority for vowels is correlated with height, then this solution does not result in the domination of the more sonorous vowel, as occurs in vowel-vowel sequences with increasing sonority (see next section). This solution is advantageous because it decreases the number of syllables without losing the sonority input of either vowel, even though, theoretically, the mid vowel is less preferred than the low vowel as a syllable nucleus. In other words, the choice of a mid vowel in these cases, while less ideal in terms of sonority, is useful because it carries information about two vowels at once. As we will see in the last type of vowel-vowel sequence, the glide-insertion/deletion solution to vowel hiatus leads to deletion of the less sonorous vowel, and ultimately to the loss of linguistic information.

The sequence /oi/, although not pronounced as a different vowel, is similar to the other sequences discussed above because it is monosyllabic, yet allows preservation of both segments. As predicted, the less sonorous segment, /i/, is marginalised, while the more sonorous vowel, /o/, is preserved as the main vocalic element. Although I cannot conclude definitively as to the reason behind the apparent asymmetry in the choice of diphthong over single vowel, there are some differences between the case of /oi/ and the case of /ao/ and /ai/ which may play some role: (i) it is the only sequence of the three which does not contain the most sonorous vowel /a/, (ii) because it is a sequence between a mid vowel and a high vowel, the "compromise" vowel would likely approach the sonority of a high vowel (perhaps /ɪ/ or /ʊ/), which is dispreferred as a syllable nucleus, (iii) it is a sequence between a front vowel and a back vowel, which would perhaps make it necessary to compromise on this scale in the choice of a central vowel; however, a central vowel such as /ɨ/ is even less sonorous than the other high vowels (see, for example, Kenstowicz 1997, Parker 2002, de Lacy 2002), and (iv) the vowel space, once the newly formed vowels /ɛ/ and /ɔ/ are taken into account, has already become quite crowded, especially in the back, which works against the addition of yet another vowel.

Finally, it was seen in one example that having a pitch accent on the less sonorous vowel resulted in the preservation of this vowel. Further, the glide which was inserted to avoid vowel hiatus was homorganic with the previously more sonorous vowel, while in sequences of unaccented vowels, the glide is always homorganic with the less sonorous vowel. It seems possible to conclude that the pitch accent may increase sonority of the segment, or, at least, that accented syllables tolerate less preferred structures (such as vowel-vowel sequences with decreasing sonority); however, more examples are needed in order to make a claim of this type. Also, as the less sonorous vowel seems to be more prone to deletion, it would be interesting to investigate the role of pitch accent in the deletion of vowels and syllables.

2.3.3 Vowel-vowel sequences with increasing sonority

This section will examine the last three vowel-vowel sequences: those with increasing sonority. These include the vowel combinations /ia, oa, io/. Unlike the sequences described above, vowel hiatus is avoided by deletion of the less sonorous vowel or by insertion of a glide which is homorganic with the less sonorous vowel. This is illustrated in the following compound words:

(22) Deletion of the less sonorous vowel:

matsináwɛsːtaːm	matsini-áwɛsːtaːm	‘Moose Jaw’
	tongue-flag	
isːistsáːkiː	isːistsiː-aːkíː	‘wolverine in the form of a woman’
	deceive-woman	
sóːpaʔtsis	iso-opiː-aʔtsis	‘chair’
	on.a.horizontal.surface-sit-INST	
aːpátsínːapisi	waːpat-inːo-apisi	‘snowshoe hare’
	behind-long-legged	
ɛ́ksisːtáːnatːsi	á-iksisːto-aːnátːsiː	‘electric light’
	DUR-extravagant-light	
ijísːáːːtsiːwa	jisːoː-aːːt-iː-wa	‘he went in front of her’
	go.in.front-move.in.relation.to-PAST–3S	
aːpoxkinːiji	aːpi-oxkinːi	‘kingfisher’
	white-wear.a.necklace	
waːtːsoːxkitopiːt	waːtːsi-oxkitopiː-t	‘ride horseback daringly (imp.)’
	daring-ride.on.horseback-IMP	
ijóːmaːxkaːwa	iji-omaːxkaː-wa	‘he was a hard runner’
	endure-move.on.foot-3S	

(23) Vowel preservation via glide insertion:

náːpijáakiː	náːpi-áakiː	'white woman'
	old.man.creator-woman	
saːpíkaːkijaʔtsis	sap-íkaːki-aʔtsis	'stirrup'
	within-position.foot-INST	
sːikópiját:si	sːikopiː-at:si	'lay off from employment'
	rest-CAUS	
áːwowáːkiː	waːwo-aːkiː	'male homosexual'
	misaligned-woman	
aːtowáʔpistotoːsa	naːto-aʔpistotaki-osa	'baptise him (imp.)'
	holy-make.something	
awówaːːtsiːwa	waːwo-aːːt-iː-wa	'she passed by him'
	reverse-move.in.relation.to-PAST-3S	
pɛsːkijóʔtojiːwa	sːki-oʔto-iː-wa	'he poked her on the face'
	face-take-PAST-3S	
kíːxtsípimijotaʔsi	kiːxtsipimi-otaʔs	'pinto horse'
	spotted-mount	
isːpíːpijoːxsiwa	sːpiː-ipi-oxsi-wa	'he got into a critical situation'
	be.high-riotous-REFL-3S	

As discussed in the previous section, the more sonorous vowel in the sequence is never deleted and the glide is always homorganic with the less sonorous vowel, as is especially clear in the /io/ sequences.

Another matter of interest is the relationship between these two processes of glide-insertion and deletion. In regular pronunciation of these types of sequences where both vowels are preserved, the less sonorous vowel is often phonetically quite short, and may approach a pronunciation such as follows (examples taken from those above):

(24)	náːpjáakiː	'white woman'
	pɛsːkjóʔtoːsa	'poke him on the face (imp.)'

It is apparent from Blackfoot phonotactics that consonant-glide clusters are not allowed, as in the following examples (Frantz 1991:8-9):

(25)	póːsa	póːs-wa	'cat'
		cat-3S	
	ísːka	ísːk-wa	'pail'
		pail-3S	
	níːpi	níːp-ji	'leaf'
		leaf-4S	
	moʔtokáːni	moʔtokán-ji	'head'
		head-4S	

This may indicate why forms such as in (28) are not found phonemically, while forms with deletion of the less sonorous vowel are fairly common, as in the examples in (26).

Two similar synchronic rules which are of relevance to this section are given in Frantz (1991:151) as "i-loss" and "i-absorption" which state that the vowel /i/ is lost regularly before the vowels /a/ and /o/ and after the consonants /s/ and /j/. These rules are illustrated in the following examples:

(26)	ájoʔka:ja:wa	á-joʔka:-ji-a:wa	'they sleep'
		DUR-sleep-3P-3PRO	
	έxpijoʔpa	á-ixpiji-oʔpa	'we (incl.) dance'
		DUR-dance-21	
	ɔ́kskaʔsoʔpa	á-okskaʔsi-oʔpa	'we (incl.) run'
		DUR-run-21	
	nítsoji	nit-ioji	'I ate'
		1-eat	

The examples of compound words given above indicate that this "i-loss" can also occur in other environments, and, if it is not active synchronically at present, may have been active historically. Regardless, these phonological processes provide support for the prediction that in a sequence of two vowels, the less sonorous vowel is deleted.

2.4 Summary

In this section evidence has been presented that indicates that the vowels of Blackfoot occupy a clear sonority hierarchy, as repeated below:

(27) /a/ > /o> /ɛ, ɔ/ > /i/

Support for this scale was seen in repair strategies for vowel hiatus. There is also some indication that pitch accent may increase the sonority of the less sonorous vowels, although more data is needed in this area to come to any definite conclusion. An additional point of interest for future research involves the distribution of the allophone [u] of /o/, which should be closer in sonority to the vowel /i/. Lowery (1979) found that /iu/ sequences have free alternation of the pronunciations [iw] and [ju]; however, she assumed the vowel system /i, a, u/ for Blackfoot. It would be interesting to investigate this matter in greater detail.

Finally, the repair strategies for vowel hiatus were seen to take a variety of forms. Sequences of equal sonority preferentially combined the vowels into a single long vowel; this was not a problem because the only sequences with identical sonority (with the possible exception of [iu]) are sequences of identical vowels. Sequences of decreasing sonority (/ai, ao, oi/) resulted in a single segment, whether it was a compromise in sonority as a mid lax vowel or a diphthong. Sequences of increasing sonority (/ia, oa, io/) involved either preservation of both segments by glide insertion or deletion of the less sonorant segment; it was also suggested that these processes may have been related historically. It is interesting that Blackfoot seems to make a distinction between these two types of uneven sonority sequences, i.e., sequences with increasing sonority and sequences with decreasing sonority. The reason behind this distinction could involve a number of factors, such as phonotactics (as discussed above), psychological processing, and articulation.

3. Consonants

This section treats the consonant inventory of Blackfoot and the relative sonority of Blackfoot consonants, as evidenced by their distribution and morphophonological behaviour.

3.1 Blackfoot Consonant Inventory

The Blackfoot consonant inventory is repeated below:

(28) Blackfoot Consonant Inventory

	Labial	Alveolar	Palatal	Velar	Glottal
Stop	p p:	t t:		k k:	ʔ
Affricate		ts		ks	
Fricative		s s:		x	
Nasal	m m:	n n:			
Glide	w		j		

3.2 The Sonority Scale and Blackfoot Consonants

Also repeated below is the proposed sonority scale for Blackfoot consonants after Parker (2002):

(29) Proposed sonority scale for Blackfoot consonants

↑

Glottal Stop: /ʔ/

Glides: /w, j/

Nasals: /m, n/

Voiceless Fricatives: /s, x/

Voiceless Stops: /p, t, k/

As discussed earlier, the position of the glottal stop in this scale is tentative. As well, length distinctions are not included on this scale. While geminates will be discussed with reference to consonant-consonant sequences, I will not attempt to place geminates on the sonority scale.

The remainder of this section will provide an overview of the general phonotactic constraints for Blackfoot consonants and their morphophonological behaviour. This information will provide the basis for discussion of the relative sonority of the segments.

3.3 The Relative Sonority of Blackfoot Consonants

This section treats each class of consonants individually, discussing their phonotactic distribution, morphophonological behaviour, and their relative sonority.

3.3.1 Stops

Sequences of two stops do not occur in Blackfoot. Morphologically, however, we would expect these types of sequences to occur regularly over syllable boundaries due to the synthetic nature of the language and to the common occurrence of stems, roots and affixes which begin or end in a stop. Hypothetically, there are three possible solutions for altering stop-stop sequences to adhere to phonotactic constraints. These include deletion of one of the two stops, epenthesis of a vowel, and place assimilation resulting in a geminate consonant. I have found that deletion of stops occurs almost never; the following is the only example given in Frantz and Russell (1989):

(30) apaksist:oxkáksa:kin apak-ist:oxk-kaksa:kin 'adze'
wide.and.flat-thin-axe

However, I did not find enough examples to classify deletion as a regular process in the language; therefore, I will not discuss this further. Epenthesis (as "connective-/i/") and gemination occur both historically and synchronically, and will be discussed below.

3.3.1.1 Connective-/i/

The process known in Blackfoot literature as "connective-/i/" refers to the prefixing of word-medial consonant-initial noun and verb stems with either /i/ or the syllable /ox/. This process is not strictly phonologically motivated because connective-/i/ is not only used to break up consonant sequences but also surfaces before vowels; it might therefore be said to act as an indicator of morpheme boundary.

However, its phonological advantage is undeniable. Further, I have found that the vast majority of stop-initial stems occur word-medially with some form of connective-/i/, while this is not always true of the other consonant classes, as will be discussed in subsequent sections. The word-initial and word-medial forms for stops are illustrated in the following examples:

(31)	*Word-initial Form*		*Word-medial Form*	
	kaːxtsːín	'game'	ómaxks-í-kaxtsːin	'a big game'
			big-/i/-game	
	kaːnɛsːkiːnaː	'mouse'	ómaxks-i-kánɛsːkiːnaːwa	'rat/big mouse'
			big-/i/-mouse	
	káksaːkin	'axe'	omaxk-ox-káksáːkin	'big axe'
			big-/ox/-axe	
	piʔksːíː	'bird'	ómaxks-i-piʔksːíː	'turkey/big bird'
			big-/i/-bird	
	pokón	'ball'	omaxk-ox-pokon	'big ball'
			big-/ox/-ball	
	sáːpijaʔtsis	'mirror'	ómaxks-i-sáːpijaʔtsis	'big mirror'
			big-/i/-mirror	
	poːkaː	'child'	maːn-i-pokaː	'baby'
			new-/i/-child	
	kaʔksimo	'sage'	ninaː-i-kaʔksimo	'man sage'
			man-/i/-sage	

The distribution of /i/ and /ox/ does not appear to be phonologically motivated, and will therefore be assumed to be lexically-specified.

In terms of sonority, stops are the least sonorous consonants. Because of this quality, stops are predicted to be universally preferred as syllable onsets but universally dispreferred as codas, as was formalised in the Head and Coda Laws (see section 1.2.4). As discussed in the introduction, stops are the least vowel-like of segments, and therefore will provide the most contrast between consonant and vowel in a CV syllable. Connective-/i/ allows both stops in a sequence to be preserved, and places each stop in an ideal position in terms of syllable structure preferences. Although Blackfoot connective-/i/ may not be phonological in origin, current data suggests that it does play a significant role in preserving phonotactic preferences. Also, as will be discussed below in reference to nasals, the use of connective-/i/ for sonorants seems to be falling out of use. This suggests that the preservation of connective-/i/ in the language may have a phonological motivation.

3.3.1.2 Assimilation resulting in a geminate consonant

The second method for solving sequences of stops is regressive assimilation resulting in geminates. Although it occurs synchronically in particular situations, many of Blackfoot's geminate stops and nasals are thought to originate from a syncope rule, as discussed by Thomson (1978). He proposes that the origin of geminate stops and nasals in Blackfoot is due to a syncope/consonant assimilation process. This accounts for the presence of some stems which have a geminate word-medially. These are illustrated in the following examples of so-called "snake stems" from Thomson (1978:250):

(32)	*Word-initial*	*Expected word-internal*	*Actual word-internal*	
	piksí:ksi:na:	*-i-pitsi:ksi:na	-it:si:ksi:na:	'snake'
	kipita	*i-kipita	-ip:ita	'elderly'
	ki:pó	*i-ki:pó	-ip:o	'ten'
	ponoká	*i-ponoká	-in:oka	'elk'
	ponopa:ni	*i-ponopa:ni	-in:opa:ni	'quiver'

pinaːp-	*i-pinaːp	-inːaːp-	‘east, eastward’
ninaː	*i-ninaː	-inːa	‘man’

Thomson proposes that the medial stems were the result of syncope of the stop-internal vowel followed by regressive assimilation of the stop-stop or stop-nasal sequence:

(33)	*-i-pitsiːksiːna	> *-iptsiːksiːna	> -itːsiːksiːnaː	‘snake’
	*i-kipita	> *-ikpita	> -ipːita	‘elderly’
	*i-kiːpó	> *-ikpo	> -ipːo	‘ten’
	*i-ponoká	> *-ipnoka	> -inːoka	‘elk’
	*i-ponopaːni	> *-ipnopaːni	> -inːopaːni	‘quiver’
	*i-pinaːp	> *-ipnaːp-	> -inːaːp-	‘east, eastward’
	*i-ninaː	> *-nnaː	> -inːaː	‘man’

Synchronic assimilation occurs in stop-stop sequences, as in the example from Frantz (1991:150):[7]

(34)	nitáni<u>kː</u>a	nit-wanit-k-wa	‘he told me’
		1-tell-INV-3S	

Connective-/i/, however, assures that this will not occur in the formation of compound words composed of noun and verb stems. The use of connective-/i/ is advantageous because it allows for the complete preservation of both stops.

[7] This example also involves glide deletion; see next section.

An additional point of interest in terms of sonority is the choice of the vowel /i/ to act as the connective vowel. In the discussion of the relative sonority of vowels, evidence was presented which supported the characterisation of /i/ as the least sonorous vowel. As proposed in Howe and Pulleyblank (2004), the vowel /i/ is more susceptible to both epenthesis and deletion because of its relatively low sonority (for a vowel). Theoretically, a faithfulness violation is more undesirable when it is committed with a more sonorous vowel (for example, Blackfoot /a/). However, this does not explain the use of /ox/ as an "epenthetic syllable".

As for the relative sonority of Blackfoot stops, I will conclude tentatively at this time that the preference for stop preservation in onset position provides support for classifying stops as having low sonority as compared to other consonants. The rare occurrence of synchronic assimilation suggests that connective-/i/ does play a role in phonology as well as morphology. In the sections to follow, the interactions between stops and the more sonorous segments will provide additional support for the classification of stops as low sonority segments.

3.3.2 Glides

Glides are considered the most sonorous of all consonants excepting perhaps glottal stop. Some authors (e.g., Selkirk 1984) question whether they should have a status distinct from vowels. In the previous discussion of the relative sonority of vowels, I presented data which show that glides are often inserted to avoid vowel hiatus. In addition, glides sometimes take the place of a vowel, as in the formation of the diphthong /oj/ from the vowel-vowel sequence /oi/. This also occurs in sequences of three vowels, where a less sonorous vowel between two more sonorous vowels will be expressed only as a glide. This is illustrated in the following examples from Frantz (1991:151):

(35)	kitsíʔpowat<u>awa:</u>wa	kit-íʔpowata-oa:wa	'you (pl.) spoke harshly of/to him'
		2-speak.harshly-2P	

ájoʔka:wa	á-ioʔka:-wa	'he sleeps'
	DUR-sleep-3S	

As proposed by the Head Law (see section 1.2.4.2), onsets are more preferred the less sonorous the segment. This predicts that glides, as very sonorous segments, should be generally avoided in onset position, which is supported by glide deletion in Blackfoot, as discussed below. However, this does not explain the insertion patterns discussed with reference to vowel hiatus and in (39) above. Theoretically, a less sonorous segment should be preferred in these cases. On the other hand, because these are sequences of vowels underlyingly, it is logical to assume that Blackfoot speakers will wish to remain faithful to this input as much as possible. Therefore, as the most vowel-like of consonants, glides make a good choice as a repair strategy for vowel hiatus because there will be a relatively small decrease in sonority and minimal contrast between vowel and consonant. This also functions in light of the claim that glides are simply vowels in non-syllabic position (see section 2.3 above).

Glides do not occur next to consonants except as part of a diphthong or in fast speech (as discussed in section 2.3.3). Glides are always dropped after any consonant, including nasals, fricatives and stops,[8] while they are preserved after vowels. Presumably, the absence of connective-/i/ for glide-initial noun and verb stems results in a direct conflict between consonant and glide. This is illustrated in the following examples:

(36)	ponokáwa	ponoká-wa	'elk'
		elk-3S	
	natájowa	natájo-wa	'lynx'
		lynx-3S	

[8] The fricative /x/ and the glottal stop have a restricted distribution which will be discussed below.

nínáːwa	nínáː-wa	'man'
	man-3S	
isːtsimamsːkaːpoː	sːtsim-waːmsːkaːp-oː	'pineapple'
	throw-south-travel	
átoʔaxsima	átoʔaxsim-wa	'sock'
	sock-3S	
pokóna	pokón-wa	'ball'
	ball-3S	
moksísa	moksís-wa	'awl'
	awl-3S	
niːtójisi	niːtójis-ji	'tipi'
	tipi-4S	
ksisíːsa	ksisíːs-wa	'thorn'
	thorn-3S	
waːnɔjitanistoːt	waːnɔjit-waːnistoː-t	'clip a word/phrase (imp.)'
	before.completed-say-IMP	
áːpataːmsːtsinːimaː	aːpát-yaːmsːtsinːi	'Chinese person'
	behind-braid	
iːxtɛ́sokamisɔ́oʔp	iːxt-á-sok-waːmis-oː-oʔp	'step/ladder'
	INST-DUR-above-uphill-go-INST	
iːmɔ́xkapinakowa	iː-mɔxk-waːpinako-wa	'there was a red sunrise'
	PAST-red-dawn-3s	

This pattern can be explained in terms of the universal preferences for syllable structure, with reference to Vennemann's (1988) Head, Coda and Contact Laws (see section 1.2.4). With respect to these three laws, we can make two points concerning the patterns for glides described above. First, with reference to the Head Law, a glide, as the most sonorous consonant, is less preferred as a syllable onset as compared to any other consonant. Second, with reference to the Coda Law and the Contact Law, consonants are less preferred as syllable codas as their sonority decreases, especially if the onset of the following syllable is more sonorous than this consonant. Because glides are more sonorous than any other consonant, each of the underlying representations given above would result in a syllable contact violation if no changes were made. One possible change would be resyllabification, resulting in forms such as the following:

(37)	áto?axsi.mwa	áto?axsim-wa	‘sock’
		sock-3S	
	ksisíː.swa	ksisíːs-wa	‘thorn’
		thorn-3S	
	iːmɔ́x.kwapinakowa	iː-mɔxk-waːpinako-wa	‘there was a red sunrise’
		PAST-red-dawn-3s	

However, this would result in the creation of a complex onset, which is less preferred universally (see the Head Law, section 1.2.4.2) and not allowed in Blackfoot. The less sonorant segment (in this case the glide) is therefore deleted, resulting in the correct output forms:

(38)	áto?axsi.mwa	> áto?axsi.ma	‘sock’
	ksisíː.swa	> ksisíː.sa	‘thorn’
	iːmɔ́x.kwapinakowa	> iːmɔ́x.kapinakowa	‘there was a red sunrise’

However, for the purposes of this paper, I will simply suggest that glides are deleted after consonants because they are less ideal as onsets, because Blackfoot tends to disprefer codas word-internally, and because the underlying form constitutes a syllable contact violation.

Another process which supports the proposal that Blackfoot speakers disprefer glides as onsets is the loss of glides word-initially. This contrasts with the surfacing of glides when a vowel-final prefix is added, as illustrated in the following examples:

(39)	aːxkánijaːkit	waːxkanijaːki-t	'sew (imp.)'
		sew-IMP	
	áːsɛ́ʔniwa	waːsɛʔni-wa	's/he cried'
		cry-3S	
	áːxkijoːsiwa	jaːxkijoːsi-wa	's/he travelled by boat'
		travel.by.boat-3S	
	iːníːwaːxkaːwa	jiːníːwaːxkaː-wa	's/he picked berries'
		pick.berries-3S	
cf.	áwaːxkánijaːki	á-waːxkanijaːki	'tailor'
		DUR-sew	
	áwaːsɛ́ʔniwa	á-waːsɛʔni-wa	's/he is crying'
		DUR-cry-3S	
	ájaːxkijoːsiwa	á-jaːxkijoːsi-wa	's/he is travelling by boat'
		DUR-travel.by.boat-3S	
	ájiːníːwaːxkaːwa	á-jiːníːwaːxkaː-wa	's/he is picking berries'
		DUR-pick.berries-3S	

This runs contrary to the universal preference for onsets and CV syllables. Because it is expected that any onset should be preferred to the absence of an onset, this process demonstrates the extent to which Blackfoot speakers will avoid glides as onsets. The two patterns for glide insertion and deletion may be explained with reference to vowel hiatus. Word-internally, even glides that are not obviously derived from vowel hiatus must be preserved because deletion would result in vowel hiatus. Word initially and after a consonant, deletion of the glide does not result in vowel hiatus and is therefore allowed.

In conclusion, it is apparent that placing glides near the top of the sonority scale for consonants is well-founded in two respects: first, that glides are readily inserted to avoid vowel hiatus, and second, that glides are deleted whenever deletion does not cause vowel hiatus, both after less sonorous consonants and word-initially.[9] This adheres to the claim that syllable onsets are more preferred the less their sonority: from the examples given in (40), all of nasals, fricatives and stops are preferred as onsets as compared to glides.

3.3.3 Nasals

As demonstrated below, nasals are preserved before glides:

(40)	áto?axsi<u>ma</u>	áto?axsim-wa	‘sock’
		sock-3S	
	asóka?si<u>mi</u>	asóka?sim-ji	‘dress’
		dress-4S	
	atapí:<u>ma</u>	atapí:m-wa	‘doll’
		doll-3S	

9 The diphthongs may provide a counter-example to this argument, depending on whether the glide is analysed as occupying the syllable nucleus or the syllable coda.

	pokóna	pokón-wa	'ball'
		ball-3S	
	istːowána	istːowán-wa	'knife'
		knife-3S	
	atsikíni	atsikín-ji	'shoe'
		shoe-4S	

It is also apparent from Blackfoot phonotactics that there are no syllable contact violations in the form of fricative-nasal or stop-nasal sequences. In word compounding, the nasal appears to be deleted after obstruents:

(41)	aʔsitápi	waʔs-matapi	'young person'
		young-person	
	miːstsójis	miːstsis-mojis	'house of wood'
		stick-dwelling	
	poːsoxsoːaʔtsis	poːs-moxsoːwaʔtsis	'pussywillow'
		cat-tail.feather	
	iːxpoxsowaʔtsiː	oxp-moxsoːwaʔtsis	'American rough-legged hawk'
		with-tail.feather	
	kímːatáʔpijaːpiːkowan	ikimːat-aʔp-naːpiːkowan	'hobo'
		poor-about-Caucasian.person	
	níːpijaːtoʔs	níːp-naːtoʔsi	'June, summer month'
		leaf-month	
	niːtojis	niːt-mojis	'tipi/lodge'
		original-dwelling	

ni:tsitapi	ni:t-matapi	‘Native American’
	original-person	
no:xki:tsitapi	no:xki:t-matapi	‘foreigner’
	unfamiliar-person	
ókamoʔtsitapijit	okamoʔt-matapi-t	‘be honest (imp.)’
	honest-person-IMP	
ni:tsá:pi:kowan	ni:t-na:pi:kowan	‘French person’
	original-Caucasian.person	
saóm:itsa:pi:kowan	saóm:it-na:pi:kowan	‘criminal’
	shifty-Caucasian.person	
ist:sikónistsi	ist:sik-manistsi	‘sleigh/sled’
	slippery-travois	
sikomaxksi:n	sik-omaxk-mi:n	‘prune’
	black-big-berry	
omaxko:kitsis	omaxk-mo:kitsis	‘thumb/big toe’
	big-toe/finger	
omaxkatajo	omaxk-natájo	‘mountain lion’
	big-lynx	
óʔkapajin	oʔk-napajin	‘flour’
	raw-bread	
ipaxkína:t	pa:xk-nina:-t	‘be a disagreeable man (imp.)’
	bad-man-IMP	

However, the distribution of nasals cannot be explained only with reference to syllable contact violations, because nasals in onset position are also deleted in unexpected places, such as word-internally after vowels:

(42)	ómaxkínɔtoxton	omaxkina:-mo:toxton (?)	'pear'
		old.man-heel	
	s:kɔʔmitao:pik:init	s:kaʔ-imita:-mo:pik:ina:n	'be daft (imp.)'
		very-dog-nostril	
	aká:apijojis	wa:ka-na:pijojis	'Fort Macleod'
		many-house	
	ɔ́xpom:a:pi:kowan	á-oxpom:a:-na:pi:kowan	'Caucasian merchant'
		DUR-buy-Caucasian.person	
	i:nijóʔtoka:n	i:ni:-moʔtoka:n	'buffalo skull'
		buffalo-head	
	ná:pi:ni:wan	na:pi-mi:ni:wan	'sugar'
		old.man-store.of.berry.preserves	
	in:ó:xsojis	in:o-moxsojis	'spoon'
		long-tail	
	na:mo:jis	na:mo:-mojis	'bee hive'
		bee-lodge	
	i:sójtaxta:	iso-ni:taxta:	'shore of a river'
		on.a.horizontal.surface-river	
	moʔká:toʔs	moʔko-na:toʔs	'October'
		autumn-month	

As stated by Frantz (1991:79), stem-initial nasals are generally dropped when they do not occur word-initially. The examples given above confirm this statement. There is no obvious reason, given Blackfoot phonotactics, why the following forms of the above examples are not allowed:

(43)	*omaxkinaːmotoxton	‘pear’
	*sːkɔʔmitaːmoːpikːinaːn	‘be daft (imp.)’
	*waːkanaːpijojis	‘Fort Macleod’
	*oxpomːaːnaːpiːkowan.	‘Caucasian merchant’

As was suggested for the deletion of word-initial glides, this process of nasal deletion stems from a general dispreference of sonorous onsets.

However, the differences between the distribution of glides and nasals are striking. Stem-initial nasals are only allowed to surface word-initially, while they are almost always deleted word-internally. Stem-initial glides are not allowed to surface word-initially, while they surface word-internally if there is no syllable contact violation. Further, with reference to the vowel-vowel sequences discussed earlier, the deletion of a nasal before a vowel may result in glide insertion to avoid a sequence of two vowels with increasing sonority. This occurs, for example, in the word /aːkijaːːxs/ ‘mother-in-law’, as given above.

The situation becomes even more complicated when compound words are examined in which nasals that are stem-final are often preserved:

(44) Before vowels:

ikːstsimijátːsoːxsit	ikːstsim-i-atːsi-oːxsi-t	‘diet (imp.)’
	be.slim-/i/-CAUS-by.the.wall-IMP (?)	
misámaːxkojinːimaːn	isam-aːxkojinːimaːn	‘long time pipe bundle’
	long.time-pipe	

iksimiʔnik:it	iksim-iʔnik:i-t	‘commit murder (imp.)’
	secret-(death?)-IMP	
komixkí:ta:n	oxkom-ixki:ta:	‘bun’
	round-bake	
akɛ́ksimon:i:poka:	wa:ka-iksim-on:i-po:ka:	‘illegitimate child’
	many-secret-father-child	
ya:mojit	ya:m-oji-t	‘have a permanently twisted mouth (imp.)’
	twisted-mouth-IMP	
oxkoniʔpojit	oxkon-iʔpoji-t	‘become choked up (imp.)’
	sad-speak-IMP	
kanoʔtsisis:in	oxkan-oʔtsisi:-xsin	‘smoke ceremony’
	all-smoking-NOM	

(45) Before other sonorants (glides and nasals):

átoʔaxsima	átoʔaxsim-wa	‘sock’
	sock-3S	
atsikíni	atsikín-ji	‘shoe’
	shoe-4S	
oxkomija:pi:ni:wa:n	oxkom-na:pi:ni:wa:n	‘candy’
	round-sugar	
awóʔtaʔno:kitsis	awoʔta:n-mo:kitsis	‘nail of the toe or finger’
	shield-toe/finger	
kanát:so:mita:	oxkan-mat:si-imita:	‘member of the Crazy Dog Society’
	all-then-dog	

(46) Before /s/:

yaːmsːkijaːkit	yaːm-sːki-t	'twist your face to one side (imp.)'
	twist-face-IMP	
otːsikiːkinɔxsowaʔtsis	motːsikiːkin-soːwaʔtsis	'snowbird'
	shoulder.blade-tail.feather	

(47) Before stops:

misámikoʔkomijaːtoʔs	isam-koʔko-naːtoʔsi	'December'
	long.time-be.night-month	
maːnipokaː	maːn-poːkaː	'baby'
	new-child	

Given the word-internal deletion of stem-initial nasals discussed above, the preservation of nasals in these contexts is surprising. Superficially, there is no identifiable advantage for the preservation of the nasal before vowel-initial stems in the examples in (48) as compared to after vowels in (46).

As discussed above, stop-initial noun and verb stems are prefixed with connective-/i/ word-medially, a morphological process which at the same time functions like an epenthetic vowel to avoid sequences of consonants and stops. Therefore, the nasal-stop sequences given in (49) do not constitute any type of phonotactic violation; these forms are virtually identical to the vowel-initial stems given in (46). In practice, then, the preservation of nasals before stops as opposed to after stops is not an issue because nasal-stop sequences will never occur, at least in word compounding.

The question to ask is whether stop-nasal sequences actually occur. Due to nasal deletion before vowels, I proposed above that deletion of the nasal is not simply a repair strategy for a syllable contact violation, as was suggested for glides. There is some evidence that connective-/i/ was prefixed before word-internal nasal-initial noun stems as well as stop-initial stems. This is seen in a few examples where both connective-/i/ and the nasal are preserved: [10]

(48)	ómaxksína:ma:	ómaxk-í-na:ma:	'big gun'
		big-/i/-gun	
	saxksiná:maji	saxk-i-ná:ma-ji	'short bow'
		short-/i/-bow-4S	

There are also several verbs which Frantz and Russell (1989) list as dictionary entries already prefixed with connective-/i/. I have not determined which of these are actually nasal-initial and which are vowel initial, if it is possible to do so.

There is additional evidence that connective-/i/ before nasals was present at one point in time. This is seen in a few examples where the vowel /i/ is preserved before the deleted nasal:

(49)	kím:atáʔpija:pi:kowan	ikim:at-aʔp-i-na:pi:kowan	'hobo'
		poor-about-/i/-caucasian.person	
	ní:pija:toʔs	niíp-i-na:toʔs	'June, summer month'
		leaf-/i/-month	

Historical presence of connective-/i/ is also indicated by /t/-assibilation[11] in the absence of the vowel /i/, as in the following examples:

[10] Some of these examples involve /k/-assibilation, a process which occurs before some instances of the vowel /i/. This is further discussed in section 3.3.4.2.

(50)	ni:tsá:pi:kowan	ni:t-na:pi:kowan	‘French person’
		original-caucasian.person	
	saóm:itsa:pi:kowan	saóm:it-na:pi:kowan	‘criminal’
		shifty-caucasian.person	

In most examples, however, there is no remaining trace of connective-/i/:

(51)	po:soxso:waʔtsis	po:s-moxso:waʔtsis	‘pussywillow’
		cat-tail.feather	
	i:xpoxsowaʔtsi:	oxp-moxso:waʔtsis	‘American rough-legged hawk’
		associate.with-tail.feather	
	ni:tojis	ni:t-mojis	‘tipi/lodge’
		original-house	
	omaxko:kitsis	omaxk-mo:kitsis	‘thumb/big toe’
		big-toe/finger	
	omaxkatajo	omaxk-natájo.	‘mountain lion’
		big-lynx	
	óʔkapajin	oʔk-napajin.	‘flour’
		raw-bread	
	ipaxkína:t	pa:xk-nina:-t	‘be a disagreable man (imp.)’
		bad-man-IMP	

[11] /t/-assibilation is a fully regular phonological process in Blackfoot in which /t/ becomes /ts/ before /i/; see section 3.3.4.2.

aká:apijojis	wa:ka-na:pijojis	'Fort Macleod'
	many-dwelling	
óxpom:a:pi:kowan	oxpom:a:-na:pi:kowan	'Caucasian merchant'
	buy-caucasian.person	

Because the pattern of nasal deletion correlates exactly with the distribution of connective-/i/ forms, it is likely that the losses of these two segments are somehow linked. In terms of sonority, recall that nasals, due to their relatively high sonority, do not form good onsets; additionally, however, these nasals occur between two vowels, an environment in which segments are susceptible to "weakening". Of course, nasals frequently occur intervocalically in Blackfoot.

Moreover, stem-final nasals are not preserved universally. Interestingly, they are often dropped before suffixes beginning with a vowel while they are conserved before suffixes beginning with a consonant, as before glides. Three suffixes before which nasals are often dropped each begin with the vowel /i/; these include *-istsi* 'plural inanimate', *-iksi* 'plural animate', and *-i* 'non-particular'. Frantz (1991) divides nasal-final noun stems[12] into two groups, those ending with "permanent" consonants, and those ending with "non-permanent" consonants, where permanent consonants are preserved before these suffixes while non-permanent consonants are dropped. This is illustrated in the following examples:

(52) Permanent consonants:

Singular Form	*Plural/Non-particular Form*	
a:ps:í:kam	a:ps:í:kam-iksi	'whooping crane'
	whooping.crane-4P	

[12] /s/ is also dropped in these contexts; see section 3.3.4.2 for discussion.

ist:sis:pi:-sa:m	ist:sís:pi:sa:m-istsi	‘aspirin’
	aspirin-4P	
omaxkinɛm	ómaxkínɛm-iksi	‘elderly male’
	elderly.male-3P	
mi:staks:kim	mi:stáks:kim-iksi	‘boulder’
	boulder-3P	
ná:piwa otóʔpi:m	ná:piwa otóʔpi:m-istsi	‘rainbow’
	old.manrope-4P	
mojstóm	mojstóm-istsi	‘body’
	body-4P	
mó:kowan	mó:kowan-istsi	‘stomach’
	stomach-4P	
pas:ka:n	pas:ka:n-istsi	‘dance’
	dance-4P	
aʔkoʔkin	áʔkoʔkin-istsi	‘eye tooth’
	eye.tooth-4P	
iʔnáksi:n	iʔnáksi:n-istsi	‘raisin’
	raisin-4P	
mo:toxtón	mo:toxtón-istsi	‘heels’
	heel-4P	
ko:n	kó:n-iksi	‘ice’
	ice-3P	

(53) Non-permanent Consonants:

asóka?sim	asóka?si-istsi	'clothes'
	clothe-4P	
aá:pan	aá:pa-istsi	'blood'
	blood-4P	
is:ts:ká:n	is:ts:ká-ístsi	'dust'
	dust-4P	
aks:ín	aks:í-ístsi	'bed'
	bed-4P	
ik:inijoxpokon	ik:inijóxpoko-iksi	'softball'
	softball-3P	
mέips:im	mέips:i-i	'belt'
	belt-NONPART	
ist:owán	ist:owá-í	'knife'
	knife-NONPART	

Upon examination of these forms as given in Frantz and Russell (1989), I found there to be a tendency for the nasal to be preserved after long vowels, especially /a/, the most sonorous vowel, and to be dropped after /i/, the least sonorous vowel. The proportions for preservation are summarised in the table below, with morphological redundancy taken into account as much as possible:

(54)Proportions of permanent/non-permanent nasals depending on the preceding vowel

Ending	Proportion of nasals preserved	Percentage of nasals preserved
am	1/1	100%
aːm	8/8	100%
ɛm	1/1	100%
im	3/6	50%
iːm	8/8	100%
om	2/2	100%
oːm	n/a	n/a
an	4/14	29%
aːn	118/125	94%
ɛn	n/a	n/a
in	8/84	10%
iːn	3/3	100%
on	3/9	33%
oːn	1/1	100%

As can be seen from the table, the examples with the long vowels tend to have values close to 100% preservation,[13] while the examples with short vowels are more varied. Although I did not have access to an even number of examples for each ending, as can be seen by the large number of examples for /aːn/

[13] The relative regularity in the preservation of /m/ as compared to /n/ may be related to articulatory complexity -- (plain) coronals are simpler along a number of articulatory dimensions (flexibility, rapidity, sensitivity) . This is discussed in Dobrovolsky (1996), as cited by Howe and Pulleyblank (2004).

and /in/ and the small number for other endings, it is possible that some endings are simply uncommon in the language, provided that the words in the dictionary are a good representation of the Blackfoot lexicon.

As for the large number of /aːn/ and /in/ endings, a large proportion of these are the result of verb nominalization by the morpheme /-n/ or /-xsin/, respectively. According to Frantz (1991), these two nominalizers occur in complementary distribution: the /-n/ suffix attaches to verb stems ending in /aː/ while /-xsin/ attaches to all others. Interestingly, Frantz (1991) classifies the /-n/ suffix as a permanent consonant and the /n/ of /-xsin/ as non-permanent. Although taking this into consideration would narrow down the morphological diversity of my sample greatly, this allomorphy does provide support for the idea that the length and/or sonority of the vowel preceding the nasal plays a role in determining which nasals are preserved and which are not. It seems too unlikely that, given the distribution of this morpheme, the allomorph that specifically attaches to verb stems ending with the most sonorous vowel coincidentally has a permanent nasal, while the nasal is non-permanent following the least sonorous vowel.

This environment for nasal deletion is strikingly similar to the environment which I proposed triggered the deletion of nasals word-internally (i.e., /i/ followed by a nasal followed by a vowel). While I suggested above that this deletion may be partially due to intervocalic weakening, the patterns seen here of preservation after longer, more sonorous vowels indicates that the length and sonority of the vowel may also play a role.

One reason why nasals are often deleted after /i/ may be that nasals are closer in sonority to /i/, resulting in a lesser vowel-consonant contrast that if the nasals were to follow a more sonorous vowel. This supports the idea that nasals were dropped because their high sonority makes them poor onsets; they seem to be treated as especially poor onsets when they occur next to the least sonorous vowel /i/. Of course, it is important to remember that the stem-final nasals were normally preserved before connective-/i/, while nasals were dropped before other vowels in word compounding. This suggests that the sonority of the preceding vowel, in combination with the intervocalic environment, may play a large role in the deletion of the nasal. However, the absence of nasals after other vowels before /i/ (as in the plural and non-particular suffixes) suggests that this process may occur progressively as well. Clearly, more research is needed to determine with greater certainty the environments for nasal deletion.

Another factor to consider is the effect of nasal deletion on syllable structure and the relative sonority of the vowel. Recall the rules for vowel combination in vowel-vowel sequence discussed earlier. When the nasal is deleted, this means that the resulting vowel hiatus must be solved in some way. In the stem-final situation (before the plural suffixes), the second vowel will always be /i/, meaning that only three sequences are possible, /ai, oi, ii/, each of which result in a single vocalic segment, /ɛ, oj, iː/. This means that when the nasal is dropped after /aː/, the result is a loss of length as well as a decrease in sonority. The vowel /i/, on the other hand, does not decrease in sonority and actually gains in terms of length. In the case of connective-/i/, loss of the nasal will result in the sequences /ia, io, ii/. It was seen in the discussion of vowels that the vowel /i/ was often deleted in sequences of /ia/ and /io/, which may provide an explanation for the loss of connective-/i/ before nasals. There is no evidence of the vowel /iː/ in these situations; however, this may be attributed to a desire for morphological regularity: after nasals were deleted, the remaining connective-/i/ was now prefixed to a vowel-initial stem. In analogy with other vowel-initial stems in the language which do not require connective-/i/, connective-/i/ as a morpheme could therefore be in the process of being lost as a morphological requirement for nasal-initial stems. This type of analysis might also help explain the irregularity seen in nasal deletion before the plural and non-particular suffixes; for example, why nasals are not always preserved after /aː/.

Frantz (1991:81) also provides an example of a group of verb stems with non-permanent nasals, which are preserved before glides but dropped otherwise. This is illustrated below:

(55)	a.	ɔ́tsimːa	‘he swims’	ɔ́tsoʔpa	‘we (incl.) swim’
		á-otsimː-wa		á-otsimː-oʔpa	
		DUR-swim-3S		DUR-swim-21	

b.	á:ksipi:m:inájі	'she will enter'	kitá:ksipi:	'you (sg.) will enter'
	á:k-ipi:m:-jini-áji		kit-já:k-ipím:	
	FUT-enter-4S-PRO.4S		2S-FUT-enter	

In both of these examples, the segment /m:/ follows the vowel /i:/. In neither case is /m:/ followed by /i:/; in fact, /m:/ is dropped word-finally in (59b). This provides additional support for the analysis presented above, where nasals are especially prone to deletion following /i/. It would be interesting to see whether these non-permanent nasals for verb-stems do in reality consistently follow /i/, and also to examine other environments where nasals show these permanent/non-permanent patterns.

In conclusion, the loss of nasals may be attributed to their high sonority and their poor ability to form onsets, especially when following or preceding a low-sonority vowel such as /i/. Their preservation before glide-initial stems and affixes indicates that this preference must occur below the surface level, where nasals are found to form better onsets as compared to glides. All in all, this discussion supports placing nasals just below glides in the sonority scale.

3.3.4 Fricatives

In this section, I will discuss each fricative separately, owing to their different distributions.

3.3.4.1 /x/

The fricative /x/ is exceptional as a Blackfoot consonant in two ways: it only occurs in coda position and it does not have contrastive length. Aside from its distribution, where it only occurs after vowels and before obstruents, it is apparent that /x/ occurs in coda position because vowel length is neutralised before it. This sort of patterning is predicted by syllable weight theories, which suggest that extraheavy syllables like V:x.C are marked (see, e.g., Kuryłowicz 1948, Selkirk 1982, Hayes 1989, Zec 1995, Gordon 1999).

The distribution of /x/ originates historically from a general process in which many consonants from Proto-Algonquian became /x/ before an obstruent. The following examples from Proulx (1989:51) are given below:

(56)	*-hpani	-oːxpínʔi	‘lung’
	*-tpikaji	-oːxpikis	‘rib’
	*-toːntani	-otuxtúnʔí	‘heel’
	*-aʔteː-	ixtsiː	‘be located’
	*nehk-	ninʔixk-	‘name’
	*-tkaːʧi	-ooxkátsi	‘leg’
	*weθkani	-xkínʔi	‘bone’
	*kaːʃkantamwa	káxtstim	‘she bites it through or off’

Although syllable contact has been proposed as an important factor in diachronic change (Murray & Vennemann 1983, Vennemann 1988) as well as in synchronic processes (Davis & Shin 1999, Gouskova 2000, Rose 2000), it does not offer a complete explanation for this process because segments more sonorous than /x/, such as /h/ and nasals, also underwent this change in coda position. According to syllable contact, these segments should be more preferred as codas and therefore less subject to change.

However, the distribution of /x/ in present-day Blackfoot does adhere to syllable contact restrictions because the process only occurred before obstruents. Thus, sequences such as /xn/ or /xw/ are never found in Blackfoot. This supports the placement of fricatives as less sonorous than nasals and glides but more sonorous than stops.

3.3.4.2 /s/

In terms of sonority, the phoneme /s/ and its long counterpart, /s:/, act exceptionally in Blackfoot. While /s/ can occur syllable initially like any other consonant, /s/ can also occur as part of a simple affricate (/ts/ or /ks/) or as part of a more complex consonant cluster. These types of “consonant clusters” may occur in the following environments:

(i) As a result of assibilation, /s/ occurs as part of an affricate in the context /t_i/ and sometimes in the context /k_i/. Also, pre-assibilation also occurs in the context /i_t/ in some cases.[14] The presence of /s/ in these situations is illustrated in the following examples:

(57)	stsíki:ksi	‘others’
	tsikatsí:	‘grasshopper’
	a:natsístotsit	‘beautify it (imp.)’
	áakatsistojxtsi:wa	‘it will be crossed diagonally’
	ksik:oko:wa	‘tent’
	ksi:stsikó	‘day’

(ii) In a few cases, /s/ may precede a stop or affricate at the beginning of the word, to a maximum of two consonants (where /ts/ is considered a single consonant):

(58)	ski:m	‘female animal’
	skínaʔs	‘louse’
	skiní:xta:n	‘pocket’
	skiní:pi:kani	‘North Peigan band of the Blackfoot tribe’

[14] The environments in which assibilation occurs may be explained by historical vowel change; see Proulx (1989).

skinítsimaːn	‘bag’
spátsiko	‘sand’
staːxtsitsis	‘underpant’
stáʔɔ	‘ghost/spirit’
stámitapoːt	‘just go there (imp.)’
stamik	‘steer’
stáʔtoksiːt	‘split it (wood) (imp.)’
stsíki	‘another’

(iii) Word-internally and word-finally, /s/ and /sː/ may form a part of consonant sequences. These are subject to the following restrictions:

(a) Sonorants, /x/, /ʔ/, and long consonants may occur only as the first segment of a consonant cluster.

(59)

omsːtskíːxtsiːt	‘lie face down (imp.)’
ikːámsːksːpoxpiʔjisi	‘if it bounces’
náːxksikːamsːksiniːʔpa	‘I might know it’
nomíːtsiksikinsːtsːpi	‘my palm (of the hand)’
moxkínsːtsisi	‘elbow/Calgary’
miːnsːpíːpijoːxsit	‘don’t get into a crisis (imp.)’
áakoxtsːpíːsɔʔtakijaːwa	‘they will draw for that car’
ómaxksksiːstsi	‘big noses’
niʔtsːksksínitaksːini	‘one minute’
nimáːtáakoxkotːsitsíʔtsksoʔkaːxpa	‘I won't be able to sleep on it if it is not covered’
ikːstsːkijómitaː	‘greyhound bus/dog’

ɛ́ksik:sksisi	'coot'
kopot:s:ksisi	'red-breasted nuthatch'
mát:s:tsíki:ksi	'still others'
ksi:stsikóm:s:ta:n	'window'
i:sá:poʔkitsikím:s:ka:wa	'it overflowed'
an:s:t	'that little one'

(b) Short stops may occur at the beginning of a consonant cluster, within a consonant cluster, or at the end of a consonant cluster, providing /s/ or /s:/ occurs between each stop.

(60)	ips:ts:tsi:	'eagle catcher'
	kíts:ps:ksínimáʔtso:ka	'he taught you at a higher level'
	níts:ts:kijo:ka	'he whipped my face'
	ikstskijó:mita:ji	'he missed the greyhound bus'
	iksíststso:xsiwa	'he settled his affairs'

(c) Lowery (1979) claims the maximum length of these sequences is probably around five consonants (depending on whether affricates and geminates are counted as one or two consonants). However, it is unclear whether or not longer sequences would be possible if required. Lowery (1979) claims that the word-final sequences cannot be as long as the word initial sequences.

(61)	niʔts:ksksínitaks:ini	'one minute'
	sistsikstska:t	'be tired from butchering (imp.)'
	níts:ksksimoka	'she sent me with a message'

(d) A number of sequences appear to occur word-initially, following /sː/; however, these will be considered word-internal sequences because they are usually pronounced as /isː/.

(62)	sːkskaːkit	> isːkskáːkit	'measure (something) (imp.)'
	sːpsːksinimaʔtsi	> isːpsːksínimáʔtsijiːwa	'he taught her at a higher level'

According to the position of fricatives as predicted by the sonority scale, we would expect /s/ to be more sonorous than stops and less sonorous than nasals and glides. We found that this appeared to be the case with /x/. With /s/, there is some support for this position, in that the phoneme does not occur before nasals or glides (which would constitute a syllable contact violation). The presence of consonant clusters such as /sp, st, sk/ violate the sonority sequencing principle and the stop-/s/ clusters involve a decrease/increase pattern for sonority, which is strange in a sequence without any vowels. However, /s/-stop clusters similar to those in Blackfoot also occur in a number of languages (examples from Gussmann 2002:107):

(63) English: *still* [stɪl]

French: *scorbut* [skɔʁbʏt] 'scurvy'

Russian: *stol* [stol] 'table'

Irish: *sparán* [spərɑːn] 'purse'

This suggests that the sonority sequencing violation that the phoneme /s/ commits in Blackfoot may be justified by some other factor. This topic will not be discussed further in this paper; for some proposed analyses, see for example Selkirk (1982) and Gussmann (2002).

Another point to be made about /s/ relates to its acoustic characteristics, namely its high frequency and inherent "noisiness". This may result in /s/ acting more like a vowel and ranking higher than expected on the sonority scale. This is supported by the non-permanent behaviour of /s/ before the same suffixes which resulted in loss of nasals. Upon analysis of the examples of the plural forms given by Frantz and Russell (1989), I found that /s/ is always non-permanent after the vowels /i/ and /iː/, but is preserved in the environments /aʔs/, /oʔs/, /aːxs/, and /iʔs/. As discussed for /x/ and as will be discussed for /ʔ/ in the next section, these segments may only occur in coda position and therefore may be said to add "weight" to the syllable (for descriptions of syllable weight, see Hayes 1989, Zec 1995, Gordon 1999). Although syllable weight will not be discussed in this paper, it appears to interact with sonority. This is illustrated in the following examples:

(64) Deletion:

apaxkís	apaxkí-ístsi	'hides'
	hide-4P	
kóːpis	kóːpi-istsi	'soups'
	soup-4P	
miːstsís	miːstsí-ístsi	'sticks, branches'
	stick-4P	

(65) Preservation:

skínaʔs	skinaʔs-iksi	'lice'
	louse-3P	
onistaːxs	onistaːxs-iksi	'calf'
	calf-3P	
niípijaːtoʔs	niípijaːtoʔs-iksi	'Junes'
	June-3P	

mó:tojiʔs	mó:tojiʔs-iksi	'navels'
	navel-3P	

This process indicates that /s/ is behaving like a nasal, which, as we have seen, tend to be deleted intervocalically following /i/.

In conclusion, it is apparent that /s/ in Blackfoot is exceptional as a consonant. Its distribution is complicated, as it surfaces in a variety of contexts. It may also form a part of consonant clusters which do not adhere to the Sonority Sequencing principle, both at word extremities and word internally. Finally, I presented some morphological evidence which suggests that /s/ behaves like a sonorant in some situations by dropping intervocalically following /i/. This suggests that Blackfoot treats all three more sonorous consonant types, glides, nasals and fricatives (at least /s/), as a natural class which is avoided in onset position, even though the specific context for deletion may differ.

3.3.5 Glottal Stop

As discussed earlier, the position of glottal stop in sonority scales has been difficult to determine. Parker (2002) refrained from placing it in his sonority scale, but noted that it patterned as a sonorant in terms of pressure, air flow, and duration, but as an obstruent in terms of intensity. In my predicted sonority scale for Blackfoot, I tentatively placed it as the most sonorous of consonants. This section will examine some of the phonological patterns which support this prediction.

The distribution of glottal stop as a phoneme of Blackfoot is such that it may occur before any consonant but only after sonorants. The variety of environments in which glottal stop may occur are illustrated in the following examples:

(66)Before obstruents:

ájoʔka:wa ‘he’s sleeping’

áakoʔtaká:atsi:ja:wa ‘they will surround them/him’

á:xkamáʔpisams:iwa ‘he might take awhile’

áakokskaʔsiwa ‘he will run’

(67)Before sonorants:

iʔnáka:kí:kowɛksi ‘little girls’

a:piʔma:n ‘makeshift shelter’

aʔpiksík:aʔjiwa ‘she walked’

nitɛ́k:ijaʔwa:xkaji ‘I have difficulty starting home’

(68)Between two vowels:

kí:xtsípimisaʔɛ ‘common goldeneye’

ksinaʔo: ‘male coyote’

nits:ɛʔitsikotoji:ma ‘my rattlesnake’

atóʔaxsim ‘sock’

áaksisawɔʔoxto:ma ‘she will change it’

(69)After a sonorant consonant:[15]

i:xkójʔs:kiji:wa ‘he tracked him’

a:kíkowanʔsa ‘poor little girl’

[15] Similar to these cases is the “automatic” insertion of glottal stop after a sonorant and before /s/ (Frantz 1991:6). However, these cases will not be discussed in this paper.

The only consonant that glottal stop may not occur before is /x/; recall that the latter is strictly postvocalic in Blackfoot. Sequences of glottal stop followed by /x/ are solved by vowel epenthesis or deletion of the glottal stop, as in the example given by Frantz (1991:153):

(70)	kátaʔ-oxtoʔtoːwa > kátɔʔxtoʔtoːwa > kátɔʔoxtoʔtoːwa	‘did he arrive from there?’
	kátaʔ-oxtoʔtoːwa > kátɔʔxtoʔtoːwa > kátɔxtoʔtoːwa	‘did he arrive from there?’

This particular distribution suggests that glottal stop, like /x/, occurs preferentially in coda position. Additional evidence which supports this proposal is the phonological process known as glottal metathesis, in which a sequence VʔVC becomes VVʔC. This is illustrated with the following examples:

(71)	isːkaʔ-iʔtaki	> isːkɛ́ʔtakiwa[16]	‘he was overwhelmed’
	isːkaʔ-imitaː-moːpikːinaːn	> isːkɔːʔmitɔ́pikːiniwa	‘she was crazy/daft’
	áʔ-omɛʔtakiwa	> ɔ́ʔmɛʔtakiwa	‘now he believes’

When glottal stop occurs before a consonant, it is clearly in coda position; only between two vowels is it “forced” into onset position. The presence of glottal metathesis indicates that this position is not preferred for glottal stop in Blackfoot. Given the discussion of vowel-vowel sequences and the relative sonority of vowels, it seems likely that the distributions of glottal metathesis and of the intervocalic glottal stop may be related, a topic which must be left to future research.

From the examples given above, glottal stop does indeed seem to pattern as the most sonorous of the consonants. Unlike the fricative /x/, which only occurs before obstruents because of syllable

[16] A sequence of two glottal stops is realised as a single glottal stop (Frantz 1991:152).

contact restrictions, glottal stop may occur before any consonant. Providing that syllable contact preferences are active throughout the language, that these sequences are allowed indicates that glottal stop is more sonorous than even the glides. This is further supported by the following example, where the sequence glottal stop-glide is preserved over a morpheme boundary, where no changes such as glottal metathesis are necessary:

(72)	kataʔjo:xtsimi	kataʔ-jo:xtsimi	'deaf person'
		NEG-listen/hear	

An additional point which supports this analysis of glottal stop is the preservation of /s/ after glottal stop before the plural suffixes as discussed in the previous section. Recall that /s/ is generally deleted before these suffixes, but is preserved following glottal stop:

(73)	*Output Form*	*Input Form*	
	skinaʔsiksi	skínaʔs-iksi	'lice'
		louse-3P	
	niípija:toʔsiksi	niípija:toʔs-iksi	'Junes'
		June-3P	
	mó:toyiʔsiksi	mó:tojiʔs-iksi	'navels'
		navel-3P	

It was also proposed that nasals were preserved before these suffixes after the longer and more sonorous vowels and dropped after shorter, less sonorous vowels, as illustrated below:

(74)	*Output Form*	*Input Form*	
	akíʔka:nistsi	akíʔka:n-istsi	'camps'
		camp-4P	
	aks:í:stsi	aks:í:n-istsi	'beds'
		bed-4P	

In keeping with the proposal given for nasals, I propose that glottal stop adds to the saliency of the vowel, increasing its sonority by adding to the duration of the vowel. This holds with theories of syllable weight (Hayes 1989, Zec 1995, Gordon 1999) which propose that coda consonants add to the weight of a syllable while onset consonants do not. This is supported by compensatory lengthening in the deletion of glottal stop before long consonants, as in the following examples (Frantz 1991:152):

(75)	kátaʔ-ot:akiwa:tsi > kátaoʔt:akiwa:tsi > kátao:ʔt:akiwa:tsi	'is he a bartender?'
	áʔ-ist:oxkoxpijʔs:i > áiʔst:oxkoxpijʔs:i > áíist:oxkoxpijʔs:i	'when he fell down'

In conclusion, glottal stop patterns as the most sonorous of consonants because of its ability to occur before any consonant without incurring a syllable contact violation. Its high sonority makes it an ideal coda, which adds to the sonority of the vowel by increasing the duration of the syllable. There is no reason to suggest at present that glottal stop can act as a vowel (i.e., syllabically). [17] Therefore, I conclude that glottal stop was correctly placed on the sonority scale as the most sonorous consonant.

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[17] Places where glottal stop occurs after an sonorant may be a counterexample; however, this will not be discussed at present.

4. Conclusion

In conclusion, I have presented phonotactic and morphophonological evidence which supports the proposal of the sonority scale for Blackfoot phonemes, as proposed above and repeated below:

(76) Sonority Scale for Blackfoot:

Low Vowel: /a/

Mid Vowels: /ɛ, ɔ, o/

High Vowel: /i/

Glottal Stop: /ʔ/

Glides: /w, j/

Nasals: /m, n/

Voiceless Fricatives: /s, x/

Voiceless Stops: /p, t, k/

The relative sonority of the vowels was determined on the basis of the behaviour of the three vowels in vowel-vowel sequences, including processes such as vowel length, vowel substitution, and the marginalisation and/or deletion of the less sonorous vowel. Glottal stop was found to be the most sonorous consonant due to its ability to occur before any consonant, including glides, without incurring a syllable contact violation. Glides were determined to be next on the list, on the basis of their readiness for insertion (as a repair strategy for vowel hiatus) and of their readiness for deletion when no vowel hiatus was possible, such as at the beginning of the word and after less sonorous consonants. Nasals were determined to be less sonorous than glides because of their preservation in nasal-glide sequences. They were determined to be more sonorous than the obstruents on the basis of their tendency for deletion intervocalically following /i/ at morpheme boundaries and by the loss of connective-/i/. As for the fricatives, it was found that /x/, even in its restricted distribution, does not occur before sonorants, a sequence which would incur a syllable contact violation. The distribution of /s/, too, was found to be exceptional, at times acting like the other obstruents and at others was found to act like the sonorants, as in its deletion before suffixes beginning with /i/. The place of /s/ in the sonority scale given above may therefore be subject to revision. Finally, the stops were found to be the least sonorous consonants, due to their general preservation word-initially, word-medially (by retention of connective-/i/) and word-finally (before the same suffixes which result in the deletion of nasals and /s/).

Although not discussed specifically, it was found that length in vowels helps increase the sonority of the vowel, as was seen in the preservation of long, sonorous vowels in environments such as before suffixes beginning with /i/. This is logical, providing that sonority is related to perceptual salience. The sonority of geminate consonants was not discussed in this paper.

Possible directions for future research, as suggested throughout this paper, include the examination of the role of pitch accent in vowel-vowel sequences and more detailed study on the environments for gemination and nasal deletion. A more complete description of the distribution and behaviour of /s/ is also needed to determine its patterning with reference to sonority. Finally, the data used in this paper will need to be checked with native speakers to ensure the accuracy of the orthography.

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