A Comparison of Japanese and Blackfoot Vowel Devoicing

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Abstract

This paper compares and contrasts the factors that contribute to devoicing in Japanese and Blackfoot. Japanese vowel devoicing has received rigorous discussion in linguistic literature. Tsuchida (2001) provides a particularly persuasive argument for Japanese vowel devoicing using the Optimality Theory Framework (Prince and Smolensky 2004); she argues that all Japanese voiceless fricatives are specified for [SG] and devoicing occurs when this [SG] feature is shared within a syllable.

The notion that voiceless vowels carry the feature [SG] can also be extended to instances of Blackfoot vowel devoicing. Blackfoot voiceless vowels generally occur in two contexts: They occur word finally, and word-medially when they are followed by the palatal/dorsal sounds [x]/[ç], which are orthographically represented as <h>. In contrast to Japanese voiceless fricatives, it appears that not all Blackfoot voiceless fricatives distribute the [SG] feature. The Blackfoot palatal fricative [ç] and the dorsal fricative [x] both trigger devoicing, whereas the fricative [s] does not. To explain this patterning of [x] and [ç], Reis Silva (2008) argues that [x] and [ç] are not fricatives, but rather preaspiration ([SG]) specified on certain obstruents.

In this paper, I will discuss the constraints proposed in Tsuchida (2001), and extend/adapt those constraints to Blackfoot word final vowel devoicing. Additionally, In my analysis of Blackfoot word-medial vowel devoicing, I will adopt Reis Silva's (2008) analysis that [x]/[ç] are not fricatives, but preaspiration specified on obstruents. Lastly, I argue that the word-medial vowel devoicing that occurs with [x] and [ç] is phonological rather than phonetic.

1. Introduction[1]

Vowel devoicing is a characteristic that is observed in both Japanese and Blackfoot. Japanese vowel devoicing has long been a topic of interest in linguistic literature and there has been considerable discussion devoted it. One particularly convincing explanation for Japanese vowel devoicing is proposed by Tsuchida (2001), who uses the Optimality Theory framework (Prince and Smolensky 2004) to explain the seemingly random vowel devoicing observed in Japanese. Blackfoot vowel devoicing, on the other hand, has not received as much attention. Though there has been some description and discussion about the conditions that cause vowel devoicing in Blackfoot, there are few papers that provide an explanation using Optimality Theory. This paper will examine the various factors that contribute to vowel devoicing in Japanese and Blackfoot.

Tsuchida (2001) proposes a set of ordered constraints to account for vowel devoicing in Japanese; she suggests that vowels which have the feature [SG][2] appear as voiceless and the interaction of multiple constraints account for instances of seemingly random vowel devoicing in Japanese. The idea that voiceless vowels are specified for [SG] can also be extended to Blackfoot vowel devoicing. Blackfoot voiceless vowels occur in two general contexts: They occur word finally, and word-medially when they are followed by the sound that is orthographically represented as <h>. Though [SG] appears to be responsible for triggering voiceless vowels in both Japanese and Blackfoot, the conditions for spreading or sharing of [SG] are quite different in each language. For example, the [SG] feature in Japanese only devoices high vowels such as [i] and [ɯ], whereas the [SG] feature in Blackfoot devoices all vowels.

Tsuchida (2001) argues that all voiceless fricatives exhibit the [SG] feature in Japanese, and the sharing of this [SG] feature causes vowel devoicing. In contrast, it appears that not all Blackfoot fricatives share or spread the [SG] feature. The Blackfoot palatal fricative [ç] and the dorsal fricative [x] both trigger devoicing, whereas the coronal fricative [s] does not. To explain this patterning of [x] and [ç], Reis Silva (2008) theorizes that [x] and [ç] are not fricatives, but rather preaspiration that is specified on certain obstruents; she proposes that there is a three way distinction among Blackfoot obstruents: 'singleton unaspirate, geminate unaspirate and pre-aspirated'. Additionally, Reis Silva *ibid.* considers the vowel devoicing associated with preaspiration to be phonetic and suggests that the devoicing is simply a 'gestural overlap' of the spread-glottis.

Using the Optimality Theory framework, I will examine some of the constraints that may be responsible for vowel devoicing in Blackfoot and Japanese. In Section 2, I will

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I would like to thank the Blackfoot speakers who shared their knowledge about the Blackfoot language with me; this includes Brent Prairie Chicken (Issapoikoan), Wes Crazy Bull (Innootaa), Sandra Many Feathers (Ahstanskiaki) and Louis Soop. All of whom patiently nurtured my learning process of the Blackfoot language.

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[2] Tsuchida (2001) represents her features using a binary system, so when she discusses the [spread glottis] feature, she represents it as [+s.g.]. I choose not to use this binary representation, and instead, I represent [spread glottis] as a privative feature [SG].The constraints and diagrams that are cited as 'adapted from Tsuchida' are altered to reflect the privative representation of [spread glottis] ([SG]) rather than the binary representation ([+s.g.]).

discuss some of the Japanese vowel devoicing constraints proposed in Tsuchida (2001). In Section 3, I will discuss Blackfoot word final devoicing, and extend/adapt some of Tsuchida's constraints to account for Blackfoot word final devoicing. In Section 4, I will argue that Blackfoot fricatives do not cause vowel devoicing, and I will present Reis Silva's (2008) analysis that [x]/[ç] are not fricatives, but rather preaspiration specified on obstruents; furthermore, I will argue that Blackfoot word-medial vowel devoicing is not phonetic, as Reis Silva *ibid.* suggests, but phonological. Finally, section 4 will conclude this paper.

2. Japanese vowel devoicing

Tsuchida (2001) examines the factors that contribute to the pattern of devoicing that is observed in Standard Japanese and many of the other Japanese dialects. Tsuchida proposes that Japanese vowel devoicing occurs when there is a [SG] feature specified on a vowel; as she recognizes, this proposal strays from the customary view that Japanese devoicing is caused by a distribution of the [-voice] feature. In general, Tsuchida claims that Japanese vowels are more likely to devoice when they appear between two voiceless stops, when they have a voiceless fricative as an onset and when they are word initial. In this section, I will present the some of the Japanese vowel devoicing constraints that Tsuchida proposes.

Tsuchida explains that devoiced vowels are generally marked in most languages. The markedness constraint which forbids [SG] vowels is typically a high ranking constraint, which means that [SG] vowels rarely occur in the phonological output. Tsuchida argues that because Japanese has [SG] vowels, there must be other constraints that outrank the markedness constraints which prohibits vowels from baring the [SG] feature. The constraints that Tsuchida proposes for [SG] vowels are seen in 1 below:

(1) *NON-HIGHV$_{[SG]}$ >> *HIGHV$_{[SG]}$
where *NON-HIGHV$_{[SG]}$: Non-high vowels with [SG] are prohibited
*HIGHV$_{[SG]}$: High vowels with [SG] are prohibited
(Adapted from Tsuchida, 2001: 230)

Crucially, Tsuchida (2001) ranks *NON-HIGHV$_{[SG]}$ as higher than *HIGHV$_{[SG]}$. In the framework of Optimality Theory, the optimal form (output) may violate the lowest ranking constraint. Because non-high vowels are never seen to devoice in Japanese, the *NON-HIGHV$_{[SG]}$ constraint must be undominated (Tsuchida, 2001). Furthermore, because devoiced high vowels are observed in Japanese, the *HIGHV$_{[SG]}$ constraint receives a low ranking, as this *HIGHV$_{[SG]}$ feature is violated every time a [SG] vowel occurs (Tsuchida, 2001).

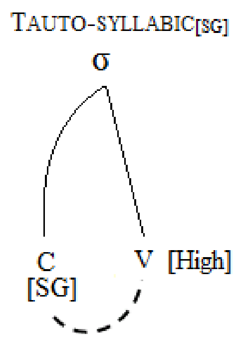
As mentioned earlier, devoiced vowels in Japanese are more likely to occur when they surrounded by voiceless consonants (Tsuchida, 2001); this tendency is captured by the constraint in 2:

(2) *VOICECONTOUR: A sequence of voiceless [voice] voiceless is prohibited.
(Adapted from Tsuchida, 2001: 230)

Tsuchida explains that the constraint seen in 2 arises from the difficult articulatory movement of stopping then starting the vocal folds. Crucially, the *VOICECONTOUR constraint, which causes vowel devoicing, is ranked higher than *HIGHV[SG] which prohibits [SG] high vowels (Tsuchida 2001). It may seem like this voiceless [voice] voiceless environment of vowel devoicing is congruent with the traditional analysis that devoiced vowels occur as a result of the assimilation of [-voice]; however, Tsuchida *ibid.* explains that the [SG] is created by a 'Gen operation' that is triggered when a vowel is surrounded by two voiceless consonants.

As discussed earlier, Tsuchida (2001) also claims that this [SG] feature is specified on all fricatives. As previously mentioned, in Japanese, vowels also tend to devoice when they follow fricatives (Tsuchida, 2001). According to Tsuchida (2001), Japanese has a constraint that favors sharing of the [SG] feature within a syllable; this constraint is diagramed in 3 below:

(3)



(Adapted from Tsuchida 2001: 234)

The constraint presented in 3 shows that the [SG] feature of the onset is shared with the high vowel. Because [SG] high vowels are more likely to occur when they have a fricative as an onset, this TAUTO-SYLLABIC[SG] constraint also ranks higher than the *HIGHV[SG] constraint (Tsuchida, 2001).

Tsuchida (2001) also recognizes that there is a tendency in Japanese to devoicing the word initial vowel, which is described in the constraint seen in 4:

(4) ANCHORL(WORD, [SG]): [SG] is associated with the left edge of a word

(Adapted from Tsuchida, 2001: 234)

The constraint in 4 accounts for the preference in Japanese to devoice word initial vowels; the only way this AnchorL constraint can be satisfied is if the word initial vowel is devoiced, otherwise, AnchorL is violated (Tsuchida, 2001).

Furthermore, Japanese is never seen to have two consecutive devoiced vowels in a row. To rule out two consecutive [SG] vowels, Tsuchida *ibid.* evokes the Obligatory Contour Principal (OCP) which prohibits adjacent syllables from having identical features, as seen in 5:

(5) OCP[SG]: It is prohibited to have two adjacent syllables that bare [SG].

(Tsuchida, 2001)

Tsuchida argues that the constraint shown in 5 is undominated, as adjacent devoiced vowels do not occur in Japanese.

The comparison tableau in 6 is adapted from a tableau presented in Tsuchida (2001). The tableau provides justification for the hierarchy of constraints proposed in Tsuchida *ibid.*:

(6)

/kiʃitsu/	OCP[SG]	*VOICE CONTOUR	ANCHORL	TAUTO-SYLLABIC[SG]	*HIGHV[SG]
a) [ki̥ʃi̲tsu] V. b) [ki̥ʃi̥tsu]	a)			b)	a)
a) [ki̥ʃi̲tsu] V. c) [ki̲ʃi̲tsu]		a)	a)		c)
a) [ki̥ʃi̲tsu] V. d) [ki̲ʃi̥tsu]			a)	d)	

(Adapted from Tsuchida, 2001: 237)

As seen above, form 6a is favored over form 6b because form 6b has two consecutive voiceless vowels, which is in violation of the undominated constraint OCP[SG]. Form 6a is also preferred over form 6c because form 6c twice violates the *VOICECONTOUR constraint, whereas form 6a violates this constraint only once. Additionally, form 6a is also preferred over form 6c in terms of the ANCHORL constraint because form 6a anchors an [SG] feature to the left edge of the word, whereas form 6c does not.

Furthermore, as seen in row three of the tableau, forms 6a and 6d equally violate the *VOICECONTOUR constraint, as they each have one voiced vowel that is surrounded by voiceless consonants. However, form 6a is ultimately preferred over form 6d because form 6a satisfies the AnchorL constraint by anchoring [SG] to the left edge of the word, whereas form 6d violates this constraint by anchoring the [SG] feature to the rightmost vowel. Additionally, form 6a violates the TAUTO-SYLLABIC[SG] constraint, whereas form 6d satisfies this constraint; however, because ANCHORL ranks higher than TAUTO-SYLLABIC[SG], form 6a is still the optimal candidate.

The constraints proposed in Tsuchida (2001) are able to explain what was previously thought to be unpredictable vowel devoicing in Japanese.[3] In the next section, I will discuss how some of the constraints proposed in Tsuchida (2001) can be adapted to account for word final vowel devoicing in Blackfoot.

3. Word final vowel devoicing in Blackfoot

I propose that the feature [SG] is also a factor in word final vowel devoicing in Blackfoot. Frantz (2009) notes that word final vowels in Blackfoot are voiceless and have a soft pronunciation. Furthermore, Reis Silva (2008) observes that when the word final vowel is long, the vowel is shortened and when the word final vowel is short it is replaced with aspiration.[4] However, unlike Japanese, Blackfoot devoicing is not restricted solely to high vowels—both high and non-high vowels can be devoiced, as the data in 7 illustrates:

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[3] See Tsuchida 2001 for her full explanation of devoicing with words that have more than two devoiceable vowels.
[4] Frantz and Russell 2009 have a slightly different view of final short and long vowels; they comment that final vowels are voiceless, so there is no contrast between word final short and long vowels in Blackfoot.

(7) a. [niksisstḁ]‘my mother’
b. [niikayaahsinsskḭ] ‘I like to sing’

As discussed in section 1, Tsuchida (2001) proposes that Japanese has two sub-constraints that account for the patterning of [SG] vowels: *NON- HIGHV$_{[SG]}$ and *HighV$_{[SG]}$. Because Blackfoot doesn’t have a height restriction on [SG] vowels, I propose that Blackfoot has a more general, low ranking constraint for [SG] vowels, as seen in (8):

(8) *V$_{[SG]}$: Vowels with [SG] are prohibited.

The constraint in 8 is an adaptation of the *NON- HIGHV$_{[SG]}$ and *HIGHV$_{[SG]}$ constraints proposed by Tsuchida (2001).

As previously discussed, Tsuchida (2001) proposes that the Japanese [SG] either originates from a fricative, or is generated when a vowel is surrounded by two voiceless consonants; additionally, there is a preference in Japanese to anchor the [SG] feature to the left edge of the word. However, in Blackfoot word final [SG] seems to be something that is associated with the end of a word. Additionally, the word final [SG] doesn’t appear to originate from any of the other features within the word, but simply seems to be added to the final vowel[5]. To account for word final [SG] in Blackfoot, I propose the following constraints in 9:

(9) ANCHORR(WORD, [SG]): [SG] is associated with the rightmost edge of a word.
DEP$_{[SG]}$: Do not add [SG] in the output that is not present in the base.

The ANCHORR(WORD, [SG]) constraint in 10 is adapted from the Tsuchida (2001) constraint ANCHORL(WORD, [SG]). Importantly, the Blackfoot constraint ANCHORR(WORD, [SG]) must be a higher ranking constraint than *V$_{[SG]}$ and DEP$_{[SG]}$ because the [SG] feature is added to the word final vowel in Blackfoot.[6] The tableau in 10 shows justification for the ordering of the constraints proposed in 8 and 9:

(10)

/niksissta/ ‘my mother’	ANCHORR(WORD, [SG])	*V$_{[SG]}$	DEP$_{[SG]}$
a) [niksisstḁ] V. b) [niksissta]	a)	b)	b)

In the tableau in 10, I argue that ANCHORR(WORD, [SG]) ranks higher than *V$_{[SG]}$ because the optimal form 10a violates *V$_{[SG]}$ and DEP$_{[SG]}$, but satisfies ANCHORR(WORD, [SG]).

Word final devoicing is something that is frequently observed in Blackfoot, and it occurs with both lexical words and demonstratives.[7] Though devoicing does occur with the majority of Blackfoot word final vowels (Frantz, 2009), sometimes demonstratives resist the ANCHORR(WORD, [SG]) constraint. I have not observed enough Blackfoot data in order to confidently offer a proposal about the environments where ANCHORR(WORD, [SG]) is

[5] Windsor & Cobbler 2013 argue that [SG] occurs at the right edge of prosodic phrase, and not a word.
[6] [SG] appears to be applied to final consonants as well, though word final consonants are infrequent in Blackfoot, due to fact word final agreement morphemes commonly end in vowels.
[7] This was my personal observation over multiple elicitation sessions with Blackfoot speakers.

violated; however, Frantz (2009) does comment that a pitch accent can sometimes occur on the final vowel of a demonstrative. Speculatively, Blackfoot may also have a constraint that maintains faithfulness to word final accented vowels. However, the environment of this accenting is not certain, and is beyond scope of this paper, so I will not be discussing it further; though it may be an interesting topic for future research.

This section highlighted the differences between Japanese devoicing and word final devoicing in Blackfoot. However, Blackfoot is also seen to have word-medial vowel devoicing, which again appears to be different than the vowel devoicing in Japanese. Tsuchida (2001) proposes that all Japanese voiceless fricatives have the [SG] feature; however, in Blackfoot, it seems that this [SG] feature may not appear on all fricatives, as [s] is not seen to trigger devoicing. The next section will discuss the difference between Blackfoot and Japanese fricatives, and present Reis Silva's (2008) analysis that [x] and [ç] are actually preaspiration. Furthermore, I will propose some constraints that account for the patterning of [x]/[ç] in Blackfoot.

4. Blackfoot word-medial devoicing and pre-aspiration

As previously discussed, Tsuchida (2001) proposes that all Japanese fricatives are specified for [SG], and vowel devoicing occurs when the [SG] feature is shared within a syllable (Tsuchida, 2001). In contrast with Japanese, the Blackfoot fricative [s] is not seen to cause vowel devoicing; this could mean that either [s] does not have the [SG] feature, or [s] does not share or spread [SG]—in either case the Blackfoot fricative [s] does not cause vowel devoicing.

Word-medial devoicing in Blackfoot is exclusively associated with the feature that is orthographically represented as <h>, and which is phonetically pronounced as [x] or [ç]. The traditional view is that [x] and [ç] are dorsal or palatal fricatives, which take the shape of the preceding vowel (Frantz, 2009). For example, when <h> is preceded by the high, front vowel [i], a palatal fricative [ç] is produced, and when <h> preceded by the high, dorsal [o], the dorsal fricative [x] is produced[8] (Frantz, 2009); according to this analysis [x] and [ç] are fricatives that assimilate to whatever vowel they follow. However, it is odd that Blackfoot would have one type of fricative that causes vowel devoicing ([x] and [ç]), and one type of fricative that does not ([s]).

To account for the odd patterning of [x] and [ç], Reis Silva (2008) argues that [x] and [ç] are not fricatives. She notes that [x] and [ç] do not have the same characteristics as other Blackfoot obstruents. For example, all other Blackfoot obstruents appear as both long and short, whereas [x]/[ç] only have singleton forms (Reis Silva, 2008). So, instead of analyzing [x] and [ç] as having a fricative feature, Reis Silva (2008) suggests that [x]/[ç] is actually preaspiration [SG] ([^{h}]) that is associated with the obstruents [p], [t], [k], [s]; she proposes that Blackfoot obstruents have a three way distinction: 'singleton unaspirated, geminate unaspirated, and preaspirated' (Reis Silva, 2008). This proposal that [x]/[ç] is preaspiration from an obstruent, explains why [^{h}] is always followed by an obstruent (Reis Silva, 2008). Furthermore, as Reis Silva (2008) notes, in general, pre-aspiration is something that is commonly influenced by the place of the preceding vowel, and usually

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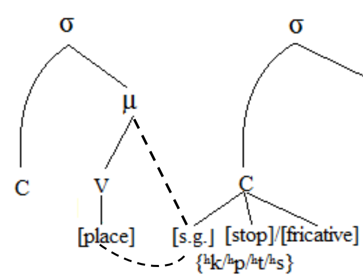
[8] Please note that the dorsal vowel [a] can also produce [x]. However, some Blackfoot speakers variably produce a uvular fricative [χ]; it may be possible that the retracted tongue root [rtr] specification of [a], gives rise to uvular [χ], whose place of articulation is further back than the high dorsal fricative [x].

involves 'supralaryngeal constriction' which causes frication (Reis Silva, 2008). These two common characteristics of pre-aspiration are indeed congruent with the patterning of [^{h}] in Blackfoot.

In my analysis of Blackfoot word-medial vowel devoicing, I will adopt the Reis Silva (2008) proposal that [^{h}] is preaspiration associated with obstruents, and that the frication associated with [^{h}] is the phonetic implementation of preaspiration. However, Reis Silva (2008) suggests that the vowel devoicing caused by [^{h}] is a 'gestural overlap' from the preaspiration [SG] feature; I, on the other hand, argue that this devoicing process is phonological.

As previously mentioned, the preaspiration [SG] feature, [^{h}], is always observed to assume the place of articulation of the preceding vowel. To explain this patterning, I propose that the preaspiration feature [^{h}] requires a mora in order to be expressed. I argue that the [SG] feature aligns with the immediately adjacent mora to the left, as expressed in the constraint proposed in 11:

(11) ALIGNR$_{\text{PREASP[SG]}}\mu$: Align the right edge of the preaspiration feature [SG] to the right edge of the immediately adjacent, retrograde mora



The diagram in 11 shows that the preaspiration [SG] in the onset of the second syllable, aligns with the mora in the first syllable; furthermore, the [SG] feature assumes the place features of the vowel. This ALIGNR$_{\text{PREASP[SG]}}\mu$ constraint ranks higher than *V$_{\text{[SG]}}$, which is demonstrated in the tableau in 12:

(12)

/yáa.ko.^{h}too/ 'arrange'	ALIGNR$_{\text{PREASP[SG]}}\mu$	*V$_{\text{[SG]}}$
a) [yáa.ko̥.^{h}too] V. b) [yáa.ko.^{h}too]	a)	b)

With the tableau in 12, I argue that ALIGNR$_{\text{PREASP[SG]}}\mu$ ranks higher than *V$_{\text{[SG]}}$. As seen above, candidate 12b is ruled out because it violates the high ranking ALIGNR$_{\text{PREASP[SG]}}\mu$. Though form 12a violates the lower ranking *V$_{\text{[SG]}}$ constraint, it is ultimately the optimal form because it satisfies the higher ranking ALIGNR$_{\text{PREASP[SG]}}\mu$.

According to Reis Silva (2008), preaspirated obstruents have a similar distribution to geminates. Like geminates, preaspirated obstruents commonly occur word-medially, as seen with [no̥^{h}pikísi] 'she might have gone to town' (Frantz, 1995), and with [naḁ^{h}sḁ][9] 'my

[9] As a side note, the form [naḁ^{h}sḁ] shows two consecutively devoiced vowels in a row, which means that the Tsuchida's (2001) OCP$_{\text{[SG]}}$ constraints is not a factor vowel devoicing in Blackfoot.

grandmother' (adapted from Reis Silva 2008: 2) [10]. However, I have recently observed that there are some Blackfoot nouns which appear to have plain obstruent onsets, but when a prefix is added, the nouns' initial consonants surface with preaspiration, as illustrated by the data in 13:

(13) a. [poosi] 'a cat'
[ot] + [poosa] → [otǫʰpoosiimḁ] 'his/her cat'
(Frantz, 2009)
b.[11] [kiáájoi] 'a bear'
[aap] + [kiáájoi] → [aapǫʰ kiáájoi̥] 'a white bear'
[nit] + [kiáájowa]→ [nitǫʰkiáájomḁ] 'my bear'

As seen in 13, when /poosi/ 'a cat' receives the /ot/ (3SG) prefix, the [p] becomes preaspirated [ʰp]. Similarly, when /kiáájoi/ 'a bear' takes the /aap/ or /nit/ prefix, the [k] also appears to be preaspirated [ʰk]. I argue that [poosi] has the underlying representation /ʰpoosi/, and [kiáájoi] has the underlying representation / ʰkiáájoi/. The data in 13 show that preaspirated consonants can occur word initially, however, without a mora, this pre-aspiration cannot be expressed. If the preaspiration [SG] feature did not require a mora, then it would perfectly fine to express this preaspiration word initially, however, as seen in 13 that is not the case in Blackfoot.

The examples in 13 show that when a morpheme that ends in a consonant (/ot/ /aap/ or /nit/) is prefixed to a word that begins with a preaspirated obstruent, a mora must be epenthesized. To explain this mora epenthesis, I propose the following constraints in 14:

(14) *PREASP$_{[SG]}$Cμ: The preaspiration feature [SG] cannot align with a moraic consonant.
DEPμ$_{(wm)}$: Do not insert moras (word-medially)[12] in the output that are not present in the base.

The high ranking *PREASP$_{[SG]}$Cμ constraint ensures that preaspiration cannot be expressed on a moraic consonants (or geminate); this constraint is important because Blackfoot is seen go through a process of gemination when two consonants meet at a morpheme boundary. Frantz (2009) describes this gemination process in 15 below:[13]

[10] Reis Silva (2008) also includes 'my grandmother' <naahs> in her data; however, her transcription differs slightly as she transcribes the word as [naḁʰs] without the final devoiced [a]; however, the Blackfoot speakers with which I consulted concluded that they felt the silently articulated [a] should appear word finally, which is why I included the final devoiced [a] in my transcription.
[11] I observed this data during elicitation sessions with Kainai Blackfoot speakers.
[12] The 'word-medial' specification may seem odd; however, later I propose a constraint that restricts epenthesis word initially, so, because a mora is epenthesized word-medially with the word [aapǫʰkiáájoi̥], it was necessary to specify that this constraint applies specifically to word-medial epenthesis.
[13] There is some controversy in the literature about whether or not plain coda consonants have a mora (or carry weight by position) in Blackfoot. Donald (2006) argues that plain Blackfoot codas do not have moras, but geminates do, which is the position that I have adopted for my analysis.

(15) Gemination: $C_1 \rightarrow C_2$ /_+C_2
nitánIt + k + wa → nitánIkk +wa → nitánIkka 'He told me'

(Frantz 2009)

The gemination rule in 15 illustrates that when two consonants meet, the first consonant assimilates to the second. I recognize that this gemination process that Frantz *ibid.* observes strays from current theories of gemination which suggest that gemination occurs when a coda consonant meets an onsetless syllable: It is theorized that the coda consonant lengthens to simultaneously fill the onset position, and stay faithful to the underlying moraic representation of the coda (Elfner 2006). However, according to Frantz's observation, in Blackfoot, when two consonants come into contact, the leftmost consonant assimilates the place features of the following adjacent consonant, which results in a geminate.

The process in 15 clearly does not follow the patterning of traditional gemination, and may be better defined as assimilation; however this process does have an impact on my analysis. Crucially, I argue that the process seen in 15 can only occur with plain obstruents and not preaspirated obstruents because preaspiration cannot be expressed on a moraic consonant: I propose that ALIGNR$_{\text{PREASP[SG]}}$μ seen in 11, aligns the preaspiration [SG] feature with the neighboring mora to the left, but the constraint *PREASP$_{\text{[SG]}}$Cμ prevents the preaspiration from being expressed on a moraic consonant. The epenthesis of a mora between the prefix's consonant and the noun's initial preaspirate ensures that the AlignR$_{\text{Preas[SG]}}$ constraint is met, and the *Preasp$_{\text{[SG]}}$Cμ is not violated. I argue that the constraints listed in 11 and 14 have the hierarchy in 16 below:

(16) ALIGNR$_{\text{PREASP[SG]}}$μ >>*PREASP$_{\text{[SG]}}$Cμ >>DEPμ$_{\text{(wm)}}$

The tableau in 17 below shows justification for the hierarchy seen in 16:

(17)

/aap/ + /ʰkiáájoi/ 'a white bear'	ALIGNR$_{\text{PREASP[SG]}}$μ	*PREASP$_{\text{[SG]}}$Cμ	DEPμ$_{\text{(wm)}}$
a) [aapo̥ʰkiáájoi̥] V. b) [aakkiáájoi̥]	a)	a)	b)
a) [aapo̥ʰkiáájoi̥] V. c) [aakʰkiáájoi̥]		a)	c)
a) [aapo̥ʰkiáájoi̥] V. d) [aapʰkiáájoi̥]	a)		d)

As seen in the first line of the comparison tableau above, form 17a is the optimal candidate because it satisfies ALIGNR$_{\text{PREASP[SG]}}$μ, as form 17a has the preaspiration [SG] aligned with the immediately adjacent mora to the left. Form 17b, on the other hand, violates the ALIGNR$_{\text{PREASP[SG]}}$μ constraint, as form 17b does not express the preaspiration [SG] at all. Additionally, though form 17a violates DEPμ$_{\text{(wm)}}$, as it epenthesizes a mora, it is still the optimal form because DEPμ$_{\text{(wm)}}$ ranks lower than ALIGNR$_{\text{PREASP[SG]}}$μ.

Furthermore, as seen in the second line of the tableau above, forms 17a and 17c both satisfy AlignR$_{\text{Preas[SG]}}$μ because both forms have their preaspiration [SG] aligning with the neighboring moras to the left. However, form 17c has its preaspiration [SG] aligned with a moraic consonant so it violates the *PREASP$_{\text{[SG]}}$Cμ constraint. In contrast, form 17a does not violate *PREASP$_{\text{[SG]}}$Cμ because form 17a has its preaspiration [SG] aligned with a vowel, which means that form 17a is preferred over form 17c; this shows that form 17a is the optimal form because form 17c violates the second highest ranking constraint *PREASP$_{[SG]}$Cμ which prohibits [SG] from being expressed on a moraic consonant. Again, form 17a violates DEPμ$_{(wm)}$, however, because DEPμ$_{(wm)}$ is ranked lower than *PREASP$_{[SG]}$Cμ, form 17a is still the optimal candidate.

Lastly, as seen in the third row of the tableau above, form 17d violates the ALIGNR$_{PREASP[SG]}$μ constraint, because the preaspiration [SG] in form 17d does not align with a mora. So, form 17a is preferred over form 17d because form 17a satisfies the high ranking ALIGNR$_{PREASP[SG]}$μ constraint, whereas form 17d does not.

As discussed earlier, Blackfoot word initial preaspiration cannot be expressed in the output because preaspiration requires a mora. However, theoretically, a mora could be epenthesized word initially so that [SG] could be expressed; however, this is not observed in Blackfoot. To account for this lack of word initial epenthesis, I propose that Blackfoot has the constraint in 18:

(18) DEPμ$_{WI}$: Do not insert word initial moras in the output that are not present in the base.

I argue that word initial epenthesis is prevented because DEPμ$_{WI}$ ranks higher that ALIGNR$_{PREASP[SG]}$μ. The tableau in 19 shows justification for the proposal that DEPμ$_{WI}$ ranks higher than ALIGNR$_{PREASP[SG]}$μ:

(19)

/ʰkiáájoi̥/ 'bear'	DEPμ$_{WI}$	ALIGNR$_{PREASP[SG]}$μ
a) [kiáájoi̥] V. b) [o̥ʰkiáájoi̥]	a)	b)

The tableau above shows that candidate 19b satisfies the ALIGNR$_{PREASP[SG]}$μ constraint, but violates the DEPμ$_{WI}$. Candidate 19a, however, violates ALIGNR$_{PREASP[SG]}$μ but satisfies DEPμ$_{WI}$. Because DEPμ$_{WI}$ has a higher ranking than ALIGNR$_{PREASP[SG]}$μ candidate 19a is the optimal form. The addition of the constraint presented in 19 ensures that vowels are not epenthesized word initially.

The constraints proposed in this section offer an explanation for vowel devoicing associated with preaspiration in Blackfoot. To summarize, the constraints that I have discussed in section 3, have the hierarchy in 20:

(20) DEPμ$_{WI}$ >> ALIGNR$_{PREASP[SG]}$μ >> *PREASP$_{[SG]}$Cμ >> DEPμ$_{(wm)}$ >>*V$_{[SG]}$.

The ordering of the constraints seen in 20 account for the patterning of Blackfoot preaspiration [SG]: The ALIGNR$_{PREASP[SG]}$μ constraint explains why the preaspiration takes on the place features of the preceding vowel, and why the preceding vowel is always devoiced. The *PREASP$_{[SG]}$Cμ constraint restricts the preaspiration [SG] from surfacing on moraic consonants, and the interaction of ALIGNR$_{PREASP[SG]}$μ and *PREASP$_{[SG]}$Cμ accounts for the epenthesis of a word-medial vowel (the low ranking of DEPμ$_{(wm)}$ explains why this word-medial epenthesis surfaces). The high ranking AlignR$_{Preas[SG]}$μ explains why preaspiration is not observed word initially, as there is no mora with which the preaspiration [SG] can align. Finally, the high ranking DEPμ_{WI} constraint prevents vowel epenthesis from occurring word initially.

5. Summary and Conclusion

This paper presents various constraints that account for vowel devoicing in Japanese and Blackfoot. In Section 2, I examined the constraints proposed in Tsuchida (2001) which explain the many factors that contribute to vowel devoicing in Japanese. In section 3, I compared the word final vowel devoicing in Blackfoot with devoicing in Japanese, and adapted/extended some of the constraints proposed in Tsuchida (2001) to Blackfoot word final vowel devoicing. Finally, in section 4, I contrasted the characteristics of Japanese fricatives with the characteristics of Blackfoot fricatives; additionally, I presented Reis Silva's (2008) analysis that Blackfoot has a three way distinction between singleton unaspirated, geminate unaspirated, and preaspirated obstruents. Furthermore, adopting the Reis Silva (2008) analysis of preaspirated obstruents, I argued that word-medial vowel devoicing is caused by the alignment of the preaspiration [SG] feature with a mora. Lastly, I proposed a set of constraints that account for the patterning of word initial preaspiration in Blackfoot.

Though both languages have vowels that are specified as [SG], Japanese and Blackfoot differ greatly with respect to the constraints that govern the appearance of [SG] vowels. The table in 22 summarizes the factors that contribute to Japanese and Blackfoot vowel devoicing:

(22)

Language Characteristics	Japanese	Blackfoot
Vowels that are specified for [SG] are voiceless.	X	X
[SG] originates with an adjacent segment.	X	X word medial
[SG] is generated by a voiceless [voice] voiceless sequence.	X	
[SG] features is epenthesized		X word final
All voiceless fricatives are specified for [SG].	X	
[SG] can only appear on [high] vowels.	X	
[SG] can appear any type of vowel.		X
[SG] is preferentially anchored to the left edge of a word.	X	
[SG] anchors to the right edge of the word.		X word final
[SG] aligns with the immediately adjacent, retrograde mora.		X word medial
OCP prevents [SG] from appearing in consecutive adjacent syllables.	X	

As evident in the table above, Japanese and Blackfoot vowel devoicing, appear to have a few similarities, but generally differ greatly with respect to the factors that constrain the distribution of [SG] on vowels. As seen in 22 above, the [SG] specification on vowels triggers devoicing in both languages; however, in Japanese [SG] comes from or is generated by adjacent voiceless segments. In contrast, Blackfoot [SG] either derives from an adjacent preaspirated obstruent in the case of word-medial devoicing, or may be epenthesized in the case of word final devoicing. Furthermore, as Tsuchida (2001) argues, all Japanese voiceless fricatives are specified for [SG] and are seen to be a primary factor in devoicing, whereas in Blackfoot, it appears that only preaspirated obstruents carry this [SG] specification.

Japanese and Blackfoot also diverge with respect to the type of vowels on which [SG] can appear. In Japanese, only high vowels are observed to carry [SG] features, while Blackfoot allows any manner of vowel to carry the [SG] specification. The positioning of [SG] within a word is also different in Blackfoot and Japanese. As seen in 22 above, Japanese prefers to anchor [SG] to the left edge of a word, whereas Blackfoot aligns the [SG] feature to the right edge (with word final devoicing). Furthermore, Japanese onsets that are specified for [SG] share their [SG] specification with the following vowel, creating syllable tautology. However, the [SG] from the Blackfoot preaspirated obstruent aligns with the adjacent retrograde mora from the previous syllable. Lastly, Japanese is seen to have an undominated OCP constraint that prevents [SG] from occurring on consecutive adjacent syllable, whereas Blackfoot permits consecutively devoiced segments, as seen with the form [naḁʰsḁ] which shows devoicing on the final two syllables.

This discussion of Japanese and Blackfoot vowel devoicing has also exposed some interesting topics for future research. As mentioned in section 3, word final vowel devoicing is sometimes resisted when a word final vowel is accented; however the patterning of this accenting is not clear. In the future, it would be interesting to investigate the environments that give rise to accenting, and the effect that this accenting has on word final vowel devoicing.

Additionally, as mentioned in section 3, the process of gemination in 15, as described by Frantz (2009), has some noteworthy implications for theories of Blackfoot moraic representations. There are conflicting views in the literature about whether or not Blackfoot plain coda consonants carry a mora[14]. The currently held gemination theory is that when a coda consonant meets an onsetless syllable, a geminate is formed in order to concurrently fill the subsequent onset position and maintain faithfulness to the mora in the coda. However, the gemination process described in Frantz *ibid.* shows that when two consonants meet, the leftmost consonant assimilates the features from the right most consonant, resulting in a geminate. If Blackfoot codas do not carry weight by position, then it is odd that moraic consonant would be generated, when two non-moraic consonants come into contact. Because the gemination process described in Frantz is markedly different from traditional gemination, it would be worthwhile to investigate the implications that this process has for the latest theories of Blackfoot moraic representations.

[14] See Elfner (2006) and Donald (2006) for further information.

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