Appears 2014 in J. Iyer & L. Kusmer (eds) *NELS 44: Proceedings of the Forty-Fourth Annual Meeting of the North East Linguistic Society.* Amherst, MA: GLSA, pp. 135-148.

/s/ can be a vocoid*

Heather Goad & Akiko Shimada

McGill University

1. Introduction

Phonologists have long recognized the exceptional behaviour that clusters containing /s/ display across languages (see Vaux and Wolfe 2009, Goad 2011 for reviews). In research which defends the position that syllables are internally-structured, the behaviour of /s/ has typically been captured through formally assigning it some special status. In initial sC and final Cs clusters, /s/ is not organized into the onset and coda respectively. Instead, it has been proposed to be extraprosodic, that is, an unsyllabified segment that is protected from deletion (e.g. Steriade 1982) or, alternatively, a segment that links directly into higher prosodic structure, typically the syllable (e.g. van der Hulst 1984) or prosodic word (e.g. Goldsmith 1990). In Government Phonology, another option holds: /s/ in (initial) sC clusters is analysed as a coda preceded by an empty nucleus (Kaye 1992).

In this paper, we focus on /s/ in Blackfoot, an Algonquian language spoken in southern Alberta and northwestern Montana. In this language, /s/ goes well beyond the exceptional behaviour it displays in other languages. For example, in the most commonly discussed context for /s/ clusters in the literature, word-initial position, both sC and ssC are found: [spát͡siko] 'sand' (D220), [sspitááwa] 'He is tall' (G23);[1] in medial position, long /s/ is well-formed even when flanked by consonants, [otááhkoʔsskaani] 'his gift to his in-laws' (D1), and overlong /s/ can appear both preceding and following a consonant, [ínikátoʔkat͡siiwa anníísska ósssska] 'he imitated his son-in-law' (D61) and [ááhsssapiwa] 'he enjoyed watching' (D258). None of the approaches mentioned above is suitable for an analysis of /s/ clusters in Blackfoot. Indeed, we will argue that /s/ in this language patterns not as a special type of contoid, as it does in other languages, but, instead, as a vocoid: it can be underlyingly non-moraic (parallel to a glide), monomoraic (parallel to a short vowel) or bimoraic (parallel to a long vowel). Although /s/ is an obstruent, its unusual behaviour can be motivated on acoustic grounds: like a vocoid, /s/ has robust internal cues for place and manner, which ensures its perceptibility in non-optimal

*Earlier versions of this work were presented at mfm 2012, Phonology 2013, CLA 2013, MOT 2013, Memorial University of Newfoundland and McGill University, as well as at NELS 2013. We would like to thank the audiences for questions and comments. This research was supported by grants from SSHRC and FRQSC. An earlier version of the written paper appears as Goad and Shimada (2014a).

[1]All examples are taken from Frantz and Russell's (1995) dictionary (henceforth D) or Frantz's (2009) grammar (G). Page numbers follow D and G.

positions, even when adjacent to stops (Wright 2004); this, coupled with its special formal status, accounts for its unusual distribution across languages (Goad 2011, 2012).

We will demonstrate that the syllabification of /s/ does not have to be stipulated: rather, the segmental context in which it occurs, combined with its moraic status, determines its realization. Indeed, we will argue that the regular syllable structure constraints, which will be motivated on the basis of other segments in the language, combined with (bi)moraic /s/, lead to the unusual behaviour that this consonant displays. Depending on its position in the string, (bi)moraic /s/ will surface as a syllable head and/or coda, with or without additional links to neighbouring onset positions. In this way, our approach contrasts with Elfner (2006) and, to some extent, Denzer-King (2008), who instead choose to augment the syllable structure constraints that other consonants respect to accommodate /s/: Elfner analyses /s/ in medial sC clusters as part of a complex onset; Denzer-King analyses /s/ in initial sC clusters as a word-level appendix. In other ways, our analysis builds on Denzer-King (2008) as he proposes that Blackfoot /s/ "is inherently moraic, and can act as a syllable nucleus" (p. 51) as well as on Derrick (2006) who states that Blackfoot /s/ "sometimes acts like a vowel".

2. Inventories

We hold the view that a principled analysis of Blackfoot /s/ first requires an examinination of the distribution and syllabification of other consonants in the language. In order to do this, we begin with the phonemic inventory of Blackfoot consonants, provided in (1).

(1) *Consonant inventory:*

Labial	Coronal	Dorsal	Placeless
p	t	k	ʔ
	t͡s	k͡s	
	s		h
m	n		
w	y		

Most striking, Blackfoot lacks liquids; it also does not have a laryngeal contrast amongst obstruents. The symbols in (1) are those used by Frantz (2009) with two exceptions: we use /ʔ/ in place of /'/ and /t͡s, k͡s/ replace some cases of /ts, ks/. We opt for the ligature for the latter because /ts/ and /ks/ are ambiguous in Blackfoot (Frantz 2009): lingual stop + fricative can form clusters or complex segments. In some contexts, the analysis is indeterminate; in others, distributional considerations reveal the appropriate structure (see further Goad and Shimada 2014b). Frantz (2009:4) refers to /t͡s, k͡s/ as 'affricates' (see also Elfner 2006, Denzer-King 2009). Because the two halves of /k͡s/ do not share place, we use the term 'complex stop' instead.

Although our focus is on consonants, we briefly point out that Frantz (2009) identifies three monophthongs and three diphthongs for Blackfoot. Monophthongs contrast for length (/i,ii, a,aa, o,oo/), although long vowels are shortened in closed syllables of most types. Diphthongs (/ai, ao, oi/) are typically not realized intact, instead surfacing as coalesced vowels. Because the examples in our two main sources, Frantz and Russell (1995) and Frantz (2009), are orthographically transcribed, none of these processes are transcribed, except where noted.

We mention, finally, that Blackfoot is a pitch accent language. Every multisyllabic word minimally has one syllable with contrastive high pitch, marked with an acute accent over the vowel (Frantz 2009). We use pitch accent as a diagnostic of phonological word-hood, as follows. Since complex clusters can be found in many languages across word boundaries, to try and minimize the possibility that the unusual clusters with /s/ examined in the current work span two phonological words, we have limited the data to forms that are considered to be one (morphological) word by the sources we have consulted and that additionally contain at most one pitch accent.

3. Distribution of consonants

As in many languages, Blackfoot seems to have more than one type of /s/: 'ordinary' /s/, which behaves in a similar manner to other contoids, and 'unusual' /s/, which has an unexpected distribution and which we later analyse as a vocoid. In the following sections, we discuss ordinary /s/, alongside other consonants in Blackfoot, and arrive at a set of phonotactic constraints for the language. In section 5, we turn to unusual /s/.

Data and generalizations in Frantz and Russell (1995), Elfner (2006), Denzer-King (2009) and Frantz (2009) lead us to divide the consonants from (1) into the four categories in (2). (2) reveals that ordinary /s/ has the freest distribution of all consonants, which may call into question its status as ordinary. We will see below that it is indeed ordinary: its wide distribution in onset follows from its place-bearing status, and in coda, from the fact that it is both coronal and a fricative.

(2) *Distribution of consonants:*

	Labial	Lingual (not /s/)	Ordinary /s/	Placeless
Word-initial onset	✓	✓	✓	✗
Intervocalic onset	✓	✓	✓	✗
Wd-internal coda (geminates aside)	✗	✗	✓	✓
Word-final consonant	?	✓ (except complex stop)	✓	✗

Turning to the other three columns, labials and linguals, on one hand, and placeless consonants, on the other, principally occur in complementary contexts: labials and linguals are restricted to onset and placeless consonants, to coda.[2] The division of labials and linguals into two classes is based on their distribution in word-final position: though stems can end in labials, it appears that these consonants cannot occur word-finally, with limited exceptions; this contrasts with non-complex lingual contoids, which can appear in this position, along with ordinary /s/: e.g. [ooyík] 'Eat!' (plural addressee) (G112), [maʔtóós] 'Take it! (anim, singular addressee) (G112). In light of this, it is difficult, at present, to determine how to classify word-final consonants in Blackfoot. The restriction of placeless consonants to coda position word-medially and their absence from word-final position suggests that the latter position has an onset profile, although the lack of

[2]Labial and lingual nasals appear to be permitted in word-internal coda position, e.g. [ikkámsswohkókkiiniki…] 'If we see it, (we'll eat it)' (G111). All examples we have found, however, involve the nasal appearing before long /s/ which we analyse, for independent reasons, as unusual /s/. One consequence of this is that the preceding nasals are not syllabified as codas but, instead, as onsets.

labials in this position casts some doubt on this. In view of the difficulties that hold for an analysis of word-final consonants, we refrain from discussing this position in this paper.

Turning finally to the placeless column in (2), this groups together /ʔ/ and /h/. /h/ takes on the place of articulation of the preceding vowel: it is realized as [ç] after /i/, [x] after /a/, and [x^w] after /o/ (Frantz 2009), leading some researchers to phonemicize it as /x/ (e.g. Frantz 2009:162, Elfner 2006:12). We propose that this fricative, along with /ʔ/, is inherently placeless principally based on its distribution and thus opt for the symbol /h/. First, if /h/ were underlyingly place-bearing (/x/), we would expect it to pattern with the linguals and yet the table in (2) reveals that it does not. Second, its restriction to coda position is consistent with the cross-linguistic observation that codas cannot license their own place features (e.g. Itô 1986); conversely, its absence from onset position follows if onsets must bear place in many languages (Qu 2011). Finally, /h/ has the same distribution as /ʔ/,[3] a segment normally considered to lack place (e.g. Rose 1996). The finding that /h/ assumes the vocal tract shape of adjacent vowels in Blackfoot holds of placeless /h/ in other languages as well (see Keating 1988 on English, Farsi and Swedish).

The complementary distribution of labials/linguals and placeless consonants observed in (2) will prove to be essential for our analysis of unusual /s/, which we have seen can be both preceded and followed by consonants. When preceded by [p], for example, a consonant that can only be in onset, we can conclude that the immediately following [s] is nuclear (e.g. [itápsskonakiwai͡ksi] ‘(My friend) shot at them’ (G50)); when preceded by a placeless consonant, by contrast, the immediately following [s] must be in onset (e.g. [otsítssonao͡ʔsskipo.ka] ‘…then kissed him’ (G128)).

4. Syllabification

The distribution of consonants in (2) suggests that, when unusual /s/ is set to one side, Blackfoot syllabification is relatively straightforward. We expand on this more concretely in this section, beginning with onsets. First, true branching onsets are banned in Blackfoot. This is as expected, as (1) revealed that the language lacks liquids. Obstruent + liquid is the most commonly attested profile for branching onsets; indeed, some researchers have argued that other clusters cannot have this analysis in the absence of obstruent + liquid (Clements 1990), a position that we accept.

Other rising sonority clusters arise through morpheme concatenation, but they do not surface intact. The examples below show that contoid + glide is resolved through glide deletion (3a),[4] and stop + nasal (after vowel lenition) through gemination (3b).

The absence of rising sonority clusters in Blackfoot suggests to us that medial clusters cannot be analysed as complex onsets but, instead, require some other analysis. This is in contrast to Elfner (2006), who analyses /s/ + stop and stop + /s/ as complex onsets. Following from these observations, the constraint in (4) is undominated in our analysis.

(3) *Rising sonority clusters:*

a. /nit-yáak-itsiniki/ → [nitáakistiniki] ‘I will tell a story’ (G32)
   /póós-wa/ → [póósa] ‘cat’ (G27)

b. /siksi-ponokawa/ → siksipnokawa → [siksínnokawa] ‘black elk’ (G78)

(4) NoComplexOnset: Complex onsets are forbidden

[3]There are a handful of examples of intervocalic [ʔ] (e.g. [saʔáí] ‘duck’ (D206)).

[4]Glottal stop + glide is well-formed, which we return to below.

The second property of onsets that concerns us is that word-medial syllables normally require onsets. According to Elfner (2006), vowels in hiatus are resolved through coalescence (/a/ + /i/ → [ɛ:], /a/ + /o/ → [ɔ:]), diphthong formation (/i/ + /a/ → [ya], /i/ + /o/ → [yo], /o/ + /i/ → [oy]) and, rarely, elision (/i/ + /a/ → [a], /i/ + /o/ → [o], /o/ + /a/ → [a]). Hiatus is permitted only with /o/ + /a/ (→ [o.a]). Elfner (2006) and Denzer-King (2009) point out that the near absence of medial onsetless syllables cannot be captured with ONSET, which forbids onsetless syllables. This is because vowel-initial words are perfectly licit in Blackfoot ([akóka**ʔ**tssiist͡si] 'circle camps' (D10)); in fact, initial glides are often deleted (/w-óko**ʔ**s-ik͡si …/ → [óko**ʔ**sik͡si …] 'His kids (are sleeping)' (G49)). As we will see in section 6.4, ONSET must be low ranking for an additional reason: it will be a critical part of our analysis of word-initial sC and ssC clusters.

In view of these facts, it is NOHIATUS, rather than ONSET, that must be high ranking. As defined in (5), NOHIATUS is effectively ONSET confined to word-internal position. Violations of NOHIATUS are resolved through diphthong formation, coalescence and onset formation. The result of onset formation strives to be an onset-nuclear sequence that rises in sonority, in respect of SONRISE in (6). This will favour the repairs to V.V strings listed above (e.g. coalescence (a+i → [ɛ:]) over onset formation (a+i → *[a.yi])), but it will also ensure that cases of unusual /s/ that are underlyingly moraic and precede vowels yield [sV] over [GV] (i.e. C+s_{μ}+V → [Cs_{μ}.si], *[Cs_{μ}.yi]) (see section 6.2). Even though /s/ is a vocoid, its features make it lower in sonority than other vocoids like /i~y/.

(5) NOHIATUS: Adjacent segments linked to separate μs cannot be in different σs

(6) SONRISE: Sonority rises toward the nucleus

Turning to codas, Blackfoot follows the common pattern where word-medial codas cannot license place features. As a result, codas are limited to the first half of geminates (7a), to placeless consonants (7b) and to /s/ followed by place-sharing consonants (7c). Accordingly, the constraint in (8) is undominated in Blackfoot.

(7) *Place in coda:*

a.	[nínna]	'my father' (G5)	[ik͡síssiwa]	'he is tough' (G5)
b.	[mo**ʔ**t͡sií]	'hand/arm' (G12)	[áakohpotaawa]	'It's going to snow' (G24)
c.	[istópiit]	'Sit there!' (F94)	[míinist͡si]	'berries' (G94)

(8) NOCODAPLACE: Coda cannot license place

/ʔ, h/ can appear in coda, but recall from (2) that their distribution is more constrained than this: they are confined to coda position. Their absence from onset position (including the absence of placeless geminates) is consistent with what is observed in some other languages, where onsets must bear place features (Qu 2011; see also Harris 1997). The relevant constraint, which we consider to be undominated (but see note 3), is in (9).

(9) ONSETPLACE: Onset consonants have place

Turning to sonority, Blackfoot respects the Syllable Contact Law (Murray and Vennemann 1983): codas must be followed by onsets of equal or lower sonority. As Blackfoot does not allow coda sonorants, SYLLCONTACT in (10) reduces to fricative + fricative and fricative + (complex) stop, shown in (11). ([s.h] is out due to ONSETPLACE.)

(10) SYLLABLECONTACT: An onset consonant cannot be more sonorous than the immediately preceding coda

(11) *Syllable contact: Fricatives in coda:*

a.	/h/ + fricative:	[ssts͡ipísoohsit]	'Punish (whip) yourself!' (G105)
b.	/h/ + (complex) stop:	[áisstaahkahtaawa]	'She is nursing' (G103)
	/s/ + (complex) stop:	[nitánistawa]	'I told him' (G154)
		[míínists͡i]	'berries' (G94)

Unlike [h], [ʔ] can be followed by any consonant, as shown in (12), seemingly in violation of SYLLCONTACT. We treat [ʔ] as featureless; regardless of what follows it, then, the cluster vacuously respects SYLLCONTACT. By contrast, although [h] is placeless, it bears [cont], like [s], and so the clusters it enters into are assessed by SYLLCONTACT.

(12) *Syllable contact: Glottal stop in coda:*

/ʔ/ + (complex) stop:	[niʔtómmoyi]	'hill' (G7)
	[iʔks͡isakoyi]	'meat' (G7)
/ʔ/ + fricative:	[asókaʔsimi]	'dress' (noun) (G11)
/ʔ/ + nasal:	[iʔnákohkitsimi]	'small doorway' (G78)
/ʔ/ + glide:	[áwaʔyiwa]	'She is pointing' (G27)

From the data and constraints introduced in this section, we conclude that Blackfoot syllable structure is relatively straightforward. As in other languages, the distribution of consonants is sensitive to considerations of sonority and place.[5] This includes the freer distribution of ordinary /s/, which follows from it being both coronal and a fricative.

5. Unusual /s/

We turn now to examine unusual /s/. Unusual /s/ appears to freely violate the constraints introduced for other consonants in section 4. However, its distribution can be captured without relaxing these constraints, if two concessions are made: (i) like a vowel, /s/ can be underlyingly (bi)moraic; and (ii) like a vowel, /s/ can be flanked by consonants.

We begin with some examples, which illustrate, in greater detail, the types of unusual /s/ clusters attested in Blackfoot. The forms in (13a) show that, in medial position, [s] and [ss] can be flanked be consonants; (13b-c) show that [ss] and [sss] can be preceded by a consonant if followed by a vowel, or followed by a consonant if preceded by a vowel.

(13) *Medial position:*

a.	[s] & [ss] in context C_C:	[áakokstakiwa] 'She will count' (G79)	[itápsskonakiwaiks͡i] '(My friend) shot at them' (G50)
b.	[ss] & [sss] in context C_V:	[kitssoká ʔpssi] 'You are nice' (G23)	[ááhsssapiwa] 'He enjoyed watching' (D258)
c.	[ss] & [sss] in context V_C:	[ísska] 'pail' (G14)	[ínikáto ʔkatsiiwa anníisska óssska] 'he imitated his son-in-law' (D61)

[5]Elfner (2005) and Denzer-King (2009) consider sonority to be the driving factor in Blackfoot syllabification. Place constraints, which we consider to be essential, do not play a crucial role in their analyses.

Turning to initial position, the sC data in the first column in (14) are not cross-linguistically unusual; but those in the second column show that Blackfoot permits initial ssC, a type of complexity that is rarely observed. sC and ssC respect the same constraints – stops of any place can follow [s] – suggesting that the same analysis should hold for both.

(14) *Initial position:*

[spát͡siko]	'sand' (D220)	[sspitááwa]	'He is tall' (G23)
[st͡síki]	'another' (D232)	[sst͡sipísoohsit]	'Punish yourself!' (G105)
[skíímiksi]	'female animals' (D214)	[sskánatsskiniwa]	'She has nice hair' (D22)

In section 6, we will show that analysing /s/ as a vocoid leads to a straightforward analysis of the complex patterns displayed by unusual /s/, critically, one that is consistent with the syllable structure constraints introduced in section 4.

6. Analysis

Our goals are twofold: (i) to analyse unusual /s/ with the same syllable constituents available to ordinary segments, that is, without recourse to appendices (cf. Denzer-King 2009); (ii) to identify the conditions under which unusual /s/ is permitted without relaxing the syllabification constraints holding for other consonants (cf. Elfner 2006). We adopt moraic theory (Hyman 1985, Hayes 1989), as it is the only theory of syllabification that provides the flexibility required for the various parses of /s/ in Blackfoot. We propose that ordinary and unusual /s/ are distinguished in terms of moraicity and syllabification.

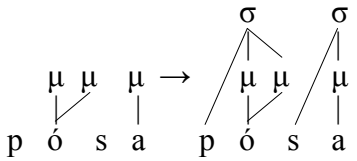
Like other consonants, ordinary /s/ is underlyingly non-moraic or monomoraic. Non-moraic /s/ is syllabified as an onset, or acquires weight-by-position (Hayes 1989) when in coda. In intervocalic context, monomoraic /s/ yields a geminate. Like vowels, unusual /s/ is underlyingly monomoraic or bimoraic. When monomoraic, it differs from ordinary /s/ in that it projects a syllable.[6] This difference between ordinary and unusual /s/ need not be stipulated: it follows from the segmental context in which /s/ occurs. In short, ordinary and unusual /s/ are not formally different, aside from their underlying moraic status. We will, however, continue to use the terms ordinary /s/ and unusual /s/ for ease of reference.

6.1 Ordinary /s/ in medial position

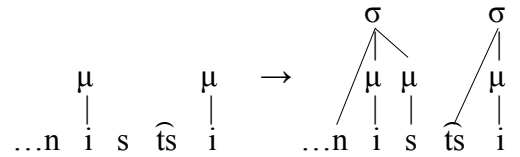
In the interest of completeness, we begin with ordinary /s/. In intervocalic position, non-moraic ordinary /s/ undergoes onset adjunction, in order to satisfy NOHIATUS, as shown in (15a). In coda position, /s/ acquires a mora to satisfy weight-by-position, (15b).

(15) *Underlyingly non-moraic /s/:*

a. Onset: [póó.sa] 'cat' (G9)



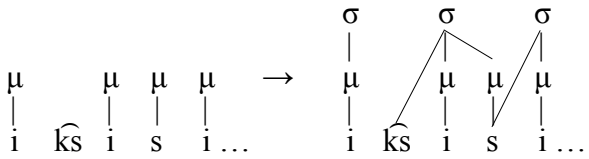
b. Coda: [míí.nis.t͡si] 'berries' (G94)



[6]As mentioned earlier, our analysis builds on Denzer-King (2009), who also proposes that /s/ is underlyingly (bi)moraic and can project a syllable. Denzer-King, however, assumes that /s/ is moraic in all positions (p. 52). He thus has no principled way to explain how /s/ loses its moraic status in singleton onsets.

Monomoraic ordinary /s/ in intervocalic position surfaces as a geminate; see (16). NOHIATUS is again responsible for onset adjunction.

(16) *Underlyingly monomoraic /s/:*
[i.k͡sís.si.wa] 'he is tough' (G5)



6.2 Monomoraic unusual /s/ in medial position

Monomoraic unusual /s/ is minimally parsed as a short nucleus in medial position. When flanked by consonants that must be in onset position, it is syllabified as nuclear only; see (17a). It is additionally parsed as an onset under three conditions. It becomes: nucleus+ onset [ss] when preceded by an onset and followed by a vowel (17b); onset+nucleus [ss] when preceded by a vowel or coda and followed by an onset (17c); and onset+nucleus+ onset [sss] when preceded by a coda and followed by a vowel (17d).[7] Effectively, then, the consonant immediately preceding or following /s_μ/ can also be realized as [s] through multiple linking, depending on the syllabification requirements of adjacent segments.

(17) /s_μ/

a. Nuc:	áa.ko.ks.ta.ki.wa	'She will count.' (G79)
	mí?.ks.ka.pa.yi.nis.t͡si	'crackers' (G65)
b. Nuc+Ons:	i.ps.sáá.kit	'mend!' (D80)
	ii.k͡sí.kin.ns.si.wa	'it is warm' (D39)
c. Ons+Nuc:	í.ss.ka	'pail' (G14)
	o.t͡sí.ts.so.nao?.ss.ki.po.ka	'…then kissed him' (G128)
d. Ons+Nuc+Ons:	ááh.ss.sa.pi.wa	'he enjoyed watching' (D258)
	iihpohtóóma anni aoó?.ss.si.ni	'he added sugar to the berry soup' (D147)

We provide structures for (17a-d) below. For the first three, we focus on examples where a vowel precedes the Cs syllable. In (18a), /s_μ/ projects a syllable node; the string cannot otherwise be syllabified, as both flanking consonants must be parsed as onsets. Recall from section 4 that /k/, the consonant preceding /s_μ/, cannot be syllabified in coda due to NOCODAPLACE. In (18b), /s_μ/ similarly projects σ, but it must become an onset as well, yielding [ss]. The alternative parse (*[i.ps.á]) violates NOHIATUS. In (18c), a vowel precedes /s_μ/; NOHIATUS thus forces /s_μ/ to become onset of its own syllable, yielding [ss]. The first alternative (*[is.ka]) is ill-formed due to NOCODAPLACE: [s] is only permitted in coda when it can share place with a following onset. The second alternative (*[i.ys.ka]), where /i_μ/ instead of /s_μ/ fills the onset position, is ruled out because of SONRISE: [s] is less sonorous than the true vocoid [i]/[y], making [ys] a non-optimal onset-nuclear string.[8] In both forms in (17d), as in the second forms in (17a-c), the Cs

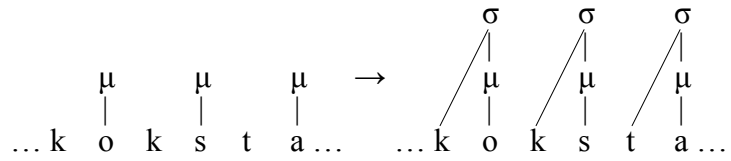
[7]Regarding (17d), we have found no words of the shape …V.ss.sV…, , but we have no principled reason to rule out forms of this type.

[8]Thanks to Emily Elfner for helpful discussion on the role of sonority here.

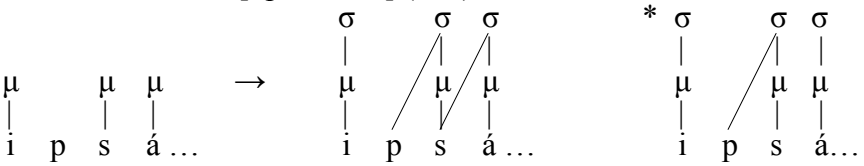
syllable is preceded by a consonant. The resulting syllabification is only possible if the coda+onset cluster is well-formed as per SYLLCONTACT and NOCODAPLACE. In (18d), as /h/ can only be parsed in coda due to ONSETPLACE, /s_μ/ becomes onset of its own syllable, to satisfy NOHIATUS. Since the segment following /s_μ/ is a vowel, NOHIATUS is again implicated, forcing moraic /s_μ/ to also become the onset of following syllable.

(18) *Structures for* /s_μ/

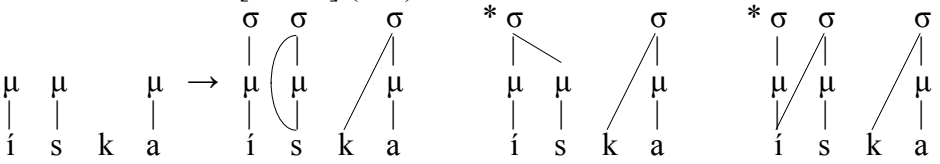
a. /s_μ/ as nucleus: [áa.ko.ks.ta.ki.wa] (17a)



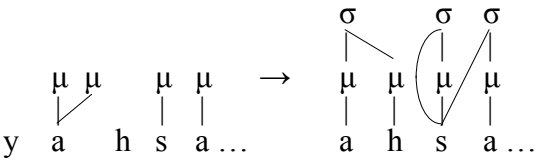
b. /s_μ/ as nucleus+onset: [i.ps.sáá.kit] (17b)



c. /s_μ/ as onset+nucleus: [í.ss.ka] (17c)



d. /s_μ/ as onset+nucleus+onset: /yááh$s_\mu$apiwa/ → [áh.ss.sa.pi.wa] (17d)[9]



6.3 Bimoraic unusual /s/ in medial position

Bimoraic unusual /s/ is minimally parsed as a long nucleus in medial position; see (19).

(19) /$s_{\mu\mu}$/

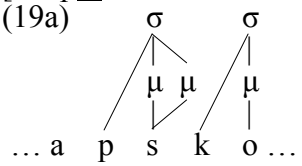
a. Nuc:	i.tá.pss.ko.na.ki.wai.k͡si á?.pss.kaat	‘(My friend) shot at them’ (G50) ‘bet!’ (D256)
b. Nuc+Ons:	s.tá.mss.sáa.ko.noo.sa ii.táí.sa.pss.siis.ts.ta.kio?.pi.k͡si	‘Try to recognize her!’ (D166) ‘washtubs’ (D29)
c. Ons+Nuc:	ínikáto?katsiiwa anníisska ó.sss.ka	‘he imitated his son-in-law’ (D61)
d. Ons+Nuc+Ons:	* …V(?).sss.sV…	

[9]The initial glide is deleted from this form, as discussed in section 4; the long vowel is additionally shortened before coda /h/ (see Elfner 2006, Frantz 2009).

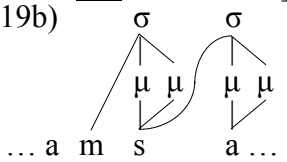
Structures are provided in (20) below. We focus on cases where a vowel precedes the Css syllable.[10] /$s_{\mu\mu}$/ is syllabified as nuclear [ss] in (20a), as the preceding and following consonant must be onsets, due to their place. Compare (17c), [o.t͡sí.ts.so.naoʔ.ss.ki.po.ka], where it is monomoraic /s/ that surfaces as [ss] because the preceding [ʔ] must be a coda, due to ONSETPLACE. In (20b), NOHIATUS forces bimoraic /s/ to become onset of the following syllable, which would otherwise begin with a vowel. In (20c), this constraint forces /$s_{\mu\mu}$/ to become onset of its own syllable because the preceding segment is a vowel.

(20) *Structures for* /$s_{\mu\mu}$/

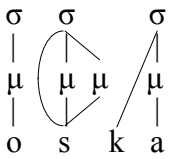
a. /$s_{\mu\mu}$/ as nucleus: [i.tá.pss.ko.na.ki.wai.t͡si] (19a)



b. /$s_{\mu\mu}$/ as nuc+ons: [s.tá.mss.sáa.ko.noo.sa] (19b)



c. /$s_{\mu\mu}$/ as ons+nuc: [ó.sss.ka] (19c)



Consider, finally, the unattested ons+nuc+ons parse for /$s_{\mu\mu}$/ in (19d). The maximum surface length for unusual /s/ is [sss], regardless of its syllabification. We expect that the upper limit of [sss] is phonetically-driven: on articulatory grounds, speakers may have difficulty sustaining the airflow required for the production of an overlong sibilant [ssss]; alternatively, it may prove difficult to perceptually distinguish [sss] from [ssss].

In sum, our analysis that Blackfoot /s/ is a vocoid can straightforwardly account for a large range of patterns exhibited in medial position, without relaxing the language's syllabification constraints on place, sonority and hiatus: the segmental context in which /s/ occurs determines its realization. There are some gaps, but we are hopeful they will be filled by careful scrutiny of the wider literature and consultation with native speakers.

6.4 Unusual /s/ in initial position

In this section, we turn to unusual /s/ in initial position. As mentioned in section 5, like other languages, Blackfoot permits sC clusters in initial position; see (21a). Elfner (2006) analyses such clusters as complex onsets, the same analysis she proposes for medial sC and Cs clusters. Our approach does not permit an analysis of this type, as we do not allow complex onsets of this shape in any language, as mentioned earlier. It is also inconsistent with the fact that Blackfoot does not permit rising-sonority complex onsets (section 4).

An alternative would be to treat /s/ in initial sC as an appendix, the analysis proposed by Denzer-King (2009). Recall, however, that Blackfoot also permits ssC, as shown in (21b). A comparison of (21a) and (21b) reveals that initial sC and ssC are subject to the same constraints: they are both followed by (complex) stops of the same profile, which suggests that the same analysis should hold for both. The appendix analysis cannot be extended to ssC, due to the Peripherality Condition: appendix/extraprosodic status can only be assigned to elements in peripheral positions (Hayes 1981, Harris 1983).[11]

[10]Aside from the parse in (19a), in all attested /$s_{\mu\mu}$/ forms, a vowel precedes the Css syllable. Yet we predict forms like …Vʔ.Css.sV… and …Vʔ.sss.CV… to be licit, alongside the attested (19b) and (19c). Although we have found strings of the shape ...Vʔ.Css.sV..., e.g. *amíʔ.tss.so.ki.mi* 'Pacific Ocean' (D10), all of them have [t] or [k] in the C position, which likely means that [tss]/[kss] forms a complex segment in onset ([t͡s]/[k͡s]) + single nucleus ([s]), rather than simple onset ([t]/[k]) + branching nucleus ([ss]). However, at present, we have no principled reason to rule out …Vʔ.Css.sV… nor …Vʔ.sss.CV….

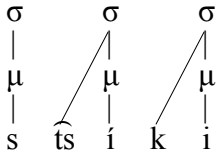
(21)

a. *Word-initial sC:*		b. *Word-initial ssC:*	
[spát͡siko]	‘sand’ (D220)	[sspitááwa]	‘He is tall’ (G23)
[stámitapoot]	‘just go there!’ (D232)	[sstamat͡sisa]	‘Tether him to the stake!’ (D229)
[st͡síki]	‘another’ (D232)	[sst͡sipísoohsit]	‘Punish (whip) yourself!’ (G105)
[skíímiksi]	‘female animals’ (D214)	[sskánatsskiniwa]	‘She has nice hair’ (D22)
?[sk͡sV…]		[ssk͡só?sat͡sisa]	‘Flesh a hide!’ (D225)

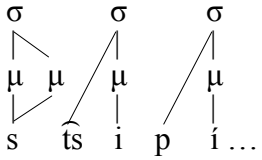
A third option would be to analyse initial sC as a coda+onset cluster, as in Government Phonology (Kaye 1992). This analysis could conceivably extend to initial ssC (#sØs.CV…), but it is challenged by the observation that medial sC coda+onset clusters respect place identity (*[Vs.pV], *[Vs.kV]; see (7)) while initial sC/ssC clusters do not.

In view of these challenges, we propose the following: [s] in initial sC is underlyingly monomoraic while [ss] in initial ssC is bimoraic. In both cases, shown in (22), /s/ projects σ, because the string cannot otherwise be syllabified, as was seen earlier for medial /s/.[12] We must ensure, however, that surface forms like those in (23) do not inadvertently arise from the representations in (22). We propose that an ‘extra’ [s] will not appear at the left edge as in (23) because there is nothing to drive onset formation in initial position. Onset formation arises under two conditions only. One, word-initial stray consonants undergo onset adjunction; in (23), however, initial /s/ is not stray. Two, NOHIATUS is resolved by onset formation; in (23), there is no hiatus to resolve.

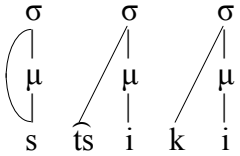
(22) a. [st͡síki] (21a):



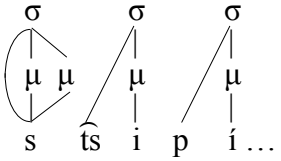
b. [sst͡sipísoohsit] (21b):



(23) a. *[sst͡síki]



b. *[ssst͡sipísoohsit]



7. Cross-linguistic implications

Before concluding, we briefly consider some cross-linguistic implications of our analysis. First, our analysis has required multiple linking of /s/ in ways that are typologically unusual: /s/ has been syllabified as onset+nucleus in strings such as [í.ss.ka] (see (17c))

[11]Denzer-King (2009) analyses [s] in #sC as a moraic appendix, but [ss] in #ssC as a bimoraic syllable. In our view, the fact that both #sC and #ssC are subject to the same constraints poses a challenge for this.

[12]sC and ssC are variably preceded by epenthetic [ə] or [ɪ] (Denzer-King 2009; see also Elfner 2006). We assume that this vowel is weightless, as is the case for epenthetic vowels in some other languages (Piggott 1995), and so links up to the leftmost mora associated with /s/. (Note that the location of [ə]/[ɪ] would be problematic for the proposed Government Phonology structure for #ssC: sØs.CV → *səs.CV.)

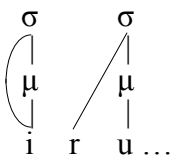
and as nucleus+onset in strings such as [i.ps̲.sáá.kit] (see (17b)). Since we have, in effect, analysed /s/ as a vocoid, the question arises as to whether there are languages with true vocoids with the same types of syllabification. The answer is clearly yes.

Leftward glide formation in Tamil involves onset+nucleus syllabification of true vowels, shown in (24a); and rightward glide formation in Sinhala involves nucleus+onset syllabification of true vowels; see (24b). Structures for both types of strings are in (25).

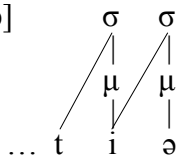
(24) a. *Tamil* (Christdas 1988):
/iruʈ̲ʈ̲/ → [yiruʈ̲ʈ̲ɯ] 'darkness'
/uuciy/ → [wuusi] 'needle'

b. *Sinhala* (Letterman 1997):
/jaati-a/ → [jaatiyə] 'kind' (SG.DEF)
/putu-a/ → [putuwə] 'chair'

(25) a. *Tamil:* [y̲iruʈ̲ʈ̲ɯ]



b. *Sinhala:* [jaatiy̲ə]



A more imperative question to answer is whether there are other languages that treat /s/ as a vowel. In section 1, we pointed out that the behaviour of /s/ can be attributed to the fact that this segment has robust internal cues for place and manner, like a true vowel. This ensures that it is perceptible, even in non-optimal positions. If the perceptual properties of /s/ are responsible for the behaviour it shows in Blackfoot, we should, of course, find similar patterns in other languages. Ōgami (Southern Ryukyuan) looks particularly promising in this respect (Pellard 2009).[13] In this language, fricatives (as well as sonorants) can be syllabic; see (26). Similar to Blackfoot, it appears that only /s/, both short and long, can be sandwiched between consonants word-internally, as in (26b).

(26) *Ōgami* (Pellard 2009: 80):

a.	[s̩tɑ]	'underneath'	b.	[ps̩tu]	'person'
	[f̩tɑi]	'forehead'		[ps̩:mɑ]	'day'

More work needs to be done to understand the range of structures that Ōgami permits. Clearly, though, ascribing the unusual behaviour of /s/ to the fact that this segment has robust internal cues for place and manner cannot mean that /s/ is the only non-sonorant consonant that can head a syllable. In Ōgami, both /f/ and /s/, along with sonorants, can function as nuclear. In Imdlawm Tashlhiyt Berber (Dell & Elmedlaoui 1985), stops and fricatives, as well as sonorants, can play this role. In several Niger-Congo and Sino-Tibetan languages, voiced coronal and labio-dental fricatives (but, surprisingly, not sonorant consonants) can head syllables (Faytak 2012). /s/, however, is the consonant that most commonly stands out across languages. It also shows a diverse range of unusual behaviour, in addition to its ability to head a syllable, which motivates a variety of analyses for this segment across languages, as will be briefly discussed in the conclusion.

8. Conclusion

In this paper, we have argued that Blackfoot /s/ is a vocoid: it can be underlyingly non-moraic, monomoraic or bimoraic. Like other consonants, singleton ordinary /s/ is under-

[13]Thanks to Matt Faytak for bringing Pellard's work to our attention.

lyingly non-moraic, and geminate ordinary /s/, underlyingly monomoraic. Like vowels, unusual /s/ is underlyingly monomoraic or bimoraic and projects a syllable. Ordinary and unusual /s/ are not formally different, aside from their moraic content. It is rather the segmental context in which /s/ occurs that determines its realization and syllabic status; critically, constraints on syllabification (place, sonority, hiatus) must be factored in.

Although /s/ is the consonant that most often stands out across languages, it is evident that a unified account of /s/ clusters cannot be provided for all languages. We conjecture, however, that the behaviour of /s/ can always be captured with /s/ being analysed as a *conventional syllable constituent* (onset, nucleus, coda, moraic), i.e. without requiring recourse to appendices or non-exhaustive syllabification, if one admits a relatively abstract view of the syllable. Specifically, unusual /s/ has been argued to be a coda preceded by an empty nucleus in (initial) sC clusters in Indo-European languages (following Kaye 1992); /s/ has been proposed to be an onset followed by an empty nucleus in initial and medial sC clusters in Acoma (Goad 2011, 2012); and following in the spirit of Denzer-King (2009), /s/ has been proposed here to be moraic and to project its own syllable in Blackfoot initial and medial clusters. It appears, at present, that the moraic analysis of Blackfoot /s/ cannot be translated into onset rhyme theory, with unusual /s/ analysed as a nucleus (although this may turn out to be appropriate for Ōgami). Indeed, moraic theory seems to be the only theory that provides the flexibility required for the various parses of /s/ in Blackfoot.

References

Christdas, Prathima. 1988. *The phonology and morphology of Tamil.* Doctoral dissertation, Cornell University, Ithaca, NY.

Clements, G. Nick. 1990. The role of the sonority cycle in core syllabification. In *Papers in laboratory phonology I: Between the grammar and physics of speech*, ed. by John Kingston and Mary Beckman, 283-333. Cambridge: CUP.

Dell, François, and Mohamed Elmedlaoui. 1985. Syllabic consonants and syllabification in Imdlawn Tashlhiyt Berber. *Journal of African Languages and Linguistics* l:105-130.

Denzer-King, Ryan. 2009. The distribution of /s/ in Blackfoot: An Optimality Theory account. MA thesis, University of Montana, Missoula, MT.

Derrick, Donald. 2006. Syllabification and Blackfoot "s". Paper presented at the 38th Algonquian Conference, University of British Columbia, 27 October.

Elfner, Emily. 2005. The role of sonority in Blackfoot phonotactics. In *Calgary Papers in Linguistics* 26, ed. by Ilana Mezhevich, Heather Bliss, and Michael B. Dobrovolsky, 27-91. Calgary: University of Calgary, Department of Linguistics.

Elfner, Emily. 2006. The mora in Blackfoot. MA thesis, University of Calgary, Calgary, AB.

Faytak, Matthew. 2012. Logical sonority scales and turbulence in fricative-vowel languages. Paper presented at the 38th Annual Meeting of the Berkeley Linguistics Society, University of California, Berkeley, 11-12 February.

Frantz, Donald G. 2009. *Blackfoot grammar,* 2nd edition. Toronto: University of Toronto Press. (1st edition 1991.)

Frantz, Donald G., and Norma Jean Russell. 1995. *Blackfoot dictionary of stems, roots and affixes,* 2nd edition. Toronto: University of Toronto Press. (1st edition 1989.)

Goad, Heather. 2011. The representation of sC clusters. In *The Blackwell companion to phonology*, ed. by Marc van Oostendorp, Colin Ewen, Elizabeth Hume, and Keren Rice, 898-923. Oxford: Wiley-Blackwell.

Goad, Heather. 2012. *s*C clusters are (almost always) coda-initial. *The Linguistic Review* 29:335-373.

Goad, Heather, and Akiko Shimada. 2014a. In some languages, /s/ is a vowel. In *Supplemental Proceedings of the 2013 Meeting on Phonology*, ed. by John Kingston, Claire Moore-Cantwell, Joe Pater, and Robert Staubs. Available at http://journals.linguisticsociety.org/proceedings/index.php/amphonology/

Goad, Heather, and Akiko Shimada. 2014b. Syllabification in Blackfoot with an emphasis on /s/. Ms., McGill University.

Goldsmith, John. 1990. *Autosegmental and metrical phonology.* Oxford: Blackwell.

Hayes, Bruce. 1981. *A metrical theory of stress rules.* Doctoral dissertation, MIT, Cambridge, MA.

Hayes, Bruce. 1989. Compensatory lengthening in moraic phonology. *Linguistic Inquiry* 20:253-306.

Harris, James. 1983. *Syllable structure and stress in Spanish.* Cambridge, MA: MIT Press.

Harris, John. 1997. Licensing inheritance: An integrated theory of neutralisation. *Phonology* 14:315-370.

Hulst, Harry van der. 1984. *Syllable structure and stress in Dutch.* Dordrecht: Foris.

Hyman, Larry. 1985. *A theory of phonological weight.* Dordrecht: Foris.

Itô, Junko. 1986. *Syllable theory in prosodic phonology.* Doctoral dissertation, University of Massachusetts, Amherst.

Kaye, Jonathan. 1992. Do you believe in magic? The story of s+C sequences. In *SOAS Working Papers in Linguistics* 2:293-313. London: SOAS, Department of Linguistics.

Keating, Patricia. 1988. Underspecification in phonetics. *Phonology* 5:275-292.

Letterman, Rebecca. 1997. *The effects of word-internal prosody in Sinhala.* Doctoral dissertation, Cornell University, Ithaca, NY.

Murray, Robert W., and Theo Vennemann. 1983. Sound change and syllable structure in Germanic phonology. *Language* 59:514-528.

Pellard, Thomas. 2009. *Ōgami : éléments de description d'un parler du sud des Ryūkyū.* Doctoral dissertation, CNRS, Paris.

Piggott, Glyne. 1995. Epenthesis and syllable weight. *Natural Language & Linguistic Theory* 13:283-326.

Qu, Chen. 2011. Prosodic licensing, elaboration of segmental structures and child consonant harmony. In *Proceedings of 2011 Annual Conference of the Canadian Linguistic Association (CLA-ACL 2011)*, ed. by Lisa Armstrong. Available at http://homes.chass.utoronto.ca/~cla-acl/actes2011/Qu_2011.pdf

Rose, Sharon. 1996. Variable laryngeals and vowel lowering. *Phonology* 13:73-117.

Steriade, Donca. 1982. *Greek prosodies and the nature of syllabification.* Doctoral dissertation, MIT, Cambridge, MA.

Vaux, Bert, and Andrew Wolfe. 2009. The appendix. In *Contemporary views on architecture and representations in phonology*, ed. by Eric Raimy and Charles Cairns, 101-143. Cambridge, MA: MIT Press.

Wright, Richard. 2004. A review of perceptual cues and cue robustness. In *Phonetically based phonology,* ed. by Bruce Hayes, Robert Kirchner, and Donca Steriade, 34-57. Cambridge: CUP.