The Icelandic sonority hierarchy: evidence from coda phonology[1]

William Brecht Welch
University of Florida

Icelandic syllables exhibit complex phonotactics such as epenthesis, glide deletion, morphophonemic alterations, and consonant deletion driven by both well-formedness and sonority contact constraints. Until recently, Icelandic codas have received modest attention in the literature, so that a complete sonority hierarchy accounting for all Icelandic phonemes is still unavailable. Using coda phonology and lenition processes, I attempt to offer a more comprehensive description of Icelandic's sonority hierarchy, incorporating the often neglected fricatives. The analysis shows some interesting parallels between coda phonotactics and those found in the onset.

1 Introduction

Icelandic syllables exhibit complex phonotactics such as epenthesis, glide deletion, morphophonemic alterations and consonant deletion driven by sonority contact constraints. Until recently, Icelandic codas have received modest attention in the literature, so that a complete sonority hierarchy, one accounting for all Icelandic phonemes, is still unavailable. By using coda lenition processes, I attempt to offer a more comprehensive, ranked diagram of the Icelandic consonant hierarchy, incorporating the often unaccounted fricatives which previous researchers have either neglected or been unable to rank.

A comprehensive sonority scale accounting for as many Icelandic phonemes as possible is an essential task to understanding the phonology of Icelandic; processes such as vowel epenthesis, coda devoicing, and preaspiration all interact, in one way or another, with sonority constraints. A clearer understanding of how sonority is structured in Icelandic should prove valuable for future studies of its phonology and, possibly, the larger Scandinavian family.

In *The Phonemics of Modern Icelandic* (1958), Einar Haugen provides a corpus of Icelandic word formations along with his empirically based assessments of the data. Expanding upon his work, I have rearranged his tables to reflect more recent discoveries in Icelandic phonology and sonority hierarchies.

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Out of this rearrangement comes unanticipated, highly structured patterning within the Icelandic system – patterns which Haugen's illustrations previously did not capture.

This paper is organized as follows: Section 2 discusses work done by both Baertsch (1998) on Icelandic onsets by factoring constraint combinations via local conjunction and Árnason on sonority interactions on vowel quantity. In section 3, I discuss Haugen's (1958) corpus of Icelandic words and the resulting patterns from reorganizing his data. In Section 4, I discuss what the reorganized data demonstrates about Icelandic. In Section 5, I demonstrate how Prince and Smolensky's (1993) Optimality Theory (OT) can account for the Icelandic sonority system. Finally, Section 6 addresses areas for future research.

2 Sonority scales used by Baertsch (1998) and Árnason (1998)

In an earlier study, Baertsch (1998) explains how Icelandic consonant clusters are parsed in onset and intervocalic positions via local conjunction of sonority constraints (using peak and margin hierarchies). In her study, she establishes the following sonority hierarchy (from most sonorous to least) (Baertsch, p. 8):

Figure 1

[j] > [v] > [r] > [l] > [n] > [m] > -tense obstruent > +tense obstruent

In Icelandic, the "-tense obstruents" are the unaspirated, voiceless stops [p], [t], and [k] (orthographic *b*, *d*, and *g*, respectively), while the "+tense obstruents" are the aspirated, voiceless stops [p^h], [t^h], and [k^h] (orthographic *p*, *t*, and *k*, respectively). Although Baertsch successfully accounts for the sonority variations between stop consonants and glides, she does not address the status of Icelandic fricatives [f], [ð], [θ], [s], [x], or [ɣ], nor their status in the hierarchy since the fricatives mentioned above (excluding [f]) play no critical role in parsing intervocalic consonant clusters. Baertsch does, however, demonstrate that Icelandic onsets require a minimum sonority difference of +2 between members of the complex onset. In Section 4, I show that constraints in the coda share interesting parallels with Baertsch's findings.

Earlier work by Kristján Árnason (1998) makes use of an Icelandic sonority scale that is a "rough classification" (footnote, p. 17) placing the Icelandic fricatives in a position of less sonority than nasals and more sonorous than the lax (voiced) consonants (figure 1, p. 17):

Figure 2

Below in section 3, I argue that consonants have more complex relationships within the sonority hierarchy than previously thought, as in the case of Árnason's scale above. My arguments are based on language patterns, phonetic articulations of Icelandic consonants, the need to preserve sonority sequencing within the syllable, and the patterning of well-formed Icelandic outputs.

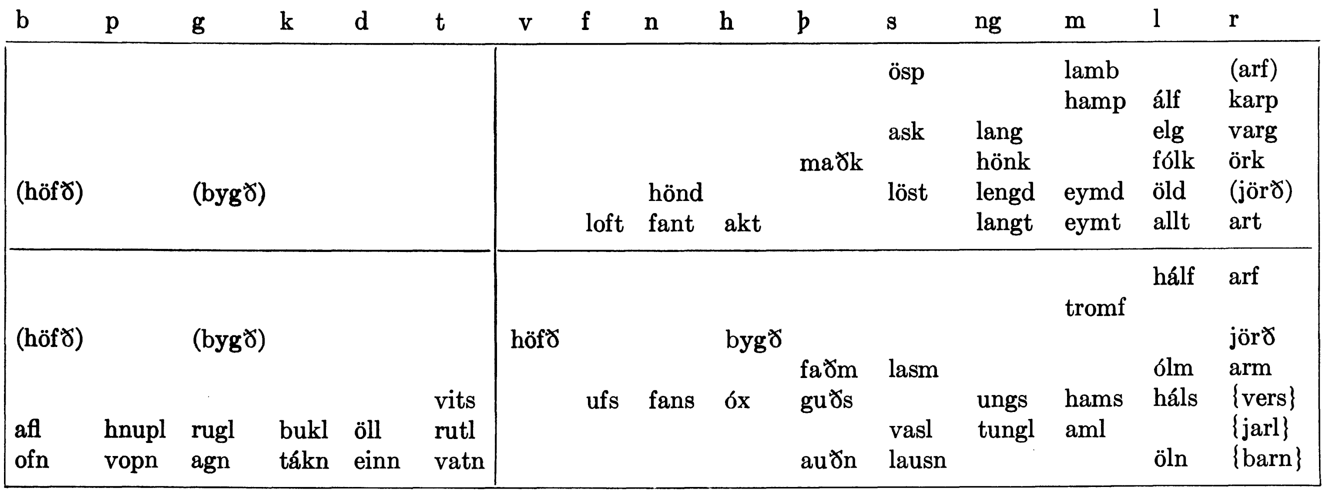
3 Previous phonemic work by Haugen

In *The Phonemics of Modern Icelandic* (1958), Haugen provides a comprehensive listing of Icelandic word formations along with empirically based assessments of the data. One such example is a listing of possible coda combinations given below as Figure 3 (table 3, p. 81). Expanding upon his work, I rearranged Haugen's table below (Figure 4) to reflect more recent theories of sonority constraints.

Once rearranged, Haugen's data show surprising patterns which had been obscured by their original arrangement. Haugen's table appears to be somewhat chaotic as the consonants are organized with only stops separated from continuants. Haugen lists words such as *höfð* and *bygð* parenthetically as they appear to have alternate pronunciations among the various Icelandic communities. The set of words in curly brackets at the bottom right portion of the table are limited to careful pronunciation; the trilled [r] drops out before an [s] or becomes a [d″] before [l] or [n] (Haugen, p. 79).

Bearing in mind recent theories of sonority processes, I rearranged the consonants into what is now Figure 4 according to Baertsch's and Árnason's consonant hierarchies. The end result yielded highly patterned data. For the sake of clarity and precision, I had to make some adjustments. Haugen uses [h] to stand for the voiced and voiceless velar fricatives [ɣ] and [x], so I replaced [h] with its velar equivalent as the situation dictated. The consonants have been rearranged according to a [cvc_1c_2] pattern (for example, [fan_1t_2]). Columns and rows symbolize outputs, while words are written in their underlying forms; for instance, /hálf/ is placed at the intersection of the C_1 [l]-column and the C_2 [v]-row because the output [halv] contains an [l] and a [v] in those positions. The shaded areas of the graph show the intersection of consonants with a sonority difference of 0 (as modeled in Baertsch's work on local conjunction).

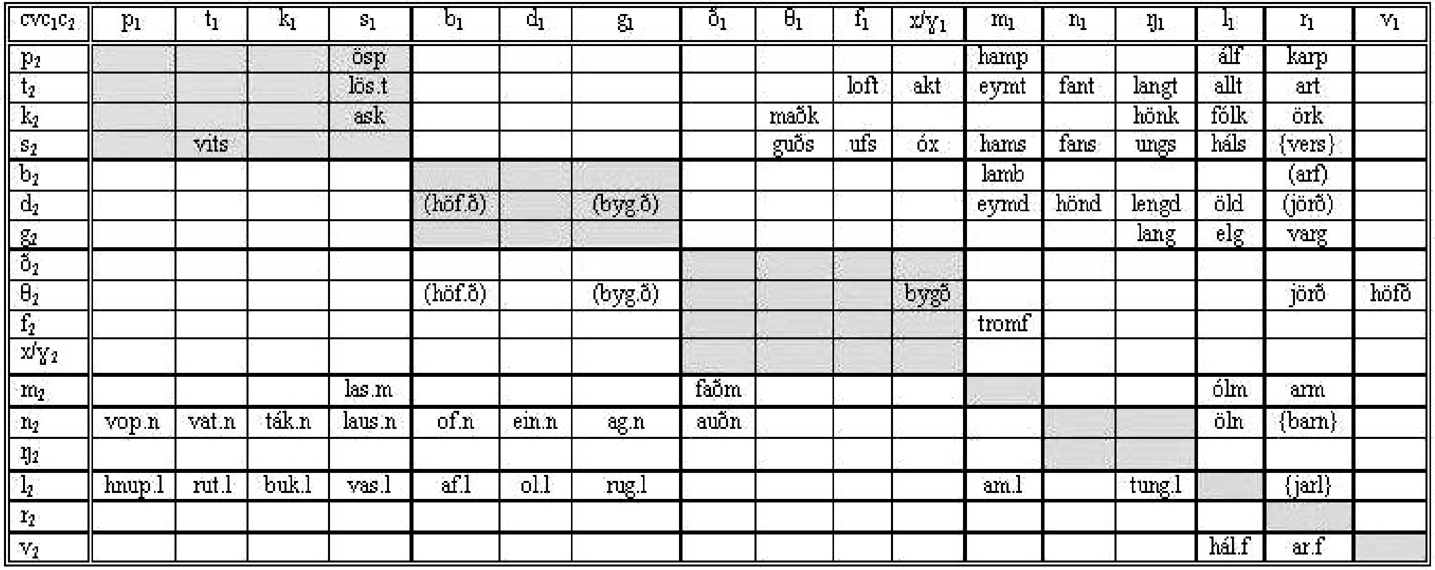
The bold lines separate consonant families assigned with varying values of sonority. Baertsch, for example, showed that [m] is less sonorous than [n].



b	p	g	k	d	t	v	f	n	h	þ	s	ng	m	l	r	
											ösp		lamb		(arf)	b
													hamp	álf	karp	p
											ask	lang		elg	varg	g
										maðk		hönk		fólk	örk	k
(höfð)		(bygð)						hönd			löst	lengd	eymd	öld	(jörð)	d
							loft	fant	akt			langt	eymt	allt	art	t
														hálf	arf	v
													tromf			f
(höfð)		(bygð)				höfð			bygð						jörð	þ
										faðm	lasm			ólm	arm	m
					vits		ufs	fans	óx	guðs		ungs	hams	háls	{vers}	s
afl	hnupl	rugl	bukl	öll	rutl						vasl	tungl	aml		{jarl}	l
ofn	vopn	agn	tákn	einn	vatn					auðn	lausn			öln	{barn}	n

TABLE 3. SEQUENCES OF NUCLEAR AND POSTNUCLEAR CONSONANTS (-C_nC_2)

Figure 3 – Haugen's original table showing possible (-C_1C_2) coda combinations



cvc_1c_2	p_1	t_1	k_1	s_1	b_1	d_1	g_1	$\eth_1$	θ_1	f_1	x/γ_1	m_1	n_1	ŋ_1	l_1	r_1	v_1
p_2				ösp								hamp			álf	karp	
t_2				lös.t						loft	akt	eymt	fant	langt	allt	art	
k_2				ask					maðk					hönk	fölk	örk	
s_2		vits							guðs	ufs	óx	hams	fans	ungs	háls	{vers}	
b_2												lamb				(arf)	
d_2					(höf.ð)		(byg.ð)					eymd	hönd	lengd	öld	(jörð)	
g_2														lang	elg	varg	
$\eth_2$																	
θ_2					(höf.ð)		(byg.ð)				bygð					jörð	höfð
f_2												tromf					
x/γ_2																	
m_2				las.m				faðm							ólm	arm	
n_2	vop.n	vat.n	ták.n	laus.n	of.n	ein.n	ag.n	auðn							öln	{barn}	
ŋ_2																	
l_2	hnup.l	rut.l	buk.l	vas.l	af.l	ol.l	rug.l					am.l		tung.l		{jarl}	
r_2																	
v_2															hál.f	ar.f	

Figure 4 – Rearrangement of Haugen’s Table 3 showing sonority groupings

Rearranged as Figure 4, Haugen's data shows two major divisions. The gray diagonal line down the middle represents a sonority difference of -2 in the coda. For ease, I call this division the 'sonority line'. Words below the sonority line are parsed as bisyllabic, while words above the sonority line are mono-syllabic. There are, however, some notable exceptions – as in the words *faðm* and *auðn* which have monosyllabic outputs appearing *below* the sonority line.

As mentioned before, Baertsch does not include fricatives in her sonority distance constraints and Árnason admits that his sonority scale is "a very rough classification of the Icelandic consonant system" (footnote, p. 17). Is it possible that some members the Icelandic fricative class [f, ð, θ, x, ɤ] are defined along more complex lines other than [+fricative] by the phonology, the same way the stop consonants are divided into feature classes based on voicing? (note that Icelandic "v" is not a fricative but a labiodental *approximant*, hence its high sonority ranking). The data suggests that Icelandic does in fact impose other sonority distinctions among some members of the fricative class.

The most obvious oddity in Figure 4 is the presence of *faðm* and *auðn* below the sonority line. According to the general pattern found in the table, one would likely expect these forms to be bisyllabic *[.auð.n.], since the C_1 consonant is, according to Figure 4, less sonorous than the C_2 consonant. Of course, since the surface forms [*.faðm.*] and [*.auðn.*] surface monosyllabically and unaltered, it is likely they do not violate any phonological constraints.

4 Regraphing the data

Figure 5 reflects the ranking [n] < [θ] < [ð] (I motivate ranking [θ] < [ð] in section 4.2). Note that, for clarity, I have removed some of the less relevant data such as carefully pronounced words, the colloquial pronunciations of *höfð* and *bygð* (indicated by parenthesis in Haugen's work), the [s] sections due to the 'troublesome s' phenomenon ([s] is often 'immune' to sonority restrictions across languages), and the loanword *tromf* (Haugen, p. 79) from Figure 4[2]. The colloquial pronunciations, on the other hand, do reveal that across Icelandic dialects, constraints on possible sonority sequences, and perhaps sonority hierarchies, vary among the dialects (see section 6 for further discussion).

The 'peculiarity' of monosyllabic forms grouping with those that are bisyllabic should be redressed. In order to maintain the patterns of sonority in Icelandic while, at the same time, accounting for the apparent higher sonority value of [ð] over [n] (and according to constraint conjunction, over [m]); [ð] should be ranked higher in the sonority scale than [n]; doing so, groups *faðm* and *auðn* with the rest of the monosyllabic outputs. I have also ranked the interdentals [θ] and [ð] below [r] given the data [.jörð.] (assuming sonority sequencing within the coda, [r] must be more sonorous than [ð]). I did not, however, rank [θ] or [ð] above [l] since (1) the data is missing and (2) if I did, there would be no obvious difference in the hierarchy. I have done as little 'shuffling' as possible to avoid any unmotivated rankings.

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[2] Haugen does not mention what dialects these 'colloquialisms' come from.

cvc_1c_2	p_1	t_1	k_1	b_1	d_1	g_1	f_1	x/γ_1	m_1	n_1	ŋ$_1$	θ_1	ð$_1$	l_1	r_1	v_1
p_2									hamp					álf	karp	
t_2							loft	akt	eymt	fant	langt			allt	art	
k_2											hönk	maðk		fólk	örk	
b_2									lamb							
d_2									eymd	hönd	lengd			öld		
g_2											lang			elg	varg	
f_2																
x/γ_2																
m_2													faðm	ólm	arm	
n_2	vop.n	vat.n	ták.n	of.n	ein.n	ag.n							auðn	öln		
ŋ$_2$																
θ_2								byg.ð							jörð	höfð
ð$_2$																
l_2	hnup.l	rut.l	buk.l	af.l	ol.l	rug.l			am.l		tung.l					
r_2																
v_2														hál.f	ar.f	

Figure 5 – New ranking of [n] < [θ] < [ð]

4.1 Findings

Using Figure 5, I redrew Árnason's original figure provided as Figure 2. The new sonority hierarchy is provided below from most sonorous to least, their sonority values, and their rankings according to distinctive feature class (see section 4.2 for an explanation of why [ð] > [θ]):

Figure 6

high sonority ↔ low sonority

j	>	v	>	r	>	l	>	ð	>	θ	>	n	>	m	>	f, x, ɤ	>	b, d, g	>	p, t, k, s
11		10		9		8		7		6		5		4		3		2		1

approximants > *liquids* > *interdentals* > *nasals* > *fricatives* > *voiced consonants* > *voiceless consonants*

Any word appearing below the sonority line is bisyllabic. Outputs may occur below the sonority line if the C_2 consonant is more sonorous than the previous C_1 consonant. Since a coda with rising sonority violates sonority sequencing, the C_2 consonant may be parsed monosyllabically if its minimum sonority value is ≤ 5 (accounting for the presence of monosyllabic [n] and the absence of monosyllabic [m]); for example, *rugl* 'non-sense' [rug$_1$l$_2$] → [.(rug$_1$).(l$_2$).].

Outputs above the sonority line have a sequence of consonants whose sonority difference is negative (i.e. falling). This occurs when the C_1 consonant is more sonorous and the final C_2 consonant.

Any input occurring within the gray boxes undergoes some phonological process to resolve the output either above or below the sonority line. There are two possibilities: (1) if the C_2 consonant is ≤ 5, the C_1 consonant may decrease in sonority (possibly becoming a stop) while the C_2 consonant gets parsed monosyllabically (as in /einn/ → [.(eid).(n).] 'one'), or (2) the C_1 consonant will *increase* in sonority (with respect to C_2) causing the word to appear above the sonority line (as in /djúpt/ → [.(djúft).]). Haugen, does not include *djúpt* 'soup plate' in his original table; I offer it here because it serves as a good example of a C_1 coda consonant undergoing lenition. Figure 5 also demonstrates that Icelandic codas require a minimum sonority distance of –2 between consonants as outputs are never found within sections adjacent (i.e. –1) to the sonority line, forming a type of one column 'buffer' zone between occupied sections and the sonority line[3].

As a point of interest, Baertsch (1998) has previously demonstrated that Icelandic onsets also require a minimum sonority difference of +2 within onset

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[3] There is one exception; *arf* [ar.v]/[.arv.]. I was unable to locate its correct syllabification or find it in any dictionary. Given its high degree of coda sonority, I do not consider it to be a good counterexample compared to the stronger patterns of the data.

structures, "[w]ord-initially, the onset cluster inventory of Icelandic is relatively straightforward. Any potential cluster separated by a sonority distance of at least two will surface" (p. 9). Sonority sequencing in Icelandic syllable margins appear to have the same restrictions applying in both onset and coda positions; well-formedness constraints appearing to mirror one another at the syllable edge.

4.2 Interdentals

By ranking the interdentals above the nasals, the data becomes more consistent as monosyllabic [*.faðm.*] and [*.auðn.*] now appear above the sonority line along with all other monosyllabic words.

The articulation of the Icelandic interdentals further supports their high ranking within the sonority hierarchy. As Einarsson (1945) notes in his well-known grammar, *Icelandic: grammar, texts, glossary*, the expression of the Icelandic interdental is more 'relaxed' than their English counterparts (p. 13). The [ð] and [θ] usually do not make contact with the teeth even in rapid speech and could better be defined as 'inter-dental approximates', as contact is minimal compared to other fricatives such as [f] and [x]. It is reasonable to assume, therefore, that the interdentals are the most sonorous members of the fricative class; their sonority values being higher than any of the other fricatives [f], [x], or [ɤ].

All data shows a sonority distance of –2 in the coda position. If the two interdentals are not ranked with respect to one another, then the sonority difference between the voiced interdental [ð] and the nasal [n] in *auðn* is –1. Ranking [ð] above the voiceless [θ] keeps to the overall –2 patterning of the data. Phonetically speaking, voiced forms are, by their nature, more sonorous than their voiceless counterparts. Moreover, ranking [ð] > [θ] does not pose any major problems nor is it a deciding factor between other coda interactions.

Another column from which data are missing is [x/ɤ]. As I have no data to justify the separation of the two phones [x] and [ɤ] from one another, so they are left within the same column. It is likely, however, that there is no separation necessary as [ɤ] and [x] are allophones of the stops /g/ and /k/, respectively. While the stops undergo lenition to satisfy sonority restrictions in output forms, the voicing of [ɤ] and [x] is based on assimilation from neighboring consonants. I find it unlikely that sonority restrictions within the language would place some type of quantitative value (like those in the sonority scale) on output forms whose ultimate surface structure is largely based on the phonetic environment. If, however, some data were to suggest otherwise, it is fair to say that the voiced phone [ɤ] would likely be ranked higher in the hierarchy than [x].

5 Optimality Theory

Sonority interactions in Figure 5 can be captured in Prince and Smolensky's Optimality Theory (OT) framework (1993). Icelandic places two well-formedness constraints on potential outputs; a local conjunction constraint to 'factor' the sonority differences between coda consonants, described as SON = -2 below, and a constraint requiring monosyllabic syllables to have a minimum sonority value of ≤ 5, SYL-CON [5]:

SON = -2	*sonority differences in coda must be "greater" than (i.e. more negative) or equal to –2*
SYL-CON [5]	*a syllabic consonant must have a sonority value ≤ 5* (allows syllabic [n], [θ], [ð], [l], [r] and [v])
SON-SEQ	*complex onsets rise and complex codas fall in sonority* (Kager, 1999)
IDENT-IO [F]	*Corresponding segments have identical values for feature [F]* (Kager, 1999)
IDENT-IO (WD FINAL, F)	*all underlying feature values [F] in the word-final segment must surface in the output*

SYL-CON [5] rules against any syllabic consonants like [t] or [m], but allows more sonorous consonants to be parsed as monosyllables. The presence of the markedness constraint, Sonority Sequencing (SON-SEQ), as defined by Kager (1999), is justified from coda patterns in the data. This constraint drives words appearing in the gray boxes to either side of the sonority line (i.e. rules against complex codas with 0 sonority derivation, as in *[einn]). Barring [s], if any rises occur within the coda, the final output is either bisyllabic or C_1 experiences an increase in sonority; there are no examples where SON-SEQ is violated (see footnote 3). Evidence from both onsets (Baertsch) and codas suggest that SON-SEQ is undominated. I have included low ranked IDENT-IO [F] to show that SON = -2, SYL-CON [5], and SON-SEQ dominate some generic Faithfulness constraint. IDENT -IO (WD FINAL, F) accounts for the absence of any feature changes to word-final consonants. If a word-final consonant satisfies SYL-CON [5] but violates SON-SEQ, then it can be parsed monosyllabically; otherwise, C_1 is obligated to increase its sonority. Alternatively, the C_2 consonant *could* increase its sonority in an effort to satisfy SYL-CON [5] and, thus, would be parsed in its own monosyllable. Of course, there is not one instance in the data of C_2 increasing its sonority due to the coda conditions placed by sonority sequencing. As a result, I have ranked IDENT-IO (WD FINAL, F) to be undominated.[4]

A sample derivation of a monosyllabic word is provided below in Tableau 1. The underlying form /akt/ violates SON-SEQ, so another output candidate must be found. Trying to make the C_1 consonant *slightly* more

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[4] There is the case of /half/ → [.hal.v.]. The underlying form *half* does not violate the –2 coda rule. The word-final [f] changes due to voicing assimilation; once this occurs a bisyllabic parsing must result.

sonorous violates SON = -2 but satisfies SON-SEQ as the sonority difference in the coda of *[.agt.] is only –1. If the C_2 consonant rises in sonority, a violation of IDENT-IO (WD FINAL, F) will occur barring a bisyllabic parsing. Any parsing of the [t] into a mono-syllable to satisfy SON-SEQ violates SYL-CON [5].

Tableau 1 /akt/ → [.axt.]

/akt/	SON-SEQ	SYL-CON [5]	SON = -2	IDENT-IO (WD FINAL, F)	IDENT-IO [F]
[.akt.]	*!		*		
☞ [.axt.]					*(manner)
[.ak.t.]		*!			
[.ak.θ.]				*!	**(place, manner)
[.agt.]			*!		*(voice)

Tableau 2 shows the parsing of a bisyllabic word. SON-SEQ rules out a monosyllabic parsing of the underlying form, so it becomes parsed as two syllables as [l]'s sonority value is 8, satisfying SYL-CON [5]. The faithfulness constraints rule out any unnecessary changes to the consonant forms.

Tableau 2 /aml/ → [.am.l.]

/aml/	SON-SEQ	SYL-CON [5]	SON = -2	IDENT-IO (WD FINAL, F)	IDENT-IO [F]
[.aml.]	*!		*		
☞ [.am.l.]					
[.amt.]				*!	**(manner, voice
[.ap.l.]					*!*(manner, voice)
[.avl.]					*!*(place, manner

6 Areas for further research

There is, however, the issue of /öll/ → [(öd).(l).]. There are many instances of C_1 consonants decreasing their sonority within the bisyllabic parsing. In the cases of [.(öd).(l).] and [.(eid).(n).], the change could be motivated by the Obligatory Contour Principle; other examples, however, offer no such motivation /afl/ → [.(ab).(l).]. For cases like [.ab.l.], it appears that a constraint preferring the lowest possible sonority is active in the coda – the challenge is anticipating what the final, lowest-sonority consonant will be.

There are also the colloquial instances of /höfθ/ → [.(höb).(d).] and /bygð/ → [.(byg).(d).]. These examples violate sonority conditions such as SYL-CON [5] and the faithfulness constraints IDENT-IO (WD FINAL, F) and IDENT-IO. My analysis cannot take the colloquial (i.e. non-Reykjavík) dialects into consideration given the lack of available data from Haugen (1958) and other sources – not to mention the problem of knowing *which* examples are from *what* dialects. It is reasonable, in light of the examples like [.(byg).(d).], to speculate that restrictions on what constitutes a well-formed monosyllable are more 'lenient' in the colloquial dialects than in the standard, Reykjavík dialect discussed in this article. In this case, the constraint SYL-CON [5] would be SYL-CON [2].

7 Conclusion

My work attempts to offer a more complete sonority hierarchy for Icelandic based on evidence from coda phonology. The interdentals show unique distribution patterns within the syllable when compared to the other consonants in the fricative class. Evidence from coda phonology demonstrates that the interdentals should not only be treated as more sonorous than the other members of the fricative class, but also the nasal class as well.

Evidence from coda phonology also supports previous work done by Baertsch (1998). Using local conjunction, Baertsch was able to demonstrate that onsets in Icelandic require a +2 sonority difference between consonants in the onset. I also demonstrate that complex codas require a –2 sonority difference between members of the coda. These findings also suggests that well-formedness conditions within the greater syllable structure are operating at syllable margins, thus onsets and codas restrictions mirror one another.

For future research, an analysis capable of predicting how a low-sonority consonant is selected against violations of Faithfulness could prove helpful. Some investigation of 'colloquial' Icelandic dialects may offer some interesting comparisons.

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William B. Welch
welch1@ufl.edu