Final devoicing of /l/ in Reykjavík Icelandic

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Abstract

Icelandic has a phonological process which devoices sonorants after voiced segments in domain-final position, but to date the category of the relevant domain and potential further factors affecting it have not been identified. The present paper studies final devoicing of /l/, by which /l/ is realized as the voiceless lateral fricative [ɬ] in domain-final position. It reports on the results of an experimental reading study designed to test the exact environments of this process and the implications for a prosodic hierarchy for Icelandic. The results suggest that devoicing of /l/ is bound by the prosodic utterance. All instances of /l/ were devoiced in utterance final position. Within the utterance, final devoicing is optional, but the frequency of its application reflects the syntactic and prosodic hierarchy such that it is most frequent at a clause/an IP-boundary, significantly less frequent at a syntactic XP-edge and it almost never occurs within a syntactic XP.

Index Terms: final devoicing, sonorant devoicing, Icelandic, prosodic hierarchy, /l/

1. Introduction

Icelandic has a phonological process which devoices sonorants "after voiced segments in phrase-final position" [1]. According to [2], this process is very common in modern Icelandic speech, indicates a break in the utterance and the end of a phonological phrase or utterance, and is likely to co-occur with a boundary tone (T%). According to [3], "phrase final devoicing in consonants is […] practically obligatory". The devoiced /l/ is phonetically realized as voiceless lateral fricative (rather than, for example, devoiced lateral approximant, e.g. [3]). Examples are given in (1) (from [4]).

(1) a. Jón er á bíl   í dag.
         ['pi:l]
         Jón is on car   today ('John is driving today.')

     b. Jón er á bíl.
         ['pi:ɬ]

While this process has been described, for example, in the works mentioned above, its distribution has never been studied systematically and formulations such as "the end of (some sort of) a phonological phrase or utterance" [2] are very vague. At the same time, a prosodic hierarchy has not yet been established for Icelandic. For the level of the Intonational Phrase (IP), it has been observed that the tonal inventory of Icelandic has two boundary tones terminating the IP (L% and H%) and that the IP is the domain for declination ([5], [6]). As for a level between the prosodic word (PWd) and the IP (e.g. phonological phrase, intermediate phrase; see [7] for an overview of hierarchies suggested in the literature), conclusive evidence has not yet been provided. To date there is only preliminary evidence from the environment of another phonological process (word-final vowel deletion, see [8]) as

well as preliminary evidence for phrase accents L- and T-, i.e. the edge tone of the intermediate phrase (see [6]), but more systematic research is necessary, especially regarding tonal events. The blocking and/or application of phonological processes have long been taken as evidence for the existence of categories in the prosodic hierarchy; e.g. Visarga in Sanskrit for Utterance level (see [9]), Italian Gorgia Toscana for IP level and Raddoppiamento Sintattico for ip level (see [10] for the latter two) to name but a few. The present paper reports on an experiment designed to test the environment of final devoicing of /l/ in Icelandic and the implications for a prosodic hierarchy in Icelandic.

2. The experiment

A reading task was designed to produce data on final /l/ in different positions. Four contexts were considered: utterance-final, clause-final, XP-final and XP-internal. The clause-final context was chosen because according to current prosodic theory, a clause in the syntactic structure is predicted to coincide with an IP in the prosodic structure (see [11], [12]). Similarly, the XP-final context was chosen because an XP in the syntactic structure is predicted to coincide with an ip in the prosodic structure ([11], [12]). Neither IP- nor ip-boundary are predicted to occur XP-internally. Since a prosodic hierarchy has not yet been established for Icelandic on the basis of tonal and/or other kinds of phonological evidence, the target contexts were chosen according to these predictions.

All target words ended in /l/ after a vowel. As a rule, Icelandic word stress falls on the initial syllable. To control for the potential effects of lexical stress, target words were monosyllabic (stress condition) and disyllabic (non-stress condition). To control for the potential effect of the following segment and voicing assimilation, the target words were followed by vowels (voiced condition) or by voiceless fricatives (/s, f, θ/) and in two cases voiceless plosives (/p, t/) (voiceless condition). Example target words and some following units are given in Tables 1 and 2.

	Example target words
mono-syllabic	kál (/ˈkʰau:l/ 'cabbage', ACC-Sg)
	stól (/ˈstou:l/ 'chair', ACC-Sg)
di-syllabic	blómkál (/ˈplou:m. kʰau:l/ 'cauliflower', ACC-Sg)
	viðtal (/ˈvɪð.tʰal/ 'interview', ACC-Sg)

Table 1. *Example target words.*

	Example words following target
voiced	en ('but'), í ('in')
	ömmu ('grandmother', GEN-Sg)
voiceless	sem (Rel-Prn), frá ('from')
	systur ('sister', GEN-Sg)

Table 2. *Examples of words following target words.*

Given that final devoicing has been described as indicating a clear break in the utterance and that a boundary tone has been considered likely to co-occur with final devoicing (see [2]), the predictions with respect to position were as follows:

- Final devoicing occurs, and is likely to be obligatory, at the end of an utterance.
- Final devoicing occurs, and is likely to be obligatory, at the end of an IP, i.e. at the end of a clause in the syntax.
- Final devoicing may occur, if bounded by a level between PWd and IP, at the end of a syntactic XP, specifically between object and adjunct, a position likely to coincide with a phonological phrase boundary in prosodic structure.
- Final devoicing does not occur XP-internally, a position likely to correspond to a PWd boundary in the prosodic structure and not a position where a break in the utterance would be expected.

2.1. Materials

The experiment considered three factors: position (4 levels: utterance-final, clause-final, XP-final, XP-internal), stress on the target syllable (2 levels: stressed, unstressed) and voicing of the following sound (2 levels: voiced, voiceless). Overall, 56 sentences were created, fourteen of which are given in (2) through (5) as examples. Eight sentences had the target word in utterance-final position; of these, four target words were mono-syllabic (see (2)a), and four disyllabic (see (2)b). Sixteen sentences had the target words in clause-final position; eight (four monosyllabic, four disyllabic) were followed by voiced segments, eight (four monosyllabic, four disyllabic) by voiceless segments; see (3) for examples. Sixteen sentences had the target words in XP-final position, with the same distribution regarding stress and following segments as in the clause-final condition (see (4)), and sixteen sentences had the target word in XP-internal position, specifically in NP-internal position (see (5)). The sentences were pseudorandomised according to the usual restrictions. Note that the voicing condition only applies to three positions; in utterance-final position, no segment follows the target word ending in /l/.

(2) Target word utterance(U)-final

a. Í gær borðuðum við svínakjöt, kartöflur og kál.
   Yesterday we at pork, potatoes and cabbage.
b. Einu sinni eldaði mamma mín oft blómkál.
   In the past my mum cooked cauliflower often.

(3) Target word clause(Cl)-final

a. [Í gær borðuðum við svínakjöt, kartöflur og kál,]_clause
   [en í dag borðum við fiskisúpu]_clause
   Yesterday we ate pork, potatoes and cabbage,
   and today we ate fish soup.
b. [Í gær borðuðum við svínakjöt, kartöflur og kál,]_clause
   [sem bróðir minn og kærasta hans elduðu fyrir okkur]_clause
   Yesterday we ate pork, potatoes and cabbage,
   which my brother and his fiancé cooked for us.
c. [Einu sinni eldaði mamma mín oft blómkál,]_clause
   [en nú á dögum eldar hún ekki neitt]_clause
   In the past my mum often cooked cauliflower,
   and today she does not cook anything.
d. [Einu sinni eldaði mamma mín oft blómkál,]_clause
   [sem hún keypti á markaðnum í hverri viku]_clause
   In the past my mum often cooked cauliflower,
   which she bought in the market every week.

(4) Target word XP-final

a. Einu sinni elduðum við [kartöflur og kál]_NP [á hverjum degi]_PP
   In the past we ate pork, potatoes and cabbage every day.
b. Á morgun þarf ég að kaupa [kál]_NP [fyrir kjötsúpuna]_PP.
   Tomorrow I have to buy cabbage for the meat soup.
c. Í morgun keypti sambýlismaður minn [blómkál]_NP [í Bónus]_PP
   This morning my flat mate bought cauliflower in Bónus.
d. Í Bónus keypti sambýliskona mín [blómkál]_NP [frá Spáni]_PP
   In Bónus my flat mate bought cauliflower from Spain.

(5) Target word XP-internal

a. Mér líkar [kál ömmu minnar]_NP sem hún eldar.
   I like my grandmother's cabbage which she cooks.
b. Mér líkar [kál frænku minnar]_NP sem hún ræktar.
   I like my cousin's cabbage which she grows.
c. Okkur þykir [súrkál ömmu okkar]_NP frábært.
   We think that our grandmother's sauerkraut is great.
d. Okkur þykir [súrkál systur okkar]_NP rosalega gott.
   We think that our sister's sauerkraut is very good.

2.2. Participants, apparatus and procedure

The recordings took place in November and December 2013 in a quiet closed room at the University of Iceland in Reykjavík. The results reported here are based on the recordings of twelve female native speakers of Icelandic. All speakers were from Reykjavík or the greater capital area or had lived there most of their lives. They were between 19 and 35 years of age and volunteered their participation. The participants were seated in front of a laptop computer. The sentences were presented one at a time on the computer screen using Microsoft PowerPoint. Sentences were presented on one line, except for the clause-final condition, where a comma was placed after the target word and a new line was started after the comma to help elicit an IP-boundary. The participants read the sentences at a normal speech rate. All utterances were recorded at a sampling rate of 44100 Hz using a Microtrack II (M-Audio) recorder and Rode NT-5 condenser microphone. The recordings were then edited into individual sound files.

2.3. Data treatment

Overall, the 12 participants produced 672 target sentences (96 utterance-final, 192 clause-final, 192 XP-final, 192 XP-internal). All targets were annotated in Praat ([13]) based on careful inspection of waveform, spectrogram and F0 contour and on perception. In the U-final, XP-final and XP-internal conditions, all utterances were annotated on at least a segmental and a text tier; in the clause-final condition all utterances were additionally annotated on a tone tier to identify boundary tones (T%) at IP-edges in target position (e.g. Figure 3). Boundary tones (L% or H%) occurred in target position in all 192 target sentences produced in the clause-final condition.

As for /l/, three realizations occurred in the data: [l], [ɬ], and [l ɬ], the latter being infrequent (N=14), and mostly produced at a clause boundary (N=11). Based on native speaker perception and articulatory differences between [ɬ] on its own and [ɬ] in an [l ɬ] sequence, [l ɬ] was counted as [l]. The realizations of /l/ as [l] and [ɬ] are illustrated in Figures 1 and 2, respectively, zooming in to the target area.
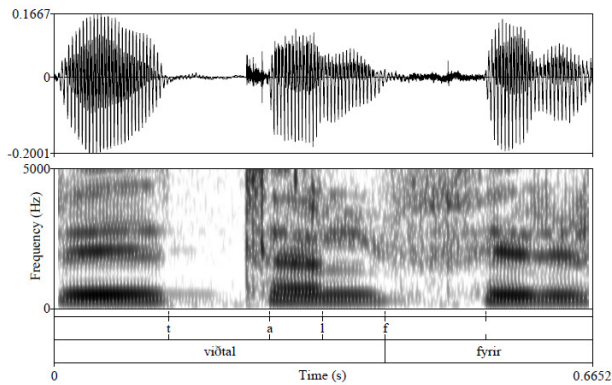
Figure 1: *No devoicing: /l/; Sentence: Blaðamaðurinn tók áhugavert viðtal fyrir Fréttablaðið ('The journalist took an interesting interview for Fréttablaðið.').*
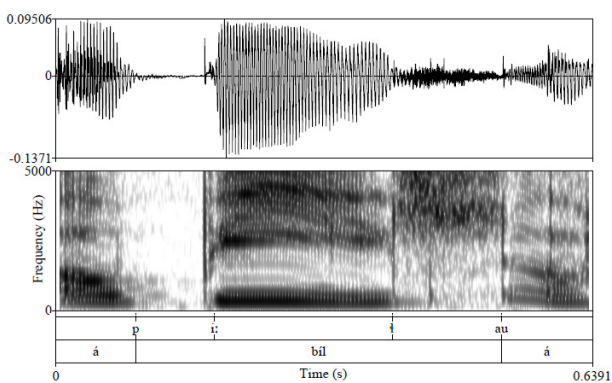

Figure 2: *Devoicing applied: /ɬ/; Sentence: Venjulega eru Jón og Brynja á bíl á sunnudögum. ('Normally Jón and Brynja take the car on Sundays.')*

2.4. Results

The results by position are as follows. First, all 96 final /l/ in utterance-final position (see (2)) were devoiced, i.e. realized as [ɬ]. Second, 126 (66%) final /l/ in clause-final position (see (3)) were devoiced, i.e. realized as [ɬ], 62 (32%) were voiced [l], and four (2%) were unclear. Third, 164 (85%) final /l/ in XP-final position were realized as voiced [l], 22 (12%) were realized as [ɬ], and 6 (3%) were unclear. Finally, XP-internally, 182 (95%) final /l/ were realized as [l], only 6 (3%) were realized as [ɬ] and 4 (2%) were unclear or not realized at all. These results are summarized in Figure 3 and Table 3 below, excluding the unclear cases.

In order to test whether these differences between positions were significant and whether stress on the syllable ending in /l/ and voicing of the following segment also affected devoicing of /l/, the data were analysed statistically. They were coded by position (as in (2)-(5)), stress on the target syllable (stressed, unstressed) and voicing of the following segment (voiced, voiceless). All unclear cases (N = 14) were discarded from the analysis. The data were aggregated by participants and analyzed using a binomial logistic regression model with devoicing ([l] vs. [ɬ]) as the dependent variable and the above-mentioned factors as fixed factors. The analysis showed no effects of stress (p > 0.2, see

Table 4) and no effect of voicing of the following segment (p > 0.12, see Table 5), but a main effect for position. Specifically, there were significantly more [ɬ]-realizations at the end of the utterance compared to the end of the clause (ß = 0.35, SE = 0.15, p < 0.05), which again had significantly more [ɬ]-realizations than target words produced at the end of XPs (ß = -1.90, SE = 0.27, p < 0.0001), which again had significantly more [ɬ]-realizations than target words that occurred within an XP (ß = -0.94, SE = 0.46, p < 0.05). There were no significant interactions between factors.
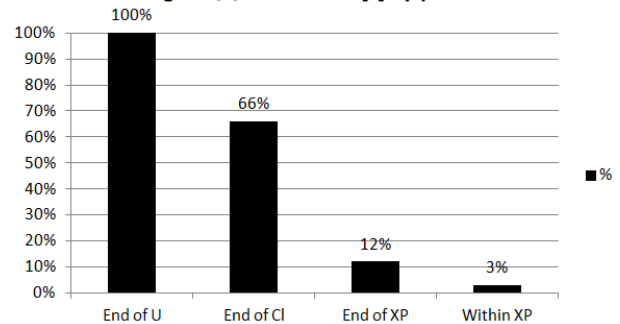
Figure 3: *Results by position*

position	[l]	[ɬ]
1 (U-final)	0	96
2 (Clause-final)	62	126
3 (XP-final)	164	22
4 (XP-internal)	182	6

Table 3. *Cross-tabulation of /l/ according to position and (de)voicing*

	stressed (mono-syllabic)		unstressed (disyllabic)	
position	[l]	[ɬ]	[l]	[ɬ]
1 (U-final)	0	48	0	48
2 (Clause-final)	32	62	30	64
3 (XP-final)	77	17	87	5
4 (XP-internal)	88	6	94	0

Table 4. *Cross-tabulation of /l/ according to position, stress and (de)voicing*

	voiced following segment		voiceless following segment	
position	[l]	[ɬ]	[l]	[ɬ]
1 (U-final)	0	0	0	0
2 (Clause-final)	19	77	43	49
3 (XP-final)	84	10	80	12
4 (XP-internal)	89	6	92	1

Table 5. *Cross-tabulation of /l/ according to position, voicing of the following segment and (de)voicing*

3. Discussion

Final devoicing of /l/ in Reykjavík Icelandic obligatorily marks the end of the utterance (U). It is thus a U limit rule in Nespor & Vogel's [10] sense and seems to resemble in its

distribution other phonological rules which mark the end of a phonological utterance, such as final devoicing in Spanish (see [10]) and in the Chadic language Angas (see [14]), as well as Visarga in Sanskrit (see [9]), although not all of these have been experimentally studied.

The process is frequent but not obligatory at the end of the IP, thus it does not necessarily co-occur with other IP-boundary markers such as boundary tones. To illustrate this, Figure 4 shows an example of [l] produced at the end of IP, clearly co-occurring with H%, a short break of roughly 50 ms, and followed by pitch reset in the following IP, serving as additional evidence for a new IP, given that the IP has been identified as the domain for declination in Icelandic ([5], [6]).
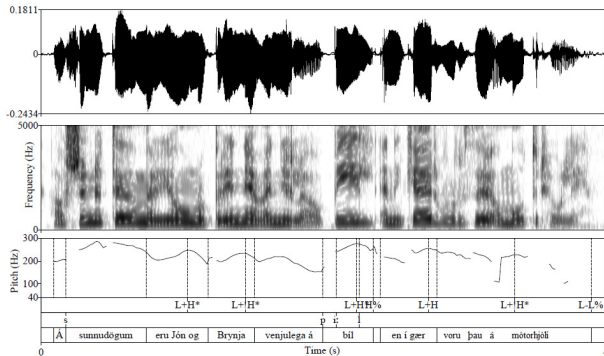

Figure 4: *[l] at IP-boundary; Sentence: Á sunnudögum eru Jón og Brynja venjulega á bíl, en í gær voru þau á mótorhjóli. ('On Sundays Jón and Brynja normally take the car, but today they were by motorbike.')*

Given the statistically significant difference between end of utterance (obligatory application of devoicing) and end of IP (optional application of devoicing, no obligatory co-occurrence with other IP-boundary markers), final devoicing in Icelandic may be taken as evidence for the level of the prosodic utterance in the prosodic hierarchy. Without this level, the difference between the two positions found in the present study cannot be accounted for.

Devoicing of /l/ is clearly disfavored, i.e. does not normally apply, within IP. If there is a level between PWd and IP in the prosodic hierarchy of Icelandic, it does not seem to affect devoicing of /l/. Note that of the 22 /l/ realized as [ɬ] at an XP-boundary, 10 are in the sequence <*bíl til*> ('car to') in the sentence <*Á síðasta ári förum við í bíl til Akureyrar*> ('Last year we drove by car to Akureyri'). Given the sequence /l t/, it is possible that even across a syntactic XP-boundary, it behaves in the same way as the same sequence of sounds word-internally, e.g. in adjectives marked for neuter on a stem ending in –l, cf. *kalt* ('cold', neuter of *kaldur*, stem *kal-*) and *gult* ('yellow', neuter of *gulur*, stem *gul-*), pronounced with devoiced /l/ before /t/ (e.g. [15]). Within XP, devoicing applies even less frequently. However, if the item involving the sequence [*bíl*]NP [*til Akureyrar*]PP is removed from the statistical analysis, the difference between position 3 (XP-final) and position 4 (XP-internal) is not significant anymore ($p > 0.9$). The few remaining instances of [ɬ] at an XP-boundary may be put down to careful articulation or promotion of the prosodic boundary at an XP-edge to IP-level.

The most interesting result is clearly the significant difference between positions 1 (U-final) and 2 (clause/IP-final), given that within IP devoicing is clearly disfavored, and given that the predictions were identical for positions 1 and 2. A factor not included in the experimental design is information structure. All utterances were produced with wide focus. Icelandic has right-most prominence at IP-level (e.g. [5], [16]), thus target words bear nuclear prominence in positions 1 and 2, and prenuclear prominence in positions 3 (XP-final) and 4 (XP-internal), but are never located in post-nuclear position. Given that stress on the target syllable turned out not to be significant, I would not expect the difference between nuclear and prenuclear prominence to be responsible for the clear position effect, and at any rate, it would not explain the significant difference between positions 1 and 2, which are both nuclear. Perhaps the size of the prosodic constituent including the target word may be another factor. However, again, this would not explain the difference between positions 1 and 2, because the size of the target constituents (U, IP) was identical; compare (2) and (3). For the time being, I thus conclude that it is the category of the prosodic constituent (U vs. IP) which is responsible for the obtained effect.

4. Concluding remarks

This paper has shown that final devoicing of /l/ (i.e. realization of final /l/ as [ɬ]) obligatorily marks the end of an utterance in Icelandic and provides evidence for utterance level in the prosodic hierarchy. It is still frequent but not obligatory at the end of an IP. If the prosodic hierarchy of Icelandic has a level between IP and the prosodic word, final devoicing of /l/ is not the process to establish this level, because its application is very infrequent within IP at potential lower level boundaries; the difference between XP-final /l/ and XP-internal /l/ is only marginally significant and disappears when one particular item is removed which may lead to devoicing of /l/ for independent reasons. Future research will have to show whether other phonological processes may help to establish more levels in a prosodic hierarchy for Icelandic. Moreover, it will show whether the results reported here extend to other sonorants which undergo devoicing in word-final position in Icelandic, e.g. /ð, r, ɣ/, and whether utterances in context (e.g. in turn-final position) will behave in the same way as utterances in isolation. Furthermore, only the results for Reykjavík Icelandic have been reported on here, thus future results may reveal regional variation in final sonorant devoicing. Given that Icelandic has phonological dialects (see [17]) and that the voiced vs. voiceless pronunciation of word-internal sonorants (e.g., /l, m, n/ before stops /p, t, k/) is one dialectal feature, it is at least conceivable that dialectal variation extends to final devoicing, too.

5. Acknowledgements

6. References

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