

The timing of nuclear and prenuclear Icelandic pitch accents

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Abstract

Two experiments were designed to test F0 alignment in Icelandic pitch accents with a view to establishing distinct intonational categories. Four conditions were tested: (i) prenuclear accents; (ii) final nuclear accents in broad focus sentences; (iii) final narrow focus; (iv) non-final narrow focus. The results are such that (i) prenuclear accents are signaled by a late rise (L*H), final nuclear accents by an early rise; (ii) peaks in prefinal nuclear accents are aligned earlier than prenuclear peaks, but later than final nuclear peaks, suggesting a boundary effect; (iii) no differences emerged between accents in sentences with broad and narrow focus.

Index Terms: Icelandic, intonation, F0 alignment, prenuclear accent, nuclear accent, focus

1. Introduction

According to previous research, Icelandic has two bitonal pitch accents (H*L and L*H; [1], [2]) and two monotonal pitch accents (H* and L*; [2]), with H*L being the most frequent one. The difference between bitonal and monotonal pitch accents has been argued to be in the timing of the pitch movement after the starred tone, which occurs on the syllable immediately adjacent to the stressed one in bitonal, but not in monotonal accent types ([2]). However, the exact relation between tonal targets on the one hand and segmental material on the other hand has not yet been systematically studied. Moreover, little is known about intonational meaning. According to [2], all four observed pitch accent types may in principle occur in prenuclear and nuclear position, in declarative and interrogative sentences, in neutral utterances and for the marking of narrow focus.

This paper looks more closely at the timing and distribution of Icelandic pitch accents. Focusing on non-(pre-)nuclear accents versus nuclear accents and on nuclear accents in sentences with broad focus and narrow focus, the following environments were tested: (i) prenuclear accents; (ii) final nuclear accents in broad focus sentences; (iii) final narrow focus; (iv) non-final narrow focus.

Quite independently from theoretical frameworks, research in intonation has long established "that intonational distinctions can be conveyed by differences in the way pitch movements are aligned with the segmental string" ([3], p. 169; see [3] also for a survey). For example, F0 alignment in Neapolitan Italian nuclear LH rises distinguishes between yes/no questions and statements (e.g., [4]). In many languages, prenuclear accent peaks are aligned later than nuclear accent peaks (e.g., [5], [6] and [7]). In prenuclear accents, the peak may be aligned in the syllable following the perceptually stressed one (e.g., [5], [8], [9], [10], [11] and [12]). However, the alignment of tonal targets perceptually associated with prenuclear or nuclear accented syllables has been shown to be subject to various factors across languages, among them syllable type/structure, prosodic context, proximity and type of

a following phrasal boundary, pre-nuclear vs. nuclear pitch accents, and speech rate. For example, the alignment of the prenuclear peak in Dutch within or after the stressed syllable is affected by the phonological length of the vowel in the stressed syllable: H is aligned before the offset of a long vowel, but in the next consonant if the vowel is short ([10]). In Egyptian Arabic, H is outside open light (CV) stressed syllables, but just inside open heavy (CVV) and closed (CVC) stressed syllables ([12]). [13] find that H is aligned late in the vowel of an open stressed syllable, but within the coda consonant in closed stressed syllables. Previous research has shown that peak alignment is earlier before a stronger prosodic boundary than before a weaker prosodic boundary (e.g., [5], [14]). At discourse level, peak alignment is earlier in paragraph-final or sentence-final contexts than in paragraph-initial and sentence-initial contexts ([15]). The location of the F0 peak in falling accents may vary according to whether the fall is linked to a neutral contour or a focus contour (e.g., [16]), or in a contrastive focus context vs. a broad focus context ([17]). Alignment and timing characteristics have also been used to decide between bitonal pitch accents on the one hand and a combination of monotonal pitch accent and edge tone on the other hand (e.g., [16], [18]).

Against this background, research questions arising for Icelandic include the following:

- Is there evidence from F0 alignment for differences between non-nuclear (prenuclear) and nuclear accents, and between nuclear accents of different types and in different positions (e.g., broad focus/ narrow focus, prefinal position/ sentence-final position)?
- Can supporting evidence be found for the accent types previously identified: H*L, L*H, H* and L*?
- Based on the evidence from F0 alignment, can other accent types be identified?

2. Method

Two reading studies were designed to produce data on F0 alignment in Icelandic pitch accents occurring in different positions and serving different functions. Pitch accents in non-nuclear position were compared with pitch accents in nuclear position, and pitch accents marking narrow focus were compared with nuclear pitch accents in sentences with broad focus. The alignment of tonal targets was measured against segmental landmarks in stressed initial syllables in words of 3 or 4 syllables. As a rule, Icelandic word stress falls on the first syllable. Target syllables were selected according to the nature of the Icelandic vowel system and syllable structure (see, e.g., [19], [20], and [21]). Generally speaking, all vowels have structurally long and short variants. A basic generalization is that long vowels occur in open syllables, short vowels occur in closed syllables. While long vowels are moraic and are lengthened under stress, short vowels are non-moraic, and cannot be lengthened or carry a regular stress beat. Therefore, short vowels take consonants as complements in the nucleus

([21]). In words with more than one syllable, a single consonant between two nuclei becomes the onset of the second syllable, resulting in an open first syllable with a long vowel. Two or more consonants between vowels are syllabified such that the first consonant closes the first syllable, while the second (and further) consonant(s) form the onset to the second syllable, resulting in a closed first syllable with a short vowel followed by a consonant. Due to these properties of syllabic structure, all primary stressed syllables in Modern Icelandic are heavy and there are no open stressed syllables with short vowels. In the present study, all target syllables were initial syllables of nouns. They were open heavy syllables (CV:) and closed heavy syllables (CVC). All target nouns were embedded in carrier sentences such that they were preceded by an unstressed mono-syllabic preposition in the same phrase. The target syllables and nouns are given in Table 1. Each experiment consisted of three experimental conditions (see below), and each condition was represented by 4 sentences, 2 with CV: target syllables and 2 with CVC target syllables. Examples are given in (1)-(4) below.

syllable type	syllable	carrier nouns
CV:	ma [ma:]	Malasú , malarú
CVC	mor [mɔr]	morgunmat
	man [man]	mandarínur

Table 1. Target syllables and nouns

2.1. Materials: Experiment 1 (Expt 1)

Expt 1 was designed to test 3 conditions: (i) prenuclear accents; (ii) final nuclear accents in broad focus sentences; (iii) final narrow focus. Narrow focus was elicited by a wh-context-question. 6 of 12 items are given in (1)-(3).

- (1) Nuclear accent in final position; broad focus
- a. CV: Icelandair er farið að fljúga til **Malasú**.
'Icelandair has now regular flights to Malaysia.'
- b. CVC Okkur finnst ávaxtasalat best með **mandarínur**.
'We like fruit salad best with mandarines.'
- (2) Nuclear accent in final position; narrow focus
- a. CV: Q: Hvert fór bróðir þinn í frí? ('Where ...?')
A: Bróðir minn fór í frí til **Malasú**.
'My brother goes on holiday to Malaysia.'
- b. CVC Q: Hvers konar köku ætlar þú að koma með?
'What kind of cake ...?'
A: Ég ætla að koma með köku með **mandarínur**.
'I'll bring a cake with mandarines.'
- (3) Prenuclear accent
- a. CV: Icelandair flýgur frá **Malasú** til Reykjavíkur.
'Icelandair has flights to Malaysia.'
- b. CVC Okkur finnst fiskur góður með **mandarínur** og karri.
'We like fish with mandarines and curry.'

2.2. Materials: Experiment 2 (Expt 2)

The purpose of this study was to compare the prenuclear rise with a nuclear accent in the same position, and narrow focus accents in final vs. non-final position. The broad focus items of Expt 1 were therefore replaced by sentences with narrow focus in prefinal position, which were lexically identical to the

prenuclear condition, but were preceded by a context-establishing yes/no-question. See (4) for examples.

(4) Nuclear accent in prefinal position

- a. CV: Q: Flygur Icelandir frá Noregi til Reykjavíkur?
'Does Icelandair fly from Norway to Reykjavík?'
A: Nei, Icelandair flygur frá **Malasú** til Reykjavíkur.
- b. CVC: Q: Finnst ykkur fiskur góður með tómatur og karri?
'Do you like fish with tomatoes and curry?'
A: Nei, okkur finnst fiskur góður með **mandarínur** og karri.

2.3. Participants, apparatus and procedure

The recordings for Expt 1 took place in May 2008 in a quiet closed room at the University of Iceland in Reykjavík with 12 native speakers of Icelandic (3 male, 9 female). Expt 2 was carried out in August 2009 in a quiet closed room at the University of Iceland with 12 speakers of Icelandic (5 male, 7 female), none of whom had also participated in Expt 1. In both studies, participants read each item three times at a normal speech rate. All utterances were recorded at a sampling rate of 44100 Hz onto a Samsung laptop computer using an AKG C444 headset microphone with AKG B29L battery power supply and Cool EditTM96 software. The same software was used to edit the recordings into individual sound files. The experiments yielded 432 tokens each.

2.4. Data treatment and analysis

All items were analysed inspecting waveform, F0 contour and wideband spectrogram simultaneously. Table 1 lists the tonal and most important segmental landmarks identified:

	landmark	
tonal	L1	beginning of F0 rise
	H	local F0 peak
	L2	end of F0 fall
segmental	C1t	beginning of onset C of σ
	Vt	beginning of vowel of σ
	C2t	beginning of final C of σ (closed σ only)
	C1f	beginning of onset C of syllable following σ
	ef	end of syllable following σ

Table 2. Tonal and segmental landmarks; σ =target syllable

On the basis of these landmarks, the measurements listed in Table 3 were performed. Mean values were calculated for each variable and speaker, organised according to experimental condition. They were submitted to two-way analyses of variance (ANOVA) with two independent variables: (1) ACCENT TYPE/POSITION (three levels); (2) SYLLABLE TYPE (two levels). Variables involving C2t were submitted to ANOVAs with the independent variable of ACCENT TYPE/POSITION.

Variable	
L1-C1t	distance of L1 from C1t
L1-Vt	distance of L1 from Vt
H-C1t	distance of H from C1t
H-Vt	distance of H from Vt
H-C2t	distance of H from C2t
H-C1f	distance of H from C1f
L2-C1f	distance of L2 from C1f
L2-ef	distance of L2 from ef

Table 3. Variables

3. Results (Experiments 1 and 2)

According to the mean values, the alignment of the tonal landmarks to the segmental string is as follows (see Figure 1).

- Open syllables

H: In prenuclear accents, H is within C1f. In sentence-final nuclear accents (both broad and final narrow focus), H is within Vt. According to the mean value, it is earlier in broad focus than in narrow focus accents. Likewise in non-final nuclear accents, H is within Vt, but later than in final accents.

L1: L1 is shortly after the onset in C1t in prenuclear accents and in non-final nuclear accents, and it is shortly before the onset of Ct1 in sentence-final nuclear accents.

L2: Where obtainable, L2 was after ef in all conditions.

- Closed syllables

H: All H values are within the target syllable, but later in prenuclear than in nuclear syllables, and later in non-final nuclear accents than in final nuclear accents. Specifically, H is within C2t in prenuclear accents and in non-final nuclear accents (but later in prenuclear ones), and it is within Vt in nuclear accents (both broad and final narrow focus).

L1: L1 is in C1t in prenuclear syllables, and before the onset of C1t in all three nuclear conditions.

L2: Where obtainable, L2 was after ef in all conditions.

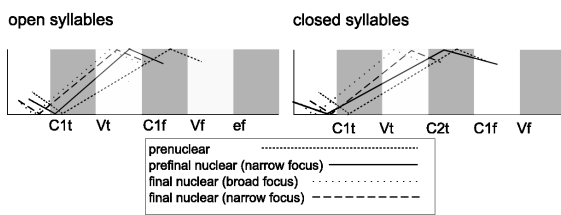


Figure 1: *Schematic representation of the eight pitch accents according to the combined measurement results of Expt 1 and 2; idealised segment durations.*

The factor ACCENT TYPE/POSITION reached significance for all variables involving H in both experiments (see Table 4). Individual comparisons revealed that in Expt 1, the main effects were due to significant comparisons between prenuclear and nuclear accents, but not between the two final nuclear accents. In Expt 2, the effects were due to differences between prenuclear and final nuclear syllables, and between prefinal nuclear and final nuclear syllables. The difference between prenuclear and prefinal nuclear was significant only for H-C1f. Variables involving L1 or L2 did not reach significance.

variable	Expt 1	Expt 2
H-C1t	F[1,11]=76.895, p<.001	F[1,11]=26.253, p<.002
H-Vt	F[1,11]=86.860, p<.001	F[1,11]=19.680, p<.002
H-C2t	F[1,11]=50.340, p<.001	F[1,11]=9.349, p<.015
H-C1f	F[1,11]=96.557, p<.001	F[1,11]=21.807, p<.002

Table 4. *Results; factor ACCENT TYPE/POSITION*

In both experiments, the factor SYLLABLE TYPE reached significance only for variable H-C1f (Expt 1: F[1,11]=136.179, p<.001; Expt 2: F[1,11]=60.797, p<.001).

Due to the structure of Icelandic syllables, which have structurally long vowels in open syllables but short vowels complemented in the nucleus by consonants which can be lengthened under stress, H is in C1f in open syllables, but in C2t in closed syllables.

4. Discussion and conclusion

These results are reminiscent of much of the recent literature on F0 alignment. For example, the stable alignment of L at the beginning of the stressed syllable was also the result of studies on a number of other languages, as was the more variable alignment of H (e.g., [14], [9]; [8], and [10]). Second, the fact that H is reached later in prenuclear accents than in nuclear accents has been observed for other languages, too (e.g., [5]). Third, the difference between open and closed syllables for the position of H in prenuclear accents is reminiscent of [12]'s results for Egyptian Arabic and [10]'s results for Dutch.

4.1. Intonational distinctions in Icelandic

Based on the present findings, the following intonational distinctions can be identified for Icelandic. First, there is no evidence from F0 alignment for a difference between a sentence-final broad focus nuclear accent and a final narrow focus. Second, a prenuclear accent is different from a final nuclear accent such that the prenuclear accent is represented by a late rise and the final nuclear one by an early rise. Perceptually, the prenuclear accent is a rise from a low accented syllable, while the nuclear accent is a fall from a high accented syllable. Third, comparing prefinal nuclear accents with final nuclear accents, the shape of the two accents is very similar, but the tonal event is later in prefinal than in final position. In particular, H is reached later in the vowel of the target syllable in prefinal than in final position. This effect is probably due to the position of the accented syllable in the sentence: peak alignment is earlier before a stronger prosodic boundary. The final nuclear syllable, but not the prefinal nuclear syllable is followed by an utterance boundary. Fourth, nuclear accents in prefinal position differ from prenuclear accents in the same position. H is aligned later in prenuclear accents than in prefinal accents, even if this difference fails to reach significance in most comparisons. According to the mean values, H is within the consonant following the vowel of the stressed syllable in prenuclear accents: C1t in open, C2t in closed syllables in prefinal nuclear syllables it is in Vt in open syllables, and in C2t, but earlier than in prenuclear accents, in closed syllables. Moreover, in prefinal nuclear accents, an immediate fall from H on the target word to a low level in the speaker's tonal range can be observed, while in prenuclear accents, there is no such rapid downward pitch movement.

4.2. Accent types

On the basis of the present evidence I suggest the following intonational categories. I analyse the prenuclear late rise as L*H: a rise from a low accented syllable. This analysis is supportive of the original analysis of this accent as L*H by [1] and [2]. Evidence comes from the stable alignment of L in C1t, and from the equally stable alignment of H in the consonant following the vowel of the stressed syllable. The L*H analysis is consistent with the assumption that the starred tone is linked to the stressed syllable such that it is temporally aligned with it. It is also consistent with the fact that Icelandic prenuclear accents sound low, which is expected if the starred tone represents the central, stronger one, and the unstarred tone represents the weaker one.

I analyse the final nuclear accent as LH* followed by a low edge tone. The strict alignment of L1 just before C1t, the fixed position of H within Vt and the fact that there is no stable alignment between L2 and a segmental landmark all serve as phonetic evidence for LH*. The analysis of H as the central tone of the pitch accent and the fall to a low edge tone is in line with earlier work on Icelandic, which on the basis of perceptual evidence reports a local pitch peak to mark the accent and a fall at the end of the utterance ([19]). It is also compatible with more recent work, which analyses the same accent as H*L ([1], [2]). The analysis as H*L differs from the present account in that there is a trailing tone but no leading tone. H*L has been suggested on the perceptual basis that (i) the accent is a local peak followed by a rapid fall to a low level, and that (ii) the fall is usually completed on the syllable following the stressed one. For (ii), the present study did not find consistent phonetic evidence. (i) is certainly true but does not necessarily justify the assumption of a trailing tone. The rapid fall can be argued to be towards a low edge tone.

Finally, I analyse the nuclear accent in prefinal position as LH* with a subsequent fall to a low edge tone. The stable alignment of L1 and the stable position of H within Vt serve as evidence. This is the same accent type as in final nuclear accents. Based on previous research, the variation in peak alignment, i.e. later alignment in prefinal than in final nuclear accents, is put down to the position in the sentence and the corresponding effect of the prosodic boundary. Perceptually, unlike the prenuclear accent, the prefinal nuclear accent sounds high. Moreover, while the prefinal nuclear accent is followed by a fall to a low target, any downward trend after the peak in a prenuclear L*H accent is qualitatively different. On the basis of the current evidence, no further accent types can be identified. In particular, whether Icelandic has the monotonal accents H* and L* and whether they are phonologically distinct from the accent types identified here, is a topic for future research. Also, the experimental material used here turned out not to provide enough information on the alignment of L2. It does not follow from this lack of evidence that the L trailing tone does not occur in Icelandic, or that falls from H will generally have to be analysed as falls to a low edge tone, but future studies will have to show if and when there is reason to assume a low trailing tone instead.

4.3. Summary, conclusion and outlook

This paper reported on the findings of two production studies designed to test F0 alignment in Iceland pitch accents in four different conditions. The results were as follows. First, the Icelandic prenuclear accent is a rise from a low accented syllable (L*H), confirming earlier results based primarily on intuitive and perceptual data. Second, nuclear accents are early rises followed by an immediate fall, both in final and prefinal position. The difference in peak alignment such that H is later in prefinal than in final nuclear accents is ascribed to the position of the target noun in the sentence and its respective proximity to a strong prosodic boundary. No evidence was found in this study for a L trailing tone. Falling nuclear accents were just analysed as LH* followed by an L edge tone. Some open questions remain. For example, future research will systematically compare prenuclear L*H as identified here with nuclear L*H, observed, for example, in yes/no-questions ([1], [2]). Moreover, there is reason to assume regional intonational differences between northern and southern varieties of Icelandic. A systematic comparison between these varieties will shed more light on possible intonational differences.

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