Declination, peak height and pitch level in declaratives and questions of South Connaught Irish

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Abstract

As South Connaught Irish typically uses the same (falling) tune type in both questions and declaratives, this paper examines whether sentence mode might be differentiated in this dialect by other aspects of the contour realization, namely declination slope, peak height and pitch level. A set of matched declaratives (DEC), wh- questions (WHQ) and yes/no questions (YNQ) of two phrase lengths (with 2 and 3 accent groups) was analysed. The results indicate that sentence type is reflected in the measured f0 parameters. Compared to declaratives, WHQ exhibit markedly steeper declination slopes and somewhat higher IP-initial peaks, while YNQ raise the pitch level and the IP-initial peaks. Phrase length influences declination slope, but does not appear to affect peak height.

Index Terms: South Connaught Irish, prosody, sentence mode, declination, peak height, pitch level

1. Introduction

This paper explores the prosody of f0 contours in declaratives and two question types, wh- and yes/no questions, in the Irish of South Connaught (Figure 1). Declarative questions are not included, as they may not feature frequently in Irish [1]. While the tonal composition of declaratives and questions in the South Connaught dialect has already been described [1, 2], little is known about phonetic aspects of sentence mode production such as declination, peak scaling and pitch level.

The role of intonation in conveying sentence mode is of particular interest to us for a number of reasons. First, it should help improve the prosody of our TTS for Connaught Irish [3]. Also, this work contributes to our growing understanding of the prosody of Irish, of Celtic languages, and of intonational typology in general.

With respect to work on sentence mode, the features which are typically reported for question intonation include f0 events at the local (related to a pitch accent or phrase boundary) and global (related to a part of, or, an entire contour) levels. The local effects used for marking interrogativity include raising of the IP onset and of the accentual peaks [4, 5]. The global effects may involve higher overall pitch such as observed in register level and span [6-8], as well as changes in declination slope [7-9]. Furthermore, as peak height and/or declination can be influenced by phrase length [9-13], we include sentences of two different lengths in the analysis.

The immediate questions which are addressed here can be summarized as follows:

- Do wh- and yes/no questions differ from declaratives with respect to declination, peak height and pitch level?
- If so, do wh- questions differ from yes/no questions in the use of these f0 metrics?
- Does phrase length influence the declination slope, the scaling of the initial and nuclear peaks or the pitch level?

2. Methods and materials

The sentence mode data presented here was obtained from nine informants representing the South Connaught Irish dialect in the west of Ireland (Figure 1). Four of the informants are from Cois Fharraghe on the coast of County Galway, and five from Inis Mór, the largest of the three Aran Islands off the coast of County Galway (the two locations are shown in Figure 1). All informants in the study are native speakers of the local variety with Irish as their first language. None of them are professional speakers (e.g. newscasters, actors). No requirements were imposed on speaker gender or age, as the main selection criterion was that they be native speakers and use Irish daily. Thus, the group comprises five females and four males between 20 and 60 years of age.

The sentence mode experiment includes read speech, where the target phrases are embedded in mini-dialogues (question-answer type) with a concrete pragmatic context to evoke the ‘typical tune’. The target phrases are presented in Table 1. These simple 2- and 3-accent everyday-speech phrases were designed to elicit the production of single intonation phrases with the same number of pitch accents (IP-
medial accentuation being optional). Five repetitions of each target phrase were obtained, thus giving 270 tokens in total. Out of those, 254 contained no errors/disfluencies, and were deemed suitable for the subsequent prosodic analysis.

Table 1: Target phrases in the sentence mode experiment with their translations into English. Stressed syllables are marked in red bold font.

<table>
<thead>
<tr>
<th>Short IP</th>
<th>DEC</th>
<th>WHQ</th>
<th>YNQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhi Cian ag an margadh.</td>
<td>Cian was at the market.</td>
<td>’Was Cian at the market.’</td>
<td>’Was Cian at the market?’</td>
</tr>
<tr>
<td>Is cé bhí ag an margadh?</td>
<td>’And who was at the market?’</td>
<td>’Who was at the market?’</td>
<td>’Who was at the market?’</td>
</tr>
<tr>
<td>’Raibh Cian ag an margadh?</td>
<td>’Was Cian talking with them in the market.’</td>
<td>’Was Cian talking in the market.’</td>
<td>’Was Cian talking in the market?’</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Long IP</th>
<th>DEC</th>
<th>WHQ</th>
<th>YNQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhi Cian ag caint leo sa margadh.</td>
<td>Cian was talking with them in the market.’</td>
<td>’Was Cian talking with them in the market?’</td>
<td>’Was Cian talking to them in the market?’</td>
</tr>
<tr>
<td>Is cé bheas á mbaílios an margadh?</td>
<td>’And who will them collect from the market?’</td>
<td>’And who will collect from the market?’</td>
<td>’And who will collect from the market?’</td>
</tr>
<tr>
<td>’Raibh Cian ag caint leo sa margadh?</td>
<td>’Was Cian talking with them in the market?’</td>
<td>’Was Cian talking to them in the market?’</td>
<td>’Was Cian talking to them in the market?’</td>
</tr>
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</table>

The Cois Fharraige recordings were carried out in a semi-anechoic room, while the Inis Mór recordings were done on the island, in a quiet room. Data was recorded at the 44,100 Hz sampling frequency onto a laptop using the Audacity software [14].

The prosodic annotation and measurements were done using the Praat software [15]. F0 was extracted using the autocorrelation method, with pitch floor set at 70 Hz for the male speakers, and 100 Hz for the female speakers. Prior to carrying out the measurements, all f0 contours were inspected for possible octave jump and segmental f0 errors, which were accordingly hand-corrected (set to the frequency calculated from the sound wave, or removed).

The tonal transcription with the IViE labelling system [16, 17] was performed to (1) find out what tune types were present in these data, and (2) provide the basis for selecting uniform contour types for the quantitative analysis. The dominant tune found in the South Connaught data was H*+L (H*+L) H*+L% in all three sentence types (DEC = 83%, WHQ = 86%, YNQ = 75%). All this data, together with a handful of the H*+L (H*+L) H*+LH% contours (n = 13), gave a total of 220 tokens (DEC: n = 71, WHQ: n = 82, YNQ: n = 67) which were used for the subsequent f0 measurements.

The excluded data (n = 34) incorporates the H* (H*) H*+L% contours (produced mainly by one of the Inis Mór speakers, whose data was fully excluded), as well as any contour which involved a rise in the prenuclear or nuclear accent. These contour types occurred less frequently, and their use was not limited to a particular sentence type.

The measurements carried out on the sentence mode data are presented in Figure 2. These include: scaling of the IP-initial prenuclear (Hpn) and nuclear (Hn) peaks, declination slope (slope) and pitch level (level). Additionally, the peak height difference between Hpn and Hn was calculated.

The f0 measurements were performed as follows. Declination was estimated with the slope of the all-points (here called the ‘middle’) regression line [as in e.g. 7, 12, 13, 18]. For the H*+L (H*+L) H*+LH% contours the rising f0 at the IP-final boundary was removed before fitting the regression line. Peak height was defined as the f0 maximum of the prenuclear and nuclear H*+L accents. The Hn peak (in ‘margadh’) was measured at the absolute f0 maximum (as in Hn in Figure 2); the Hpn peak (in ‘Cian’ and ‘cé’) was measured 5-6 glottal pulses into the vowel (as in Hpn in Figure 2). Pitch level was captured through the global f0 minimum in the IP, which usually coincided with the phrase-final low.

All f0 measurements in the sentence mode data involve the semitone [ST] scale particularly suited for intonation research [19]. Declination was calculated in semitones per second. The peak and level measurements were converted to semitones relative to the speaker-specific baseline defined as the lowest f0 in that speaker’s data (ranging from 80 to 95 Hz for the male speakers, and 102 to 155 Hz for the female speakers), thus yielding positive ST values only.

The results are discussed mainly with respect to the mean (for scaling of Hpn and Hn) or median (for the remaining f0 measurements) values, and occasionally, the interquartile range. The influence of sentence mode and IP length on the f0 measurements is tested using ANOVA with factors Mode and Length (3x2). Repetitions are averaged within each Mode-by-Length condition for each of the eight speakers. Exact p values are reported for the results of ANOVAs and the post-hoc Tukey HSD and Student’s t-tests.

3.1. Declination in sentence mode

Figure 3 presents the results for declination slope in the long IPs (left) and short IPs (right) differentiating by colour the
individual sentence modes. The boxes represent the interquartile ranges.

In the long IPs (left in Figure 3), declination slope in WHQ (-6.2 ST) is notably higher compared to DEC (-4.4 ST) and YNQ (-5.0 ST). The same trend is found in the short IPs, but the difference in declination slope between WHQ (-12 ST) and the other two modes (DEC = -6.1 ST; YNQ = -8.4 ST) is more dramatic. Small differences are observed in the median values between DEC and YNQ, but the interquartile ranges are nearly identical for the two sentence modes both in the long and short IPs. Overall, the short IPs exhibit steeper slopes than the long IPs.

The ANOVA of declination slope shows significant effects of Mode ($F(2,40) = 11.29, p = .001$) and Length ($F(1,40) = 29.33, p < .001$) on this f0 metric. The post-hoc test of Mode reveals that the slope is significantly steeper in WHQ than in the other two modes (WHQ/DEC: LSM difference = 3.7 ST, $p = .001$; WHQ/YNQ: LSM difference = 2.9 ST, $p = .003$). With respect to Length, the difference in slope between the short and long IPs (LSM difference = 3.6 ST) is also highly significant ($p < .001$).

![Figure 3: Declination slope (middle regression line) in the sentence mode data.](image)

3.2. Peak scaling in sentence mode

Figure 4 shows the results for scaling of the IP-initial (Hpn) and the nuclear (Hn) peaks in the long IPs (left) and short IPs (right) differentiating by colour the individual sentence modes. Means and standard deviations are shown.

The IP-initial peak (Figure 4, upper panel) is higher in questions compared to declaratives. This holds for both the long IP (DEC = 12.2 ST vs. WHQ = 13.5 ST and YNQ = 14.0 ST) and short IP (DEC = 11.9 ST vs. WHQ = 14.7 ST and YNQ = 14.5 ST) conditions.

The ANOVA of Hpn scaling gives a significant result for Mode ($F(2,40) = 4.69, p = .014$) but not for Length ($F(1,40) = 0.06, p = .808$). The post-hoc test of Mode shows that the significant difference is between YNQ and DEC (LSM difference = 2.6 ST, $p = .016$). The difference between WHQ and DEC (LSM difference = 2.0 ST) approaches borderline significance ($p = .071$), presumably reflecting the peak being raised less in long WHQ than in short WHQ (see Figure 4).

For scaling of the nuclear peak (Figure 4, lower panel), an overall similar trend is observed both in the long and short IPs. However, peak raising in questions is less pronounced here, particularly in WHQ (long IPs: DEC = 8.1 ST vs. WHQ = 8.8 ST and YNQ = 9.5 ST; short IPs: DEC = 7.9 ST vs. WHQ = 9.6 ST and YNQ = 10.2 ST).

The ANOVA of Hn scaling gives a near-significant result for Mode ($F(2,40) = 2.45, p = .099$). The effect of Length is not significant ($F(1,40) = 0.06, p = .811$). The raising of Hn in YNQ compared to DEC approaches borderline significance, as indicated by the results of the post-hoc test of Mode (LSM difference = 2.0 ST, $p = .082$). The mild increase of Hn in WHQ relative to DEC (LSM difference = 1.1 ST) is not significant ($p = .430$).

Overall, therefore, the height of the IP-initial peak appears to help differentiate yes/no and also wh- questions from declaratives. The height of the nuclear peak may also play a role in distinguishing yes/no questions from declaratives, but the effect is of borderline significance.

![Figure 4: Scaling of the IP-initial (Hpn) and nuclear (Hn) peaks in the sentence mode data.](image)

3.3. Prenuclear-to-nuclear peak height difference

Figure 5 illustrates the f0 difference between the IP-initial and the nuclear peaks in the long IPs (left) and short IPs (right) differentiating by colour the individual sentence modes. The boxes represent the interquartile ranges.

It is striking that the Hpn-to-Hn drop remains rather constant regardless of sentence mode and IP length (DEC long and short = 3.9 ST; WHQ long = 4.9 ST, WHQ short = 5.4 ST; YNQ long = 4.6 ST, YNQ short = 4.3 ST). There is an appreciable overlap in the Hpn-Hn difference values across all data (see Figure 5). This is directly reflected in the results of the ANOVA test, where neither Mode ($F(2,40) = 0.75, p = .480$) nor Length ($F(1,40) = 0.01, p = .997$) are significant.

The fact that the f0 drop is a near-constant regardless of IP length is likely correlated with the fact that declination slopes are much greater in the short IPs than the long IPs. The near-constancy of the Hpn-Hn difference also appears to reflect aptly the tendency of both the IP-initial and the nuclear peaks to be little influenced by IP length (which was shown in Section 3.2).
3.4. Pitch level in sentence mode

Figure 6 illustrates the results for pitch level in the long IPs (left) and short IPs (right) differentiating by colour the individual sentence modes. The boxes represent the interquartile ranges.

Pitch level appears higher in yes/no questions compared to declaratives (Figure 6). In wh- questions, the medians are higher than in declaratives, but the interquartile ranges largely overlap. Little difference can be seen due to phrase length (long IPs: DEC = 2.7 ST, WHQ = 3.1 ST, YNQ = 4.3 ST; short IPs: DEC = 2.0 ST, WHQ = 3.0 ST, YNQ = 3.5 ST).

The ANOVA of pitch level reveals a significant effect of Mode on this parameter ($F(2, 40) = 5.10, p = .010$). The post-hoc test confirms that the significant difference is between YNQ and DEC (LSM difference = 1.4 ST, $p = .007$). The effect of Length is not significant ($F(1, 40) = 0.19, p = .663$).

4. Discussion

This study confirms earlier findings on tonal patterns in South Connaught Irish [1, 2], where H*+L (H*+L) H*+L% is reported as the dominant tune in both declaratives and questions. However, sentence mode appears to be signaled prosodically by:

- declination slope, which is significantly steeper in WHQ than in DEC and YNQ;
- pitch level, which is significantly raised in YNQ compared to DEC;
- scaling of the IP-initial prenuclear (Hpn) peak, which is significantly higher in YNQ and near-significantly higher in WHQ compared to DEC;
- mild upward scaling of the nuclear (Hn) peak, which is near-significantly higher in YNQ than in DEC.

Not surprisingly, declination is strongly influenced by phrase length in this dialect of Irish. The tendency for declination slopes to be higher in shorter phrases has been reported in a number of studies on sentence intonation [9, 12, 13, 20]. With regard to the scaling of the IP-initial peak, some researchers have observed its increase with increasing IP length [10, 11, 21], while other researchers have reported no such effect [22-24]. The results for South Connaught Irish are more in line with the latter view, where the height of the IP-initial (and indeed the IP-final) peak is little influenced by phrase length.

What is striking in this dialect is the degree of constancy in the melodic interval between the initial and final peaks, regardless of the length of the IP, or of the sentence mode. As was shown in Section 3.3, a near-constant f0 drop from Hpn to Hn is retained across all three sentence types, even when the pitch level is raised, as in YNQ.

5. Conclusions

Sentence mode in South Connaught Irish is not signaled by contour type, where the dominant H*+L (H*+L) H*+L% pattern is used in declaratives and questions alike. However, sentence mode does involve finer phonetic differences in the realisation of the contours, including a steeper declination slope for WHQ, and a raised pitch level in YNQ. Upward scaling of the initial prenuclear peak is found in YNQ and, to a lesser degree, in WHQ. A small amount of raising of the nuclear peak may also contribute to differentiating YNQ from declaratives.

Phrase length affects the slope of declination, but does not influence the scaling of the IP-initial or the nuclear peak. The f0 interval between the initial and final peaks stays remarkably constant across differences in IP length and sentence mode.

6. Acknowledgements

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7. References


