Sentence mode, alignment and focus in the intonation of Cois Fharraige, Inis Mór and Gaoth Dobhair Irish – A dual approach

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Thesis submitted for the Degree of Doctor of Philosophy

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2014

Declaration

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Summary

This work is devoted to the analysis of the intonation in three varieties of Irish: Gaoth Dobhair (Donegal within Ulster), and Cois Fharraige and Inis Mór (Connemara within Connaught).

The experimental work is carried out at two levels of analysis. The melodic contours are described in terms of their tonal composition with the IViE annotation system, and the phonetic parameterisation is conducted by means of parallel contour-based and Fujisaki model measurements.

The aims of this study are (1) to gain new insights into the intonation of two dialects of Irish with respect to cross-dialect and within-dialect variation, and (2) to assess the Fujisaki model for its suitability to perform analysis (and to some degree also synthesis) of the intonation of Irish dialects.

With respect to aim (1), the work confirms an intonational divide between Ulster and the rest of the island and shows that the differences are not limited to the phonological level. The quantitative results indicate that the differences conveyed on the tonal level are further enhanced by concomitant phonetic effects in the melodic contour. Possible phonetic differences between the intonation of Cois Fharraige and Inis Mór were not found. However, the Inis Mór speakers were found to use a wider array of tunes than the Cois Fharraige speakers.

In relation to aim (2), the Fujisaki model is shown to be adequate for the synthesis of f0 contours of Irish, and is found to perform better on the Gaoth Dobhair data compared to the data from Cois Fharraige and Inis Mór. Unfortunately, the model is not an equally promising analytical tool in the linguistic sense. Drawing meaning directly from the model's amplitude parameters is made difficult because of the superposition of the phrase and accent components; the timing parameters of the model, however, are easily interpretable.

Acknowledgements

First of all, I would like to thank my supervisor, Professor Ailbhe Ní Chasaide for her guidance and encouragement during the research process and in the final stages of the dissertation write-up. She taught me how to look at data like a phonetician, and how to collaborate with other people and enjoy the research. Her support sometimes went far beyond the duties of a supervisor, for which I am deeply grateful to her.

I would also like to thank my co-supervisor, Dr. Christer Gobl, with whom I had interesting discussions about the Fujisaki model, and without whose insightful comments I might have been less rigorous in the set-up of the modelling strategy.

I would like to express my respect and deepest gratitude to Professor Hiroya Fujisaki for his guidance on using his intonation model. Fujisaki-Sensei was very kind to convey his modelling method to me over a number of informal discussions at various conferences. If I have strayed from his original teachings in any way, I have done so with one objective in mind: to use the model uniformly for both the Ulster and the Connaught varieties of Irish. I hope Professor Fujisaki accepts my interpretation of his model as valid.

I would also like to thank the German-speaking experts on the model. I am grateful to Professor Hansjörg Mixdorff for sharing his experience of working with the Fujisaki model, as well as his technical support which included the creation of the extremely neat .eps images. I thank Professor Bernd Möbius for his advice on this project and for kindly presenting me with a copy of his valuable Ph.D. dissertation. And thanks to Dr. Adrian Leemann, whose path crossed mine while he was searching for the ideal alpha setting, for his friendship and the stimulating discussions on intonation.

I owe a big thanks to Dr. Irena Yanushevskaya and the soon-to-be-Dr. John Kane for putting their research (and their own Ph.D.) experience to good practice and helping me immensely with their proof-reading skills, and of course for being great lab colleagues. I am extremely grateful to Dr. Pauline Welby for her advice on the post-graduate process, her invaluable help with Praat scripting and her intonation insights.

I absolutely need to mention my other great 'co-lab-orators': Neasa Ní Chiaráin and Christoph Wendler (the pun's for you) – thank you for your immense help with the Irish part of the experiments and the recordings (and the craic), Amelie Dorn for having fun times in the lab and sharing the challenges of work on intonation, Harald Berthelsen for some technical help, and Emer Gilmartin, who despite being busy with her own Ph.D. work, did a serious amount of proof-reading for me.

I want to thank Póilín Ní Bhairr – Pól, you are brilliant, thank you so much for your companionship and help with the Gaoth Dobhair recordings! I would also like to thank all my informants who I regret have to remain anonymous (sorry, it's the ethics) without whose speech I would have nothing to work on. And for bearing with me on the 'Meabh' task/torture.

Big thanks to my great friend Ewa, who has inspired and supported me not only during the dissertation work but for years. And to my sister Daria, who shared all the joys and pains and knows me only too well. Jarek, we'll see you again! Not forgetting Monika who has a heart of gold.

And last but not least, Aiden – you have been my inspiration and supported me at times when research was hard to handle. I only wish you could pass on some of your exceptional writing skills to me. By now you must know all about peak scaling and declination, so eventually part of this Ph.D. will belong to you, too!

P.S.: I've kept you a warm spot right beside the Table of Contents.

Table of contents

Chapter 1
Introduction

1.1 General overview of present work

This thesis presents a linguistically-guided parametric analysis of the prosody of three varieties of Irish: one variety of Donegal Irish, Gaoth Dobhair, and two varieties of Connemara Irish, Cois Fharraige and Inis Mór.

The narrower terms Connemara and Donegal are used throughout the work instead of the traditional dialect classification referring to the geographical Provinces – Connaught and Ulster Irish (Figure 1.1). The reason is that Connaught subsumes Mayo Irish (which is not studied in this work), and while Ulster Irish was historically spoken in most of the Ulster Province, currently the Gaeltacht (i.e. Irish-speaking region) is in practice limited to parts of County Donegal, including Gaoth Dobhair.

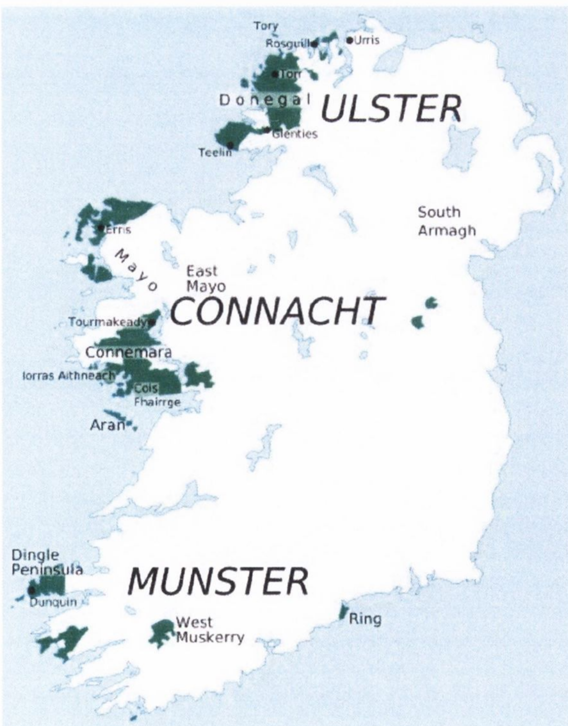

Figure 1.1 The official Gaeltacht (Irish-speaking) areas in Ireland.

The speech material was studied with regard to three specific aspects of intonation commonly discussed in the literature:

1) sentence mode: how intonation is used to mark grammatical function (statement vs. question)
2) alignment: how intonational events (H and L tones) are timed with respect to the segmental string
3) focus: how intonation is used to highlight particular constituents in a phrase.

These three topics were chosen as they are believed to provide suitable ground for (a) showing the intonational characteristics of Cois Fharraige, Inis Mór and Gaoth Dobhair Irish, and (b) looking at how the linguistic categories of pitch timing and scaling, declination and register level are interpreted in the Fujisaki model parameters.

1.1.1 Dual analytical approach in present work

A dual approach is adopted for the study – qualitative analysis using the IViE annotation system, and quantitative analysis based on the Fujisaki intonation model.

Analytical tool No. 1: the IViE annotation system

The Intonational Variation in English (IViE) system (Grabe, 2001; Grabe, Nolan, & Farrar, 1998) is a qualitative system for the transcription of intonation in a language, which was originally formulated to describe the differences between varieties of English. The system is an application of the Autosegmental-Metrical (AM) framework, in which f0 contours are represented in terms of high (H) and low (L) tonal elements pertaining to pitch accents on prominent words and boundary tones at the edges of the intonation phrase (IP).

In this thesis IViE is used to characterise the intonation of Connemara and Donegal Irish at the phonological level (i.e. classification of tonal events into accents and phrase boundaries). The accent and boundary tone categories are examined in isolation, as well as in the context of the entire IP. I attempt to follow O'Connor and Arnold's holistic approach by identifying the constituents of a tune (f0 contour) and observing how they are combined in the phrase (O'Connor & Arnold, 1973).

Analytical tool No. 2: the Fujisaki model

The Fujisaki intonation model (Fujisaki, 1981, 1992; Fujisaki & Nagashima, 1969) is a quantitative method for analysing the fundamental frequency (f0) contour of an utterance. The model decomposes a contour into a set of phrase and accent commands, each of which is characterised by its timing and amplitude parameters. This study uses the model to describe the intonation of Irish at the phonetic level. In this approach the Fujisaki model parameters are used as numerical correlates of the prosodic categories specified in the IViE transcription. The Fujisaki model is treated as a descriptive tool to flesh out the acoustic characteristics of pitch contours. It is also assessed for its usefulness as an *analytical* tool to quantitatively account for the linguistic categories.

In this sense, the Fujisaki model is used differently than in other works. In most studies the model is applied for speech *synthesis* (automatic f0 control) (e.g. Hirai, 2002; Mixdorff, 2002; Möbius, 1993; Teixeira, 2004). Some applications of the model (e.g. Leemann, 2009; Mixdorff, 1998; Möbius, 1993) impose additional constraints; however, they do not explicitly use the Autosegmental-Metrical description of tunes as a guiding device. The present work is the first AM-Fujisaki dual approach study to my knowledge. Other applications of the Fujisaki model focus on the principle of best fit without using intonation concepts in the model design (e.g. Agüero, Wimmer, & Bonafonte, 2004; Teixeira, 2004).

Because the Fujisaki model is applied as an analytical tool, and is at the same time assessed for its descriptive accuracy, an outside benchmark needs to be employed. To this end, a set of metrics was derived from the f0 contour to capture a range of features including peak height, register level, and declination. These contour-based metrics have the advantage that they correspond to the IVIE description, and also to the Fujisaki model measurements.

1.2 Research questions and motivations

The first aim of this study is to gain new insights into the intonation of two dialects of Irish, both at the cross-dialect (north vs. south) and within-dialect (within Connemara) levels. The other aim is to use the Fujisaki model to provide a quantitative description for the qualitative intonational categories generated with the IViE system.

1.2.1 Intonational variation at cross-dialect and cross-variety levels

This study is motivated by the rather sparse body of research into the intonation of Irish. There are some non-AM based accounts (Blankenhorn, 1982; Bondaruk, 2004; de Bhaldraithe, 1945; Quiggin, 1906) but these are quite general in their treatment of intonation. Some are primarily segmental descriptions (de Bhaldraithe, 1945; Quiggin, 1906). The AM framework has been used by Dalton & Ní Chasaide but the coverage of phonetic measurements in their work was limited to tonal alignment, i.e. the timing of High and Low tones (Dalton, 2008; Dalton & Ní Chasaide, 2005, 2007a; Ní Chasaide & Dalton, 2006).

Why Connemara and Donegal?

These two dialects have been shown to contrast at the structural (H*+L vs. L*+H) level (e.g. Dalton & Ní Chasaide, 2006), with Connemara chiefly employing falling (H*+L) intonation, and Donegal using the 'upside-down', rising (L*+H) pattern as the main choice.[1] It is of interest whether the structural differences are also accompanied by concomitant changes in the phonetics. Secondly, this contrast in the two dialects makes them most suitable for testing the Fujisaki model.

The description of Connemara intonation with the Fujisaki model parameters will largely apply to Mayo and Kerry Irish, as these two have been shown to share their tonal grammar with Connemara Irish (Dalton & Ní Chasaide, 2007b).

Why Cois Fharraige and Inis Mór?

Cois Fharraige and Inis Mór are two varieties of Connemara Irish. These are basically two varieties of one 'subdialect' – the Connemara subdialect of Connaught Irish. Why then should we study them?

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[1] Prenuclear L*+H and phrase-final rises also occur in West Muskerry Irish (Ó Cuív, 1944).

Firstly, from the cross-language perspective, varieties of one language or dialect have been shown to differ in terms of how they produce intonation contours. Most of this work is related to timing (alignment) of the contours, and studies have been carried out on English (Grabe, 2004; Grabe, Post, & Nolan, 2000b), Spanish (Elordieta & Calleja, 2005; O'Rourke, 2005), German (Mücke, Grice, Becker, & Hermes, 2009; Peters, Gilles, Auer, & Selting, 2002), Scandinavian languages, esp. Swedish (Bruce & Thelander, 2001) and Danish (Grønnum, 1989; Thorsen & Nielsen, 1981). These analyses have all shown that structures which appear to be similar may have intonational 'allotonic' variation (equivalent to allophones on the segmental level).

Secondly, similar variation has been shown for Irish dialects. The work of Dalton and Ní Chasaide on tonal alignment for Cois Fharraige, the south coastal area of Connemara west of Galway City, and Inis Oírr, one of the Aran Islands[2] (Dalton, 2008; Dalton & Ní Chasaide, 2005, 2007a) showed that the mainland and the island varieties differ with respect to timing of the accentual peaks. These findings indicate great potential for research into the intonational typology of varieties of Irish within Connemara. Instead of replicating work for Inis Oírr, the Inis Mór variety was chosen instead, in order to extend insight into the prosody of the Aran Islands to another location.

The Cois Fharraige and Inis Mór varieties of Irish are perceived by speakers to be distinct. This work tests if the difference is based solely or mainly on the intonation, or if researchers should consider other prosodic cues such as rhythm/tempo, segmental level, and voice quality.

1.2.2 Designing an IViE-constrained application of the Fujisaki model for Irish and assessing the model's performance

Why the Fujisaki model?

The Fujisaki model has been successfully used in synthesis of the intonation of a wide range of languages. The model was originally designed for Japanese (e.g. Fujisaki &

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[2] The Aran Islands include Inis Mór (the largest), Inis Meáin (the second largest) and Inis Oírr (the smallest).

Hirose, 1984) but since then it has been shown to work for other languages such as Standard German (Mixdorff, 1998; Möbius, 1993; Pätzold, 1991) and Swiss German (Leemann, 2009), Portuguese (Teixeira, 2004), Basque (Navas, Hernaez, Etxebarria, & Salaberria, 2000; Navas, Hernaez, & Sanchez, 2002), Argentinian Spanish (Gurlekian, Mixdorff, Evin, Torres, & Pfitzinger, 2010), and Arabic (Mnasri, Boukadida, & Ellouze, 2011).

As the Fujisaki model works for a variety of Indo-European languages, there is no *a priori* reason why it should not work for Irish as well, bearing in mind that every model comes with certain limitations. Therefore, it is assumed that the model will work for a large proportion of f0 contours of Irish in the *synthesis* sense (that is, it will give an accurate approximation of the f0 contours). The remaining question, however, is: how will it perform as an *analytical* tool? What do the parameters mean to a linguist? These questions are precisely what this study aims to answer.

1.3 Outline of dissertation

The dissertation consists of seven chapters. This chapter is an introduction to the study, briefly explaining the two research aims and their underlying motivation, and outlining the rest of the dissertation.

Chapter 2 provides an overview of the two analytic platforms used in the dissertation: the AM-based IViE system for the transcription of intonation, and the Fujisaki superpositional model for the quantification of intonational categories. The IViE section explains the main features of the annotation system. The Fujisaki model section provides a description of the model's features, and the parameter settings used in the major existing applications of the model (Leemann, 2009; Mixdorff, 1998; Möbius, 1993).

Chapter 3 introduces the informants and the speech materials used in this work, as well as the methods of data analysis, describing how the IVIE analysis is carried out on the f0 contours (tunes) of Connemara and Donegal Irish, and how the Fujisaki model parameterisation of these contours is performed.

Chapters 4 to 6 present the findings on how the speakers of Cois Fharraige, Inis Mór and Gaoth Dobhair Irish use intonation in the encoding of sentence mode, alignment and focus. The results cover both levels of analysis: the categorical description of the melodic contours, and their realisation via the corresponding f0 parameters (the Fujisaki model-derived parameters and the contour-derived metrics). Each of the three topics is covered separately in each chapter.

Chapter 7 summarises the significant findings on the three varieties of Irish, assesses to what extent the two research aims have been addressed, and suggests possible directions for future work.

Chapter 2

Background on IViE framework and Fujisaki model

2.1 Introduction

This chapter describes the two intonation models used in the dissertation. Section 2.2 presents the IViE system as the practical application of the Autosegmental-Metrical (AM) approach, which captures the prosody of a language/dialect at the structural level. The demonstration of IViE includes a general overview, the system's treatment of phrasing and accentuation based on Grabe's and Gussenhoven's underlying theoretical assumptions, and the levels of transcription used in the system. Section 2.3 explains the background on the Fujisaki superpositional model. A general overview of the model's features is presented along with the parameter settings in the four major applications of the model: the original works of Fujisaki and colleagues, and those of Möbius, Mixdorff and Leemann. The specific parameter settings are discussed in relation to each of the three model components: the base frequency, the phrase component and the accent component. The chapter concludes with a short summary (Section 2.4).

2.2 IViE framework

The IViE framework is an adaptation of the ToBI system (Beckman & Ayers Elam, 1997; Beckman, Hirschberg, & Shattuck-Hufnagel, 2005; Silverman et al., 1992). The theoretical basis of IViE can be traced back to Grabe (1998a) and Gussenhoven (1984), whose works adapt concepts from the British School of intonation (Halliday, 1967; O'Connor & Arnold, 1973; Palmer, 1922) and transpose them to the AM framework. The remaining parts of Section 2.2 outline the AM foundations on which IViE is built, describe its treatment of phrasing and accentuation, and explain IViE's tiered transcription system.

2.2.1 Groundwork on the Autosegmental-Metrical framework

The Autosegmental-Metrical (AM) approach to intonation has its roots in two seminal works from the mid-seventies. Goldsmith's work on autosegmental phonology (1976) developed the concept of coexistence of tones and segments on separate levels which are coordinated in time by means of association, and introduced the star notation, which associates a tone with a specific segment. Liberman's work on metrical phonology (Liberman, 1975), further developed in Liberman & Prince (1977), contributed the idea of prominence of a linguistic unit relative to other units in a phrase. Liberman introduced the concept of a metric grid which incorporates metrical patterns of strong and weak elements on the mutually independent text and tune levels.

Tonal analysis was expanded by Bruce in his work on the intonation of Swedish (1977). One of the major breakthroughs attributed to Bruce was showing that the two lexical accents in Swedish (Accent I and II) contain the same phonological elements (H and L) which are both associated with the stressed syllable, but differ in terms of timing.

Pierrehumbert (1980) provided a unified account of the earlier approaches in her treatment of American English intonation. In her model a tune can be broken down into H and L tones associated with metrically strong syllables (pitch accents, marked with a star symbol '*') and phrase edges (boundary tones, marked with %). A tone-bearing unit may be associated with one or more tones (mono- and bitonal accents), or may not carry a tone at all (accentless). Pierrehumbert (1980) also introduced phrase accents (marked with a minus sign '–') to account for unassociated tones following the nuclear accent.[3] Phrase accents were later re-interpreted (Beckman & Pierrehumbert, 1986; Pierrehumbert & Beckman, 1988) to describe two levels of phrasing (intermediate phrase and intonational phrase).

Pierrehumbert's model of intonation is the basis for the ToBI (Tones and Break Indices) transcription system. The conventions of prosodic transcription in ToBI were originally formulated for Standard American English (Beckman & Ayers Elam, 1997; Silverman et al., 1992). ToBI is currently the benchmark system applied to a variety of languages, e.g.

[3] One may see a parallel to Bruce's (1977) 'sentence accent' as a type of prominence operating at phrase level which is not attributable to a 'word accent' (pitch accent) or 'terminal juncture' (boundary tone).

Japanese (Venditti, 1997), Korean (Beckman & Jun, 1996), German (Grice & Baumann, 2002), Spanish (Beckman, Díaz-Campos, McGory, & Morgan, 2002) and Dutch (Gussenhoven, 2005). The transcription system for Dutch (ToDI), however, has more in common with IViE, since the two share their treatment of phrasing and the accent inventory.

2.2.2 General overview of IViE

The IViE (Intonational Variation in English) labelling system is derived from the Autosegmental-Metrical framework and in a broad sense draws on the ToBI approach. IViE was proposed by Grabe and colleagues (Grabe, 2001; Grabe et al., 1998; Grabe & Post, 2002; Grabe, Post, & Nolan, 2000a). The labelling system grew out of the IViE project on cross-dialect prosodic variation in Great Britain and Ireland (Grabe, Nolan, & Post, 1998-2003). IViE was originally developed for comparative transcription of intonation in nine selected varieties of English.[4] The choice of phonological labels is drawn from the same pool, thus ensuring comparability between varieties. Cross-variety differences in the realisation of tonal categories are accounted for on a separate level of description.

The theoretical background to the IViE system is rooted in Grabe's comparative study of the intonation of English and German (1998a). Grabe's model draws on Gussenhoven's work on Standard British English (1984) for the left-headed accent inventory and phonological adjustments which the underlying accent categories may be subject to.[5] Grabe's phonological adjustments include downstep, displacement (cf. Gussenhoven's partial linking) and deletion. She also lists gradient acoustic effects such as truncation, compression and expansion, which are not marked in surface phonology.

IViE differs from ToBI in several ways. With respect to phrasing, such differences include one level of phrasing (the Intonation Phrase) and three phrase boundary options

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[4] These include seven British varieties (London, Cambridge, Cardiff, Liverpool, Bradford, Leeds and Newcastle) and two Irish varieties (Belfast and Dublin).

[5] In Gussenhoven's account (1984) English has three tonal morphemes (H*L, H*LH and L*H) which are subject to modifications (cf. Grabe's adjustments) such as delay, stylisation, half-completion and the tone linking rule. The application of adjustments results in an additional nine modified tones.

(H%, L% and 0%). The level of intermediate phrase (e.g. Beckman & Pierrehumbert, 1986) and the related concept of ToBI break indices are not utilised in IViE. In terms of accentuation, the differences involve the above mentioned left-headed structure of pitch accents and the resulting tonal inventory, as well as the use of the phonetic level in the transcription. These features are covered in Sections 2.2.3 and 2.2.4 devoted to phrasing and accentuation in IViE.

2.2.3 Phrasing

IViE proposes one level of phrasing, the Intonation Phrase (IP), whose external edges are marked with boundary tones.[6] As the concept of ToBI intermediate phrases is absent in the IVIE approach, no phrase accents are needed. The IViE treatment of phrasing makes the system transparent, as the most complex nuclear tonal cluster will contain only three elements.

Three boundary tone options are available in IViE (Table 2.1). Apart from the high (H%) and low (L%) options, which also exist in Pierrehumbert's and Gussenhoven's models, the tonally unspecified (%, also 0%) option can be used. The zero boundary was proposed by Grabe (1998a, 1998b) to account for phrase edges where no change from the preceding tone occurs. It appears to have been motivated by a three-way distinction in northern varieties of English such as Belfast English (Nolan & Grabe, 1997). As will become apparent in subsequent chapters, the % option is indispensable for transcribing nuclear tunes of Donegal Irish.

Table 2.1 IViE intonation phrase boundary specifications (from Grabe, 2001).

Phrase-initial	Phrase-final	Transcribes:
%H	H%	high target
%	%	no pitch movement at boundary
%L	L%	low target

[6] IP (also known as intonation group, or breath group) is most frequently signalled by a pause, final lengthening, a terminal pitch movement or the presence of anacrusis (Cruttenden, 1997).

2.2.4 Accentuation

IViE has a compact inventory of accent labels (Table 2.2). In accordance with the AM theory, two distinctive tonal elements, H and L, are the building blocks of a tune. Following the British School tradition, all accents are treated as left-headed, i.e. the accent group starts with the stressed syllable and includes the remaining unstressed syllables up to the onset of the next 'beat'.[7] The high or low target on the accented syllable is annotated with a starred tone (H* for high, and L* for low). If there is a relative change in f0 on the following unstressed syllables, the starred tone is accompanied by an H or L trailing tone (two in tritonal accents).[8] Effectively, the entire f0 event in the accent group is accounted for.

Table 2.2 IViE accent label inventory (from Grabe, 2001).

IViE option	Contour can look like this (description and possible tone target labels)
H*L	High target on prominent syllable followed by low target in same ID, e.g. H-l, mH-l or mHl-l
H*	High target, common in initial position in so-called flat hats, e.g. lH-h
!H*L	Downstepped high target, low target, e.g. hM-l
L*HL	IP internal or IP final rise-fall: Low target on prominent syllable, high target on next syllable followed by low target, e.g. lLh-l
L*H	Low target on prominent syllable followed by high target, e.g. mLh-h, mL-h, or lL-h
L*	Low target
H*LH	IP internal or IP final fall-rise: high target on strong syllable, low, high, e.g. mHl-h

Three tone modifications (upstep, downstep and displacement) are available in IViE. These are not listed in the official labelling guide (Grabe, 2001), but can be found elsewhere (e.g. Grabe et al., 1998; Grabe et al., 2000a). Upstep ('^' diacritic) and downstep ('!' diacritic) are used to indicate the location of tones in the f0 domain, while displacement ('_' diacritic) denotes a rightward shift of the trailing tone in the time domain.

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[7] The left-headedness principle used in IViE is a common feature of Gussenhoven's (1984) and Grabe's (1998a) model of intonation.

[8] ToBI permits right *and* left-headed accents (e.g. Beckman and Hirschberg, 1999). This, in the author's opinion, seriously complicates deciding which particular tonal combinations are contrastive. For criticism of the ToBI system see e.g. Nolan & Grabe (1997), Wightman (2002).

2.2.5 Transcription tiers

The full IViE transcription is made on five tiers, three of which reflect the intonational structure of an utterance. The prosodic transcription is carried out on Prominence, Target and Phonological tiers presented in Figure 2.1 (bottom to top). The other two tiers (not shown in Figure 2.1) are Orthographic for the transcription of words, and Comment, which is reserved for alternative transcriptions, as well as for marking disfluencies and errors.

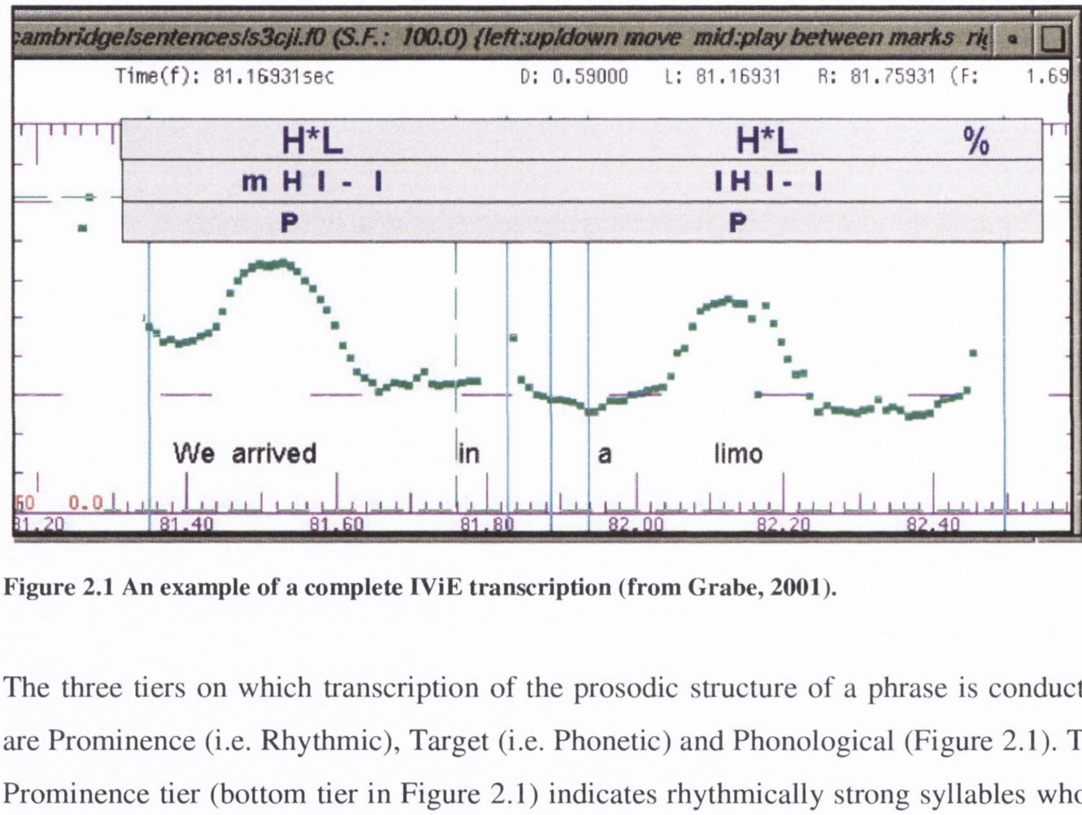

Figure 2.1 An example of a complete IViE transcription (from Grabe, 2001).

The three tiers on which transcription of the prosodic structure of a phrase is conducted are Prominence (i.e. Rhythmic), Target (i.e. Phonetic) and Phonological (Figure 2.1). The Prominence tier (bottom tier in Figure 2.1) indicates rhythmically strong syllables whose location is indicated by placing the 'P' (Prominent) symbol in the centre of the strong vowel. The Target tier (middle tier in Figure 2.1) describes the phonetic realisation of a pitch accent in the Implementation Domain (ID) which corresponds to a sequence of a pre-accentual syllable, the accented syllable and the remaining syllables within the rhythmic foot. This tier is particularly useful for marking differing phonology-phonetics mappings across varieties (e.g. the H*+L category can be realised as hM-l, mH-l, hH-l, Mh-l or lH). The Phonological tier (top tier in Figure 2.1) completes the prosodic transcription with pitch accent and boundary tone labels.

2.3 Fujisaki model

Section 2.3 presents the Fujisaki intonation model in terms of its mathematical representation and the linguistic interpretation of its parameters in three selected major works on different dialects of German to which the model was applied. First, a general overview of the Fujisaki model is provided in Section 2.3.1. Sections 2.3.2 to 2.3.4 provide a description of the three model components: the base frequency, the phrase component and the accent component.

2.3.1 General overview of Fujisaki model

The Fujisaki model is classified as a superpositional phonetic model of intonation. It represents the melodic contour at phrase and accent levels through a set of parameters characterising each component. The command-response model, as it is alternatively called, was first formulated in 1969 (Fujisaki & Nagashima) and has been further developed over the past number of decades. It was inspired by earlier work by Sven Öhman (Öhman, 1967; Öhman & Lindqvist, 1965) who formulated a model of f0 production based on positive 'sentence intonation inputs' and negative 'word intonation inputs', each controlled by its own filter. The Fujisaki model was originally developed for Japanese, but has since then been successfully applied to other prosodically diverse languages such as English (Fujisaki, Ohno, Yagi, & Ono, 1998), Spanish (Fujisaki, Ohno, Nakamura, Guirao, & Gurlekian, 1994), Swedish (Fujisaki, Ljungqvist, & Murata, 1993), Thai (Potisuk, Harper, & Gandour, 1999), and especially German (Leemann, 2009; Mixdorff & Fujisaki, 1994; Möbius, Demenko, & Pätzold, 1991).

The model represents an f0 curve as a sum of phrase command impulses and accent command step inputs on the natural logarithmic scale (Figure 2.2). Accent commands ride on the decaying crest of the phrase command(s). The two components are superposed onto the baseline frequency asymptote. Fujisaki motivates his model with the physiological explanation of the f0 production process. He argues that the phrase and accent components are related to the activity of two groups of the cricothyroid muscle (Fujisaki, 1981, 1988).

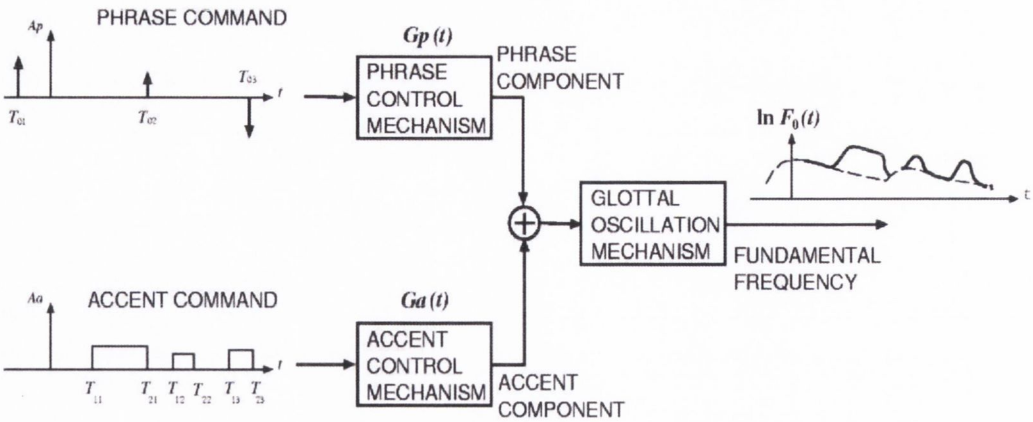

Figure 2.2 Block diagram of the Fujisaki model (from Fujisaki, 1988).

The mathematical formulation of the model appears complex, but its structure is attractively simple. The model equation is presented in Table 2.3, and all symbols which feature in the formula are explained in Table 2.4. According to the equation (e.g. Fujisaki, 1981, 1997), the approximated f0 contour (F0(t)) is the product of two sums. The first is the sum of phrase commands with amplitude Ap and onset T0 and controlled by the phrase control mechanism (Gp(t)) through α. The second is the sum of accent commands with amplitude Aa, onset T1 and offset T2, controlled by the accent control mechanism (Ga(t)) through β. The γ parameter, or ceiling level, in Ga(t), ensures that the accent component reaches the ceiling value within finite time, and is generally set to 0.9 (Fujisaki & Hirose, 1984). The phrase and accent components are added to the base value constant Fb (the first term in the formula).

Table 2.3 Mathematical formulation of the Fujisaki model.

$$\ln F0(t) = \ln Fb + \Sigma^{I}_{i=1} Ap_i\, Gp(t-T0_i) + \Sigma^{J}_{j=1} Aa_j\, [Ga(t-T1_j) - Ga(t-T2_j)]$$

where

$$Gp(t) = \alpha^2 t \exp(-\alpha t) \quad \text{for } t \geq 0, \text{ or}$$
$$Gp(t) = 0 \quad \text{for } t < 0$$

and

$$Ga(t) = \min[1 - (1 + \beta t)\exp(-\beta t), \gamma] \quad \text{for } t \geq 0, \text{ or}$$
$$Ga(t) = 0 \quad \text{for } t < 0$$

Table 2.4 Symbols in the Fujisaki model formula with their meaning.

Symbol	Meaning
Fb	asymptotic value of fundamental frequency (baseline frequency)
I	number of phrase commands
J	number of accent commands
Ap_i	amplitude of the *i*th phrase command
Gp	phrase control mechanism
$T0_i$	timing of the *i*th phrase command
α	natural angular frequency of the phrase control mechanism
Aa_j	amplitude of the *j*th accent command
Ga	accent control mechanism
$T1_j$	onset of the *j*th accent command
$T2_j$	offset of the *j*th accent command
β	natural angular frequency of the accent control mechanism
γ	ceiling level of the accent component

2.3.2 Base frequency

Baseline frequency Fb (here called base frequency) is defined as the "(…) bias level upon which all the phrase and accent components are superposed to form an f0 contour" (Fujisaki & Hirose, 1984), or as an asymptote in the absence of commands (Fujisaki, 1992, 1997). It remains constant over the utterance.

There are two methods of modelling the base frequency: it is either allowed to vary between utterances, or is kept constant for the speaker. In the original Fujisaki works the explanations remain linguistically vague, e.g. Fb "(…) is always adjusted to bring the sum of differences between the observed and calculated f0 contours to zero" (Fujisaki & Hirose, 1984). It can be inferred, however, that error minimisation in the modelling procedure involves adjusting Fb to each utterance, hence treating it as variable. Möbius (1993, 1997) also regards Fb as an utterance-dependent parameter. On the other hand, the constant setting is applied in the works of Mixdorff (1998, 2002) and Leemann (2009), where the base frequency is treated as a speaker-dependent parameter. The argument used by both authors is that the pitch floor remains largely unaffected within the utterances of the same speaker.

In the author's opinion, either of the two Fb approaches is possible but each has different implications for the phrase command settings, and the resulting modelling. The variable setting is well suited to the linguistically-motivated approach, where utterance-specific Fb ties in with the concept of register level, and may thus be beneficial for accurately capturing register effects due to sentence mode, emotional state, speaking style etc. On the other hand, the speaker-specific setting is also viable provided that their register level remains within a narrow f0 range.

2.3.3 Phrase component

The phrase component of the Fujisaki model is defined as the higher-level component which models the f0 trend at the phrase level.[9] It is regulated by the damping factor alpha (α) of the phrase control mechanism. The choice of α determines the timing and amplitude response (and thus the shape) of the phrase command. The effect of different α settings is shown in Figure 2.3. It transpires that decreasing α produces a phrase command which rises to maximum amplitude more slowly, takes longer to decay to near-zero amplitude, and produces a gentler declination slope. In this approach varying α is the marker of declination along with amplitude; however, it introduces variability in phrase command timing and amplitude, which is not desirable when comparison of the parameters is involved. Thus varying α is generally avoided.

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[9] It should be noted that negative phrase commands of constant amplitude (-0.1) are used by Möbius (1993) in the IP-final position for statements and wh- questions to model the rapid f0 drop found therein.

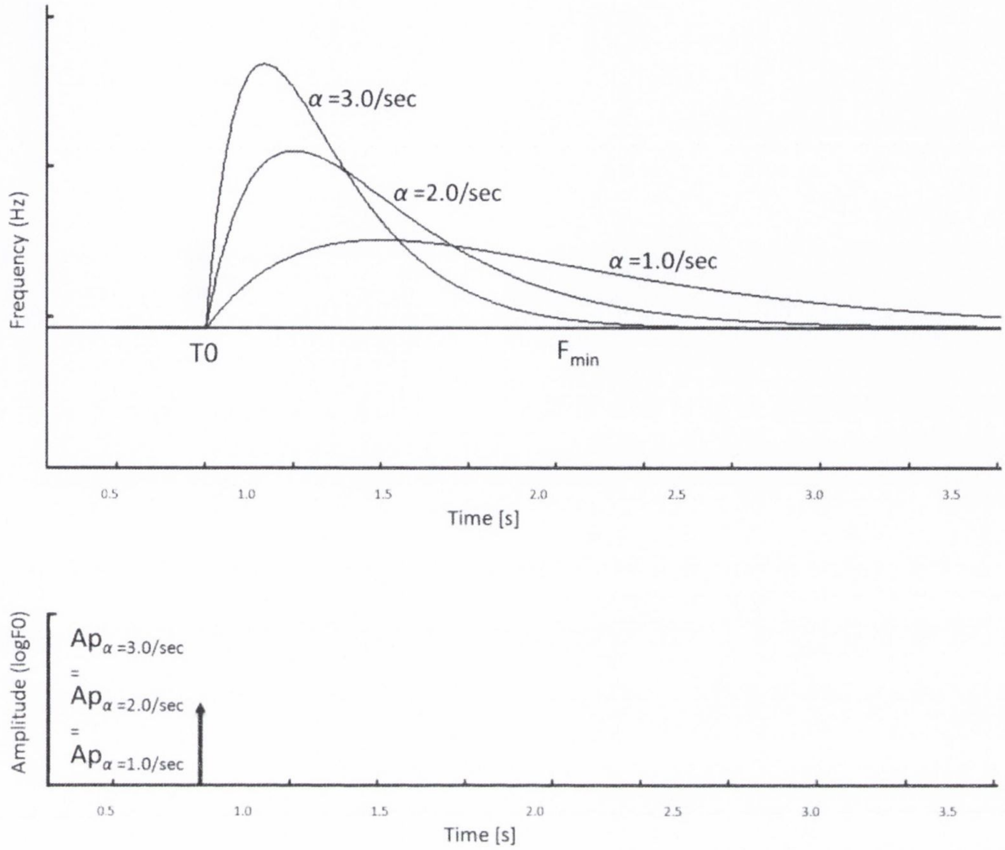

Figure 2.3 Phrase command response under varying alpha and with constant amplitude (from Leemann, 2009).

Let us now look at the phrase command shape under a constant α setting (Figure 2.4). It can be observed that once α has been fixed, the phrase command rise to maximum amplitude and decay to near-zero remains the same whatever the amplitude. Once α is held constant, the phrase command amplitude (Ap) controls the tilting of the declination curve: progressively increasing Ap values generate increasingly steeper slopes.

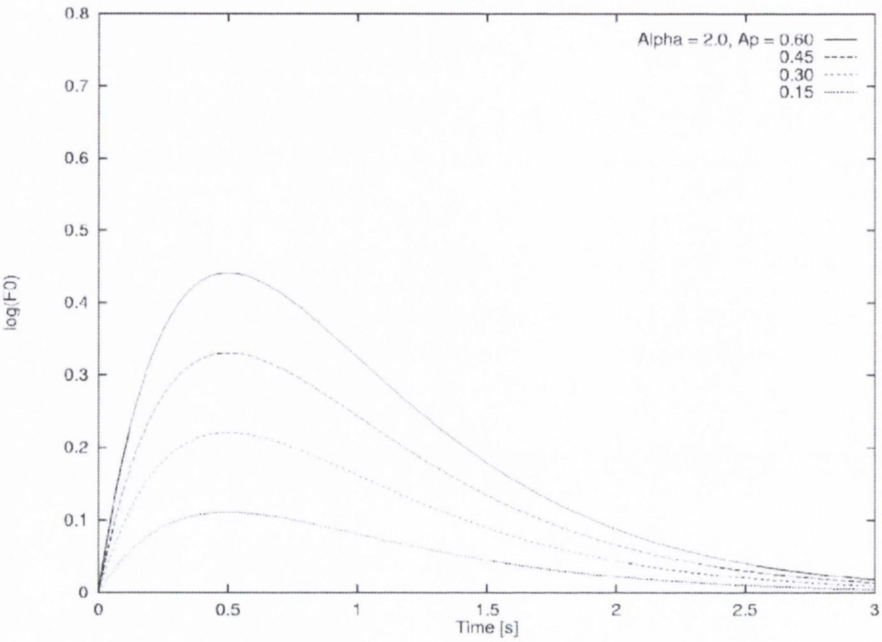

Figure 2.4 Phrase command response under constant alpha and with varying amplitudes (from Mixdorff, 1998).

The α factor is almost unanimously treated as constant but, as with Fb, the exact settings vary between authors. Only in some earlier works (Fujisaki & Hirose, 1984) α was allowed to vary slightly in relation to utterance length (values of 2.8 to 3.3). The optimal value suggested by Fujisaki is approximately 3.0/sec (Fujisaki, 1988, 2004) and is recommended for Japanese as well as other languages. Möbius (1993) uses a similar value of 3.1/sec. On the other hand, Mixdorff's (1998, 2002) and Leemann's (2009) approaches feature a comparatively lower α of 2.0/sec.

The phrase command timing settings also differ between authors. Fujisaki (1987) suggests that phrase command onset (T0) is located approximately 200 ms before the onset of an utterance.[10] Mixdorff (1998) sets T0 at 300 ms. Bearing in mind Pätzold's (1991) relationship of T0 = 1/α for the phrase command to achieve its maximum amplitude at the IP onset, Fujisaki's T0 corresponds to Ap max at about 130 ms, and Mixdorff's at 200 ms *into* the utterance. Möbius (1993) and Leemann (2009) set the phrase command to reach its maximum amplitude at the IP onset.

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[10] Fujisaki provides a physiological argument in support of this setting (activation time of the thyroid cartilage).

In the author's opinion, the α setting may be directly connected to the choice of base frequency. It hardly seems a coincidence that both Fujisaki's and Möbius's approach feature variable Fb and α close to 3.0, while Mixdorff's and Leemann's involve constant Fb and a lower α of 2.0. Variable base frequency may necessitate the use of a higher α value, as when the asymptote is close to or at the utterance-specific global minimum, steeper phrase commands are desired. Conversely, when the asymptote is set further below the global minimum, as in the constant Fb setting, the phrase command slope needs to be reduced. Testing this hypothesis quantitatively is beyond the scope of this work. However the argumentation used here is based on the modelling of some Connemara and Donegal data carried out by the author in the early stages of the dissertation work. The initial method involved the speaker-specific constant Fb setting in which the best phrase command fits were obtained when α was set to a value between 2.0 and 2.3. The (alternative) adopted approach with utterance-specific Fb performed best with α of 3.0/sec. No α alteration dependent on the dialect was required.

2.3.4 Accent component

The accent component of the Fujisaki model is defined as the lower-level component modelling a local f0 movement. The accent component is controlled by the damping factor beta (β) of the accent control mechanism. The choice of β determines the timing and amplitude response (and thus the shape) of the accent command. The effect of a variable β setting is illustrated in Figure 2.5. It can be observed that decreasing β produces an accent command which rises to maximum amplitude and falls to the baseline later, hence producing relatively gentler rising and falling slopes. In this approach, varying β along with amplitude provide a measure of rising and falling f0 movements. Varying this factor, however, hinders comparison of the timing and amplitude parameters across data. As a consequence, β is typically kept constant.

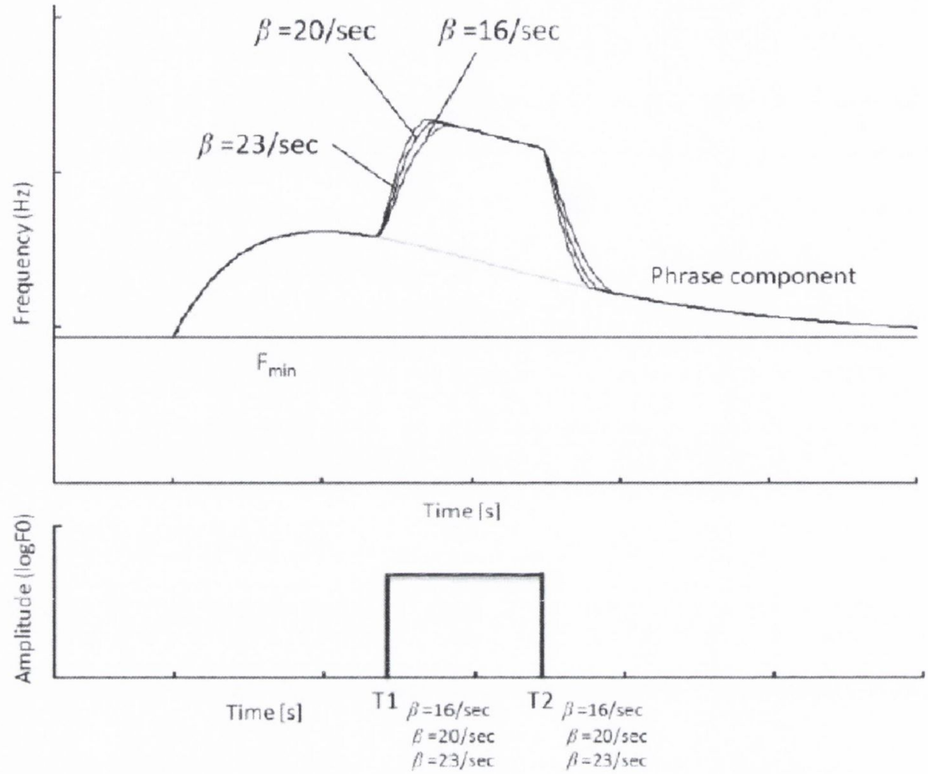

Figure 2.5 Accent command response under varying beta and with constant amplitude (from Leemann, 2009).

The accent command response under constant β and with varying amplitude is presented in Figure 2.6. Once β is fixed, the rate of rise to maximum amplitude and decay to zero remain constant provided that the accent command has been given sufficient time (duration of 194 ms or more) to reach its full amplitude (Aa). When β is held constant, the rising and falling slopes are controlled through the accent command amplitude. Progressively increasing Aa values generate increasingly steeper rising and falling gradients.

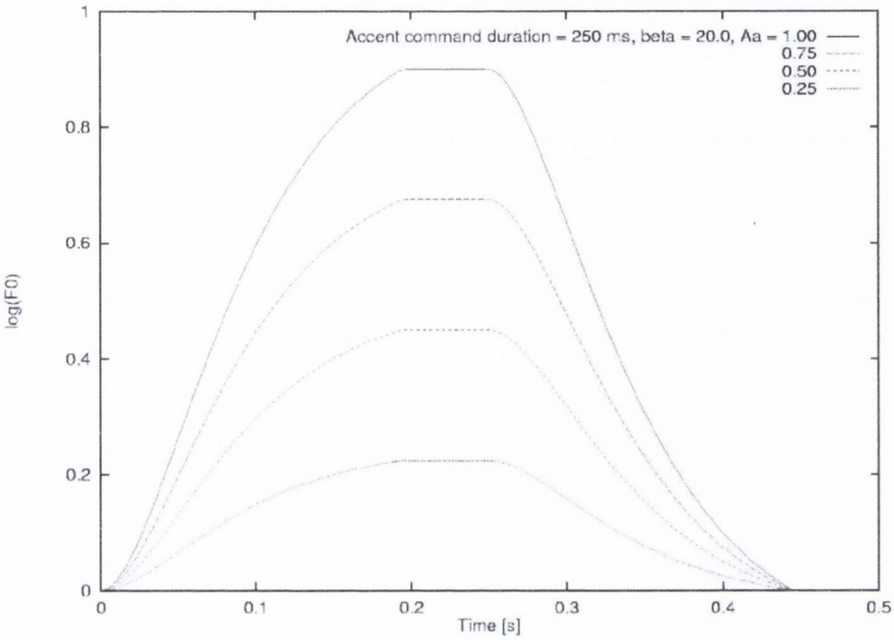

Figure 2.6 Accent command response under constant beta and with varying amplitudes (from Mixdorff, 1998).

The accent command response under constant β and with varying accent command durations is illustrated in Figure 2.7. It has been shown that the choice of β determines the accent command response, but accent command duration also plays a role. When β is set to 20.0/s, the accent command requires approximately 200 ms to reach its maximum amplitude (the 200 ms duration in Figure 2.7). Durations of over 200 ms (the 250 ms duration in Figure 2.7) produce accent commands with full Aa reached, albeit with the peak turning into a plateau (recall the gamma ceiling level in Ga(t) capping Aa at 0.9). However, durations of less than 200 ms (the 100 and 150 ms durations in Figure 2.7) produce accent commands with clipped amplitude, and the resulting curtailed course of the rising and falling slopes.

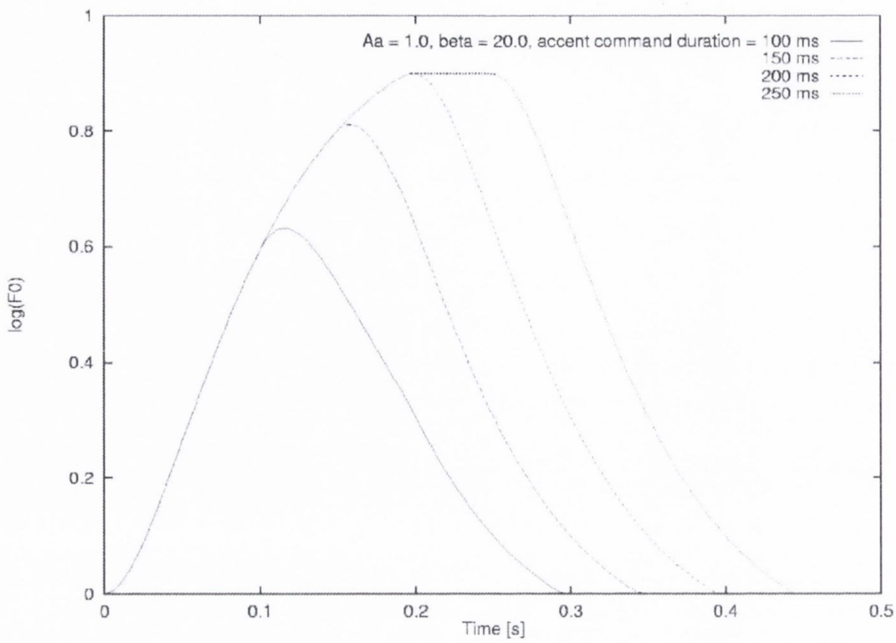

Figure 2.7 Accent command response under constant beta and with varying durations (from Mixdorff, 1998).

The β factor in the accent component is by default treated as constant, in the same way as α in the phrase component. The precise β settings vary only slightly across the main approaches. The setting recommended by Fujisaki (1987, 1992) proposes a ratio of 7:1 for β/α, which at α = 3.0/s gives β the value of approximately 20.0/s. Also Mixdorff (1998, 2002) and Leemann (2009) apply the standard value proposed by Fujisaki. Only Möbius (1993) suggests a lower value of 16.1/s as optimal for his German data.

The accent command time-points are not fixed, as they are determined by the shape of the local f0 contour. Möbius argues that T1 is significant for describing rising f0 movements and T2 for falling f0 movements. This interpretation seems to reflect the rise-fall shape characteristics of the accent command. Fujisaki (1988, 1997) talks of accent commands in Japanese starting about 50 ms before the segmental onset of a high mora, and ending about 50 ms before its offset. This setting is not intended as a prescription for modelling pitch accents in other languages, but may simply be a reflection on the regularity and compactness of the accentuation system in Japanese.

2.4 Summary

This chapter provided a description of the two analytical tools used in the present work, the IViE system and the Fujisaki model. The presentation included the treatment of phrasing and accentuation in both approaches. The theoretical basis for each approach and the use of the model elements with their associated meanings were also given.

The next chapter will demonstrate the research materials and methodology applied in this dissertation. The core sections will explain how the IViE system and the Fujisaki model were used for describing the intonation of Connemara and Donegal Irish. The explanation of the two frameworks with respect to phrasing and accentuation will parallel the structure of the present chapter.

Chapter 3
Materials and methods

3.1 Introduction

This chapter describes the experimental part of the present work. Firstly, Section 3.2.1 describes the varieties of Irish and the speakers involved in the study, and the criteria underlying the selection of the speakers. Section 3.2.2 provides an overview of the three corpora (sentence mode, alignment and focus) used in the experimental part of this dissertation. The recording procedure is covered in Section 3.2.3.

The analysis methods constitute the core part of this chapter. The two models applied in this dissertation are the AM-based IViE system to obtain the prosodic description, and the Fujisaki model to obtain quantifiable parameters for which a correspondence with the prosodic categories of the IViE description can be established. Sections 3.3 and 3.4 explain how each of the two systems was applied in the present work. The methodology involved in the two levels of analysis is identical for all three topics (sentence mode, alignment and focus).

Along with the AM and Fujisaki model descriptions, specific contour-derived measurements were taken to quantify the intonation of Connemara and Donegal Irish independently of the Fujisaki model, and at the same time to provide the basis for assessing the descriptive usefulness of the model. The choice of the contour-derived metrics was motivated by what would best capture the phenomenon under scrutiny. For ease of reference, Section 3.5 details the set of the f0 metrics used in the three topics, and how these metrics relate to their Fujisaki model equivalents. Finally, Section 3.6 briefly covers the methods of presenting the quantitative results in terms of descriptive statistics and follow-up tests of variance.

3.2 Materials

3.2.1 Informants

The informants recorded for this study represent two dialects of Irish: Donegal in the northwest and Connemara in the west of Ireland (Figure 3.1). The Connemara data was collected from two locations, Cois Fharraige on the coast of County Galway, and Inis Mór, the largest of the three Aran Islands off the coast of County Galway. The choice of these two particular locations was motivated by the earlier accounts of Dalton & Ní Chasaide which suggested within-dialect differences in Connemara at the phonetic level (Dalton, 2008; Dalton & Ní Chasaide, 2007a, 2007b). It was shown that the Cois Fharraige and Inis Oírr varieties are similar in their intonational phonology, but they use different alignment strategies (Cois Fharraige employing fixed alignment and Inis Oírr exhibiting variable alignment).[11]

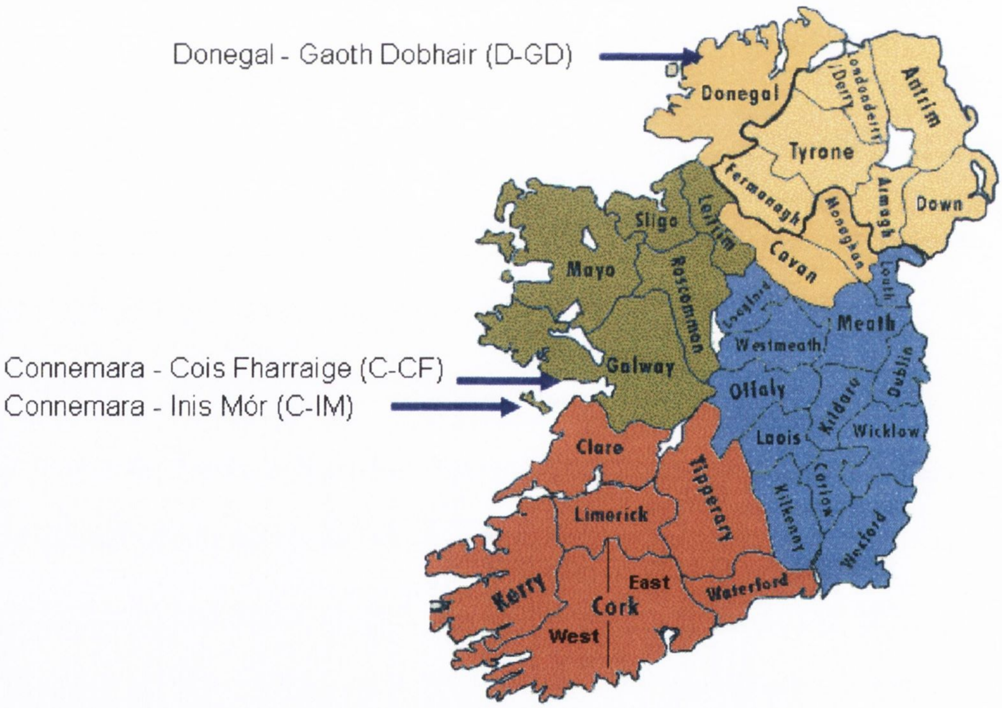

Figure 3.1 Map of Ireland indicating the three varieties of Irish investigated in the present study.

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[11] A more detailed coverage of the alignment differences reported for Cois Fharraige and Inis Oírr is provided in Chapter 5.

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. newsreaders, actors). They use Irish on a daily basis, at work and/or among family and friends. No requirements were imposed on speaker gender or age, as the main criterion for choosing the informants was that they be native speakers and use Irish daily. The Cois Fharraige and Gaoth Dobhair informants were recruited in Dublin, while the Inis Mór speakers were recruited in the Gaeltacht (more in Section 3.2.3 on the recordings).

A brief description of the informants who represent the three varieties of Irish is given in Table 3.1. A detailed view of the speakers' origins is provided in Figure 3.2. The exact locations, which are explained in the text, are marked with blue circles.

Table 3.1 Background information about the speakers recorded for the present study.

Variety	Speaker initials	Speaker code	Gender	Age group	Currently living in Gaeltacht	Irish spoken at home and/or work
Cois Fharraige	COG	CF1	M	20-30	no	yes
	COT	CF2	M	20-30	no	yes
	MUU	CF3	F	30-45	no	yes
	SD	CF4	M	20-30	no	yes
Inis Mór	AUD	IM1	F	45-60	yes	yes
	CNC	IM2	F	45-60	yes	yes
	EOC	IM3	M	45-60	yes	yes
	MR	IM4	F	45-60	yes	yes
	TNM	IM5	F	45-60	yes	yes
Gaoth Dobhair	AD	GD1	M	45-60	no	yes
	CNN	GD2	F	30-45	no	yes
	MAH	GD3	F	30-45	no	yes
	MOF	GD4	M	30-45	no	yes
	PNB	GD5	F	30-45	no	yes

Figure 3.2 Map of West Connemara (upper panel) and Donegal (lower panel) indicating the informants' places of origin. The exact locations are marked with blue circles.

The Cois Fharraige (C-CF) group recorded for this study comprises one female and three males (Table 3.1). The speakers are from two locations which are geographically close. The male speakers are from Indreabhán (Inverin, location 1 in Figure 3.2) about 30 km west of Galway City. All three were close to completing or had completed their third-level education at the time of recording, and were visiting home regularly at the weekends while living in Dublin. The male speakers belong to the youngest age group (under 30). The female speaker originally comes from An Cheathrú Rua (Carraroe, location 2 in Figure 3.2) about 42 km west of Galway City, and is a working professional living with her family in Dublin. She belongs to the 30-45 age group.

The Inis Mór (C-IM) group originally included eight speakers. Out of them the five most fluent speakers (four females and one male) were chosen for the analysis. All informants come from the island of Inis Mór (Inishmore, location 3 in Figure 3.2). They are the most uniform group in terms of age (the 45-60 age group, Table 3.1), and are close-knit (family members/friends). They were either still in the workforce or retired at the time of recording, and they were all living on the island.

The Gaoth Dobhair (D-GD) group consists of five speakers, all of whom come from Gaoth Dobhair (Gweedore, location 4 in Figure 3.2) in northwest Donegal. The participants were three females and two males (Table 3.1). Most of the Gaoth Dobhair speakers belong to the 30-45 age group, and are working professionally. All five are now living in Dublin, while two of them visit their family and friends back home fairly regularly.

3.2.2 Corpora

The full corpus recorded for the present study of the intonation of Connemara and Donegal Irish includes read and spontaneous speech. Seven tasks were recorded in total for Cois Fharraige and Gaoth Dobhair in two separate recording sessions. The Inis Mór recordings were done in one session, and include five tasks. The full recordings for all three varieties are enclosed on the CD-ROM attached to the thesis.

For the dissertation, three tasks were chosen for the intonational analysis of Connemara and Donegal Irish, as well as for testing the Fujisaki model. These tasks include only read speech. The strong advantage of using "lab speech" in experimental work is that it allows systematic control of contributing factors, which helps unravel the mechanisms involved in a language (Xu, 2010). While spontaneous data is of undoubted value in speech studies, it is not suitable for investigating the research questions pursued in the dissertation. The first aim, the cross-dialect comparison, involves the description of intonation at the phonetic level, which requires directly comparable materials for all three varieties. Controlled speech material is also crucial for the second aim: the Fujisaki model can only be properly assessed when the materials provide a suitable context for testing specific aspects of intonation. An example of such an aspect would be declination which is influenced by phrase length. Therefore, the test sentences comprise matched two- and three-accent IPs with a near-constant number of inter-stress syllables (see more on the sentence mode corpus in this section).

Before we look at each of the three corpora in depth, the general characteristics of the materials will be explained. To enable a direct comparison of the measurements, the sentences are kept nearly identical; only minor changes were introduced to suit the syntax, grammar and vocabulary of each dialect. Target phrases are simple everyday-speech phrases which are easy to pronounce, and thus promote naturalness on the part of the speakers. To ensure the production of single intonation phrases with the same number of pitch accents (IP-medial accentuation being optional), all target phrases contain either two or three accent groups. The target phrases are embedded in mini-dialogues (question-answer type) with a concrete pragmatic context to evoke the 'typical tune'. Presenting a list of isolated sentences was decided against, as this type of material can leave the speaker unsure of what pattern to use, cause the occurrence of spurious narrow focus, and may encourage drone intonation.[12] The prompts were repeated 4–5 times to strengthen observations, and were randomised to prevent order effects.

The three corpora used in the dissertation were designed to test the effects of sentence mode, alignment and focus on the intonation contours of Connemara and Donegal Irish. These materials were written and edited to suit each dialect. A comprehensive transcript

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[12] A pilot recording of a list of sentences was done with one of the Cois Fharraige speakers (CF1). After the recording session the speaker reported that he "did not know how to read the sentences". A first-pass annotation of the recording revealed frequent occurrences of narrow focus and some hesitations; also, the speech sounded drab.

of the full question-answer prompts is included in the Appendix. The selected speech material, i.e. the target phrases with all the associated analysis files (the Praat-generated .Pitch and .TextGrid annotation files, as well as the Fujisaki model parameterisation files) are enclosed on the CD-ROM attached to the thesis. The remainder of this section explains each of the three corpora which correspond to the three topics covered in this dissertation.

3.2.2.1 Corpus I: Sentence mode

Corpus I was designed to test the effect of sentence mode on the intonation contours. The target phrases of Subset A analysed here are presented in Table 3.2 (Subset B is nearly identical in design, and was not analysed, but the full prompts are included in Corpus I section of the Appendix).

Table 3.2 Target phrases in the sentence mode corpus with their translations into English. Stressed syllables are marked in bold font.

	Long phrases (3 accent groups)	Short phrases (2 accent groups)
I. Sentence mode	DEC Bhí Cian ag caint leo sa margadh. 'Cian was talking to them at the market.'	DEC Bhí Cian ag an margadh. 'Cian was at the market.'
	WHQ Is **cé** bheas á **mbail**iú ón **mar**gadh? 'And **who** will col**lect** them from the **mar**ket?'	WHQ Is **cé** bhí ag an **mar**gadh? 'And **who** was at the **mar**ket?'
	YNQ 'Raibh **Cian** ag **caint** léi sa **mar**gadh? 'Did **Cian talk** to her at the **mar**ket?'	YNQ 'Raibh **Cian** ag an **mar**gadh? 'Was **Cian** at the **mar**ket?'

The Corpus I material consists of matched declaratives (DEC) and two question types, wh- (WHQ) and yes/no (YNQ) questions with two phrase lengths expressed as the number of accent groups in the IP, either two (short) or three (long). The two lengths were chosen to examine declination; no specific predictions were made for the remaining f0 metrics. Declarative questions were omitted from the study, as they may not be used frequently in Irish (cf. Dalton (2008)).

3.2.2.2 Corpus II: Tonal alignment

Corpus II was designed to test the effect of the rhythmic context on the realisation of IP-initial and IP-final pitch accents. Particular attention is paid to tonal alignment, but f0 excursion and duration are also of interest in the context of the Fujisaki model. Target phrases are presented in Table 3.3. The Corpus II material has two subsets. First, the Tail subset features two-accent IPs where the nuclear (N) stressed syllable is *followed* by a systematically varied number of unstressed syllables (from 0 to 2, zero denoting the absence of tail). Second, the Anacrusis subset includes 2-accent IPs where the prenuclear (PN) stressed syllable is *preceded* by a systematically varied number of unstressed syllables (from 0 to 2, zero denoting the absence of anacrusis).

Table 3.3 Target phrases in the alignment corpus with their translations into English. Stressed syllables are marked in bold font.

	Tail (0-2 unstressed syllables)	Anacrusis (0-2 unstressed syllables)
II. Alignment	N0 (CI) Bhí an **carr** seo **lán**. 'That **car** was full.' (DI) Tá mo **mhála** **lán**. 'My **bag** is full.'	0PN **Lán** go dtí'n **do**ras. '**Full** to the **door**.'
	N1 (CI) Tá'n **ci**teal **lán** a'm. 'I've the **kettle** **filled**.' (DI) Tá'n **ci**teal **lán** de. 'The **kettle**'s **full** of it.'	1PN A **lán** de na **sean**daoine. 'A **lot** of the **older** people.'
	N2 Tá'n **ci**teal lán aici. 'She's the **kettle** filled.'	2PN Bhí a lán acu ar **mei**sce. (CI) Bhí a lán acu ag **ól**. (DI) 'A lot of them were **drunk**.'

3.2.2.3 Corpus III: Focus

Corpus III was designed to test the effect of focus on the f0 contour. Subset A compares contrastive and narrow focus to broad focus in three accent positions in the IP. The target phrases of Subset A analysed here are shown in Table 3.4 (Subset B for emphatic focus was not analysed but the materials are included in Corpus III section of the Appendix).

The Subset A material includes one target phrase embedded in a number of contexts which elicit broad focus (one context), and contrastive focus on the 1st, 2nd or 3rd item in the phrase (three contexts). Narrow focus phrases (two contexts with focus on the 1st or 3rd item) were used where the contrastive rendition was lost due to disfluencies or failure to produce the contrast.

Table 3.4 Target phrases in the focus corpus with their translations into English. Stressed syllables are marked in bold font.

	Broad focus (bf)	Contrastive focus (cf1, cf2, cf3) Narrow focus (nf1, nf3)
III. Focus	Bhí **Meabh** ina **luí** ar an **lea**ba. (CI) Bhí **Meabh** ina **luí** ar an **lea**baidh. (DI) '**Meabh** was **ly**ing on the **bed**.'	Bhí **Meabh** ina **luí** ar an **lea**ba. (CI) Bhí **Meabh** ina **luí** ar an **lea**baidh. (DI) '**Meabh** was **ly**ing on the **bed**.'

3.2.3 Recordings

As already mentioned, all informants are native speakers of the local variety of Irish, and were recorded at two different locations. The Cois Fharraige and Gaoth Dobhair recordings were carried out in a semi-anechoic room at the Phonetics Laboratory of Trinity College Dublin. Data was recorded directly onto the computer using Audacity software. Recordings were made at the 44,100 Hz sampling frequency using a high-quality unidirectional microphone placed approximately 30 cm from the speaker's mouth. The speakers performed the tasks with a research assistant. The Cois Fharraige informants were paired with a fluent Irish speaker, while the Gaoth Dobhair informants interacted with a native speaker from Gaoth Dobhair. All received a small amount of money for their participation in each recording session.

The Inis Mór recordings were done on the island, in a quiet room in a local private house belonging to one of the informants. Data was recorded at the 44,100 Hz sampling frequency onto a laptop using Audacity software. The speakers wore high-quality head-mounted microphones and performed the tasks in pairs. The informants received a small amount of money for their participation in the recording.

The informants were given basic information on the project and instructions were kept to a minimum. Before the recording the speakers were told that their speech will be used in a dissertation project on the melody of Irish dialects. The free tasks did not involve instructions as such: the informants received the explanation about the task on the screen in Irish. The read tasks with randomised prompts were all presented on the screen and each task was preceded by a short instruction note. The note asked the speaker to read the text at a comfortable speed ("as if you were saying it"), and if they made a mistake to simply repeat the entire phrase again.

3.3 Prosodic annotation with IViE

The IViE labelling system (Grabe, 2001; Grabe et al., 1998; Grabe et al., 2000a) was chosen for the analysis of the Connemara and Donegal data in this work. It was preferred over ToBI (Beckman & Ayers Elam, 1997; Beckman et al., 2005; Silverman et al., 1992) because of its transparency in describing the intonation contours. The IViE system is used in this work largely in its original form. The remaining parts of Section 3.3 explain how the system was used in practice (3.3.1 and 3.3.2), what tunes were found to be the main types in the two dialects (3.3.3), and how the IViE results are presented in the experimental part of the thesis (3.3.4).

3.3.1 Application of IViE in present work

The accent label pool used in this work consists of four basic categories summarised in Table 3.5. These mono- and bitonal labels are sufficient to describe the f0 course of pitch accents in any position in the phrase. The tritonal labels (H*+LH%, L*+HL%) can be viewed as cases of incorporating the f0 movement at the final boundary. The pitch accents are treated as left-headed in both dialects. The plus sign notation in H*+L and L*+H is used in this work to indicate the bitonal composition of pitch accents, i.e. that the two tones function as a unit (Grabe et al., 1998), and does not imply a constant time interval between the two tones (cf. Asu, 2004). The + sign, similarly to zero in 0%, can be dispensed with altogether, as in the official IViE labelling guide (Grabe, 2001). The '_' symbol, which is found in the earlier versions of IViE (Grabe et al., 1998) to indicate rightward displacement of the trailing tone (e.g. H*+_L), is not used here.

Table 3.5 Inventory of accent labels, tone modifiers and boundary tone labels used in the present work.

Accent label	Description
H*+L	High target followed by low target
H*	High target (occurs mostly in IP-initial position)
L*+H	Low target followed by high target
L*	Low target
Tone modifiers	**Description**
!	Downstep (of high target)
^	Upstep (of high target)
Boundary tone label	**Description**
%H H%	High boundary
%L L%	Low boundary
% %	Unspecified boundary (no change from preceding tone)

Downstep and upstep (tone modifiers in Table 3.5) are used in this work nearly exclusively for the transcription of Connemara Irish. Downstep (!), i.e. lowering of a tone relative to the preceding one, is used sparingly and applies to the IP-medial and IP-final H* tones when these are directly preceded by another H tone. Thus, in a two-accent IP, the nuclear fall can be downstepped when preceded by either H* or L*+H (i.e. H* !H*+L%, L*+H !H*+L%). In simple terms, the fall comes out as suppressed. Sequences of H*+L accents in the Connemara data generally descend along the IP by default, hence marking downstep in this tonal configuration is viewed here as notationally redundant. Similarly, the Donegal sequences of L*+H accents frequently exhibit H descent which is not marked with the downstep notation, either. Upstep (^), i.e. raising of the H tone relative to the preceding one, is usually found in the Connemara data in the nuclear position (H* ^H*+L%, L*+H ^H*+L%, also H*+L ^H*+L%). The f0 excursion of the fall appears expanded due to H being elevated.

The treatment of phrasing follows the standard IViE conventions (Grabe et al., 1998), where the annotation of phrase boundaries (Table 3.5) is straightforward. The intonation phrase (IP) is the only unit, and its right and left limits are marked by edge tones. Three options are available: high (%H, H%), low (%L, L%) and tonally unspecified (%).[13]

3.3.2 Transcription procedure

The three corpora outlined in Section 3.2.2 were processed and labelled with Praat speech software (Boersma & Weenink, 2011). Prior to labelling, the speech material was subjected to an initial auditory analysis to select fluent samples. Those which contained disfluencies were excluded from further analysis.

The annotation of the speech data used in this work is performed on four tiers, either in the original IViE form, or modified for the purpose of contour parameterisation. Figure 3.3 presents an example of the prosodic annotation of the same phrase in Connemara and Donegal Irish. The four tiers indicated are (from bottom to top): *tones, syllables, rhythmic* and *phonological*.

The *tones* tier replaces the IVIE *phonetic* (i.e. *target*) tier (bottom tier in Figure 3.3), so that phonetic measurements of the f0 contour could be taken. The appropriate H and L landmarks which correspond to the tonal targets in accents (such as the IP-initial prenuclear L (LPN) and H (HPN), as well as the nuclear L (LN) and H (HN) targets in Figure 3.3) and boundary tones (the % landmarks in Figure 3.3) are selected while taking into account the f0 and intensity information. The best tone candidates contain the least amount of segmental perturbation and a high level of intensity (cf. how the accent and boundary tones are aligned relative to the f0 and intensity traces in Figure 3.3). Apart from being measured for scaling and timing, these landmarks are also used for stylised plots which illustrate the actual realisations of the most frequently occurring f0 contours in each variety.

The *syllables* tier (second from the bottom in Figure 3.3) is similar to the IViE *orthographic* tier. It is conceptually related to the rhythmic organisation in the IP. On this tier the utterance is chunked into sequences of accented syllables and the remaining post-

[13] Note that % was accompanied by the zero symbol, i.e. the 0% label in older works (Grabe, 1998a; Grabe et al., 2000a).

accentual intervals which contain any number of unstressed syllables within the stress group. The accented syllable chunks are used for calculating relative timing of tones (see measurements in the alignment and focus data in Sections 3.5.2 and 3.5.3), and on occasion are also of interest on their own (possible lengthening of the accented syllable and the accent group under focus, see Section 3.5.3).

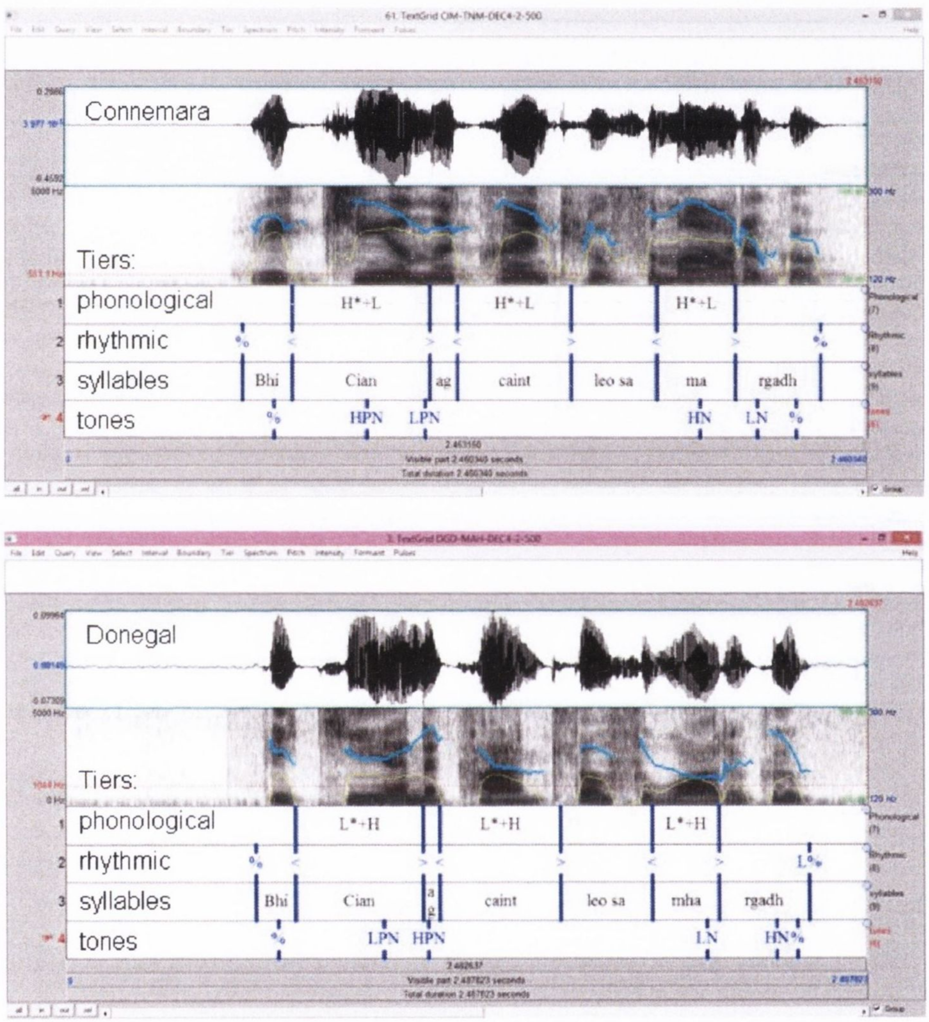

Figure 3.3 Examples of prosodic annotation of an utterance in Connemara Irish (upper panel) and Donegal Irish (lower panel) with the IViE system as used in the present work. Each panel represents (from top to bottom): the speech wave, the spectrogram with the f0 (blue line) and intensity (yellow line) traces, and the four transcription tiers.

The *rhythmic* tier (second from top in Figure 3.3) is identical to the IViE *prominence* tier. Here the location of prosodically strong (either through accentuation or stress only) syllables is identified. The start and end points of a prominent syllable are marked with the '<' and '>' symbols. The IP-initial and IP-final boundaries are marked with the standard IViE boundary tone labels given in Table 3.5. The interval between the IP boundaries, i.e. utterance length, is used for calculating declination in the sentence mode data (see Section 3.5.1).

The *phonological* tier (topmost in Figure 3.3) is used identically as in the IViE system. Here the pitch patterns corresponding to pitch accents are annotated. This work employs four basic categories: H*+L, H*, L*+H and L* (Table 3.5), the first two of which contain a starred H tone and can thus be further modified with the downstep or upstep diacritic where the relevant process occurs.

The *comment* tier, which is used in IViE for alternative transcriptions and notes, is omitted in this work. As mentioned, any speech samples which contain disfluencies or errors had already been excluded in the data selection process.

3.3.3 Most frequent tunes in Connemara and Donegal Irish

Section 3.3.3 provides an overview of the most frequent tunes (i.e. accent and boundary tone combinations) in Connemara and Donegal Irish. The presentation of the most recurring tonal configurations in the two dialects at this point is motivated by two considerations. First, the main f0 contour types are at the core of the subsequent quantitative analysis, and are common to the three topics of sentence mode, alignment and focus. Second, since the phonological level of description is the guideline for the Fujisaki modelling, it seems prudent to illustrate how the main tunes are produced before the modelling strategy has been introduced.

The typical melodic contours in the two dialects are presented in schematic form along with the tonal transcription. The schematic contours demonstrate how the most frequent tonal configurations translate into the actual f0 trace. The melodic contours of Connemara and Donegal Irish are presented as holistic units similarly to the British School tradition (Cruttenden, 1997; O'Connor & Arnold, 1973), because the pitch accents combine in a rather regular and predictable fashion. The f0 effects at phrase boundaries are viewed as modifications to the core tune.

3.3.3.1 Connemara Irish

Cois Fharraige and Inis Mór feature two leading contour types which are shown in panels (a) and (b) of Figure 3.4. The main Connemara tune is the all-falling pattern (Figure 3.4a) which consists of a sequence of falling (H*+L) accents. The H tones in the all-falling pattern usually descend relative to the preceding H along the phrase, but can alternatively stay at the same level. Accentuation of the IP-medial element is optional (the absence of accentuation is shown schematically in Figure 3.4 with a dotted line). The nuclear H*+L is occasionally produced as a 'delayed fall', i.e. a rise-fall in the O'Connor & Arnold (1973) approach, and is transcribed with the L*+HL% label (Gussenhoven, 1984).[14] The f0 at the IP-initial boundary is usually lower than the f0 of the first accentual H tone, i.e. mid-level (%). The IP-final f0 is either unchanged from the trailing L (%), or a rise can occur (H%).

The second most frequently encountered tune in the two Connemara varieties is the linked falling pattern (Figure 3.4b). It consists of a sequence of falling accents in which the underlying trailing L tone has been deleted (cf. complete linking in Gussenhoven (1984)).

There are two variants of the linked contour in Connemara Irish. The more frequently occurring type is the non-downstepped linked pattern (H* (H*) H*+L%), where the H tones are scaled similarly or mildly descend along the phrase. This effect is seen as a natural consequence of declination, similarly to the H 'downdrift' in a sequence of H*+L accents. In the present approach the medial accent is not explicitly marked as an accent (note the grey bracketed H* in Figure 3.4b). The IP-medial prominence of (H*) is thought to be achieved only through stress (the rhythmic 'beat' is retained) with no concomitant change in pitch. In the non-downstepped contour, the f0 at the IP-initial boundary is usually lower than that of the first H, i.e. mid-level (%), but can alternatively reach the same height, in which case it is marked as high (%H).[15] The IP-final f0 is either unchanged from the trailing L (%), or a rise can occur (H%).

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[14] The rising-falling nuclei in the Connemara data were produced by only one Inis Mór speaker, IM3.

[15] Marking the IP-initial boundary with %H appears optional, perhaps even redundant, from a phonological viewpoint (high IP onset could be attributed to the following accentual H). However, it has potential consequences for the Fujisaki model fit, where the phrase command amplitude is set to the IP onset in the standard setting (details in Section 3.4.5 on remedy modelling of this contour type).

The second variant of the linked contour features downstep. The H* !H* !H*+L% contour (Figure 3.4b) is understood here as a staircase pattern resembling that used in listing intonation (for classic examples see e.g. Liberman & Pierrehumbert (1984) and Grabe (1998a)). A non-initial H is treated as downstepped when it steps down relative to the preceding H, both in the acoustic trace and perceptually. The medial accent is treated as downstepped (!H*) when both stress prominence and pitch change are present. However, when no tone switch occurs, the absence of accentuation is assumed (dotted line). The nuclear !H*+L features suppression of H compared to the non-downstepped variant, but retains the characteristics of a fall, both in the f0 trace (H in the stressed syllable and L outside) as well as perceptually (cf. partial downstep in Grabe (1998a)).[16] The f0 at the final boundary remains at the level of the trailing L (%) or rises (H%).

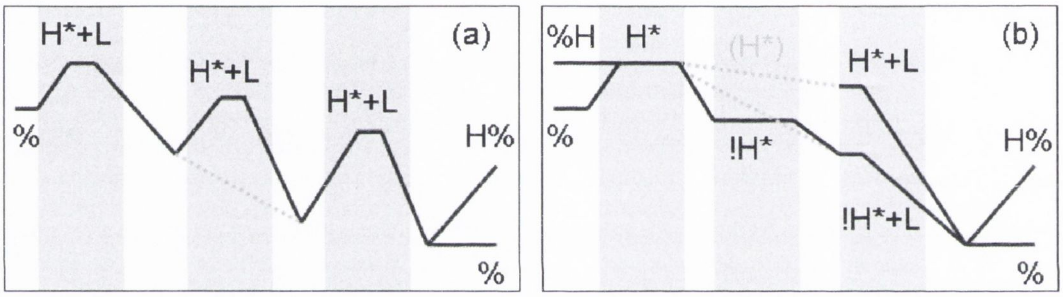

Figure 3.4 The most frequently occurring accent and boundary tone combinations in Connemara Irish and their schematic realisations. Dotted lines indicate f0 interpolation in the absence of IP-medial accentuation.

3.3.3.2 Donegal Irish

Gaoth Dobhair exhibits two main tunes which differ little from one another. The first, all-rising pattern (Figure 3.5a) comprises a sequence of L*+H accents, whose L and H usually descend sequentially (due to declination). The consecutive L*+H accents can alternatively stay at a similar level. Accentuation of the medial element is optional (dotted line). The Donegal all-rising pattern exhibits the richest array of phrase-final boundary

[16] Some L* and L*H% nuclei were encountered in the Inis Mór data. The nucleus is classified as L* rather than !H*+L when the L tone is aligned with the stressed syllable, and the main percept is that of a low (cf. total downstep in Grabe (1998a)).

tone options, where any of the three is possible: no change from the trailing H (%), an f0 drop (L%) or extra high f0 (H%).

The high-plus-rising pattern (Figure 3.5b) is rather similar to the all-rising pattern shown in Figure 3.5a. The differences involve the first accent and the IP-final boundary tone options. The IP-initial difference features H* instead of L*+H. The subsequent L*+H accents usually follow the descending pattern. The f0 at the final boundary in the high-plus-rising pattern conforms to one of the two alternatives: it remains unchanged from the trailing H (%) or drops (L%).

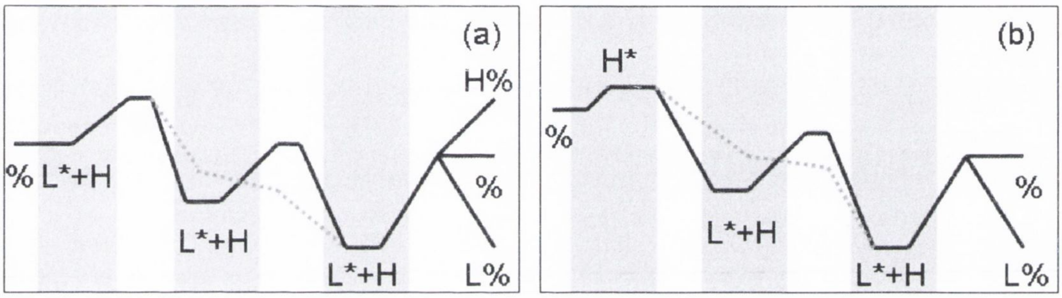

Figure 3.5 The most frequently occurring accent and boundary tone combinations in Donegal Irish and their schematic realisations. Dotted lines indicate f0 interpolation in the absence of IP-medial accentuation.

3.3.4 Presentation of IViE results

This section briefly explains how the qualitative results obtained by means of the IViE analysis are presented in the three experimental chapters. Although all of the speech data has been fully transcribed, only the IP-initial and nuclear accent plus the IP-final boundary tone are included in the results. This decision was mediated through the necessity to present the tune findings in a uniform way for all data. Since the contrastive focus and sentence mode phrases comprise between one and three accents, the results would need to be shown separately for each phrase length. This would in turn obscure the tune regularity regardless of the number of accents. The omission of the IP-medial accents in the results is justified, as they are highly predictable. The IP-medial accent either repeats the pattern of (more frequently) the first or the nuclear accent, or is absent altogether.

The IViE results are presented in the qualitative findings section of each experimental chapter, and include the accent and tune inventories in each dataset. Thus, the distributions of accent and tune types are presented separately for the sentence mode, alignment, and focus data. It has been briefly shown that each variety has a few main tune types (Section 3.3.3), as well as some lesser used ones. However, differences were found in terms of the frequency of occurrence of particular tunes depending on the dataset. For practical reasons, the tune results (and the accompanying measurement) are presented separately for each experiment, since each examines a different aspect of intonation.

A short note is due on the so-called 'excluded tunes'. The IViE analysis of the three corpora revealed that each variety had some tunes which differed too considerably from the 'standard tune' to allow comparison of the f0 measurements. To put it in context, in the Connemara data some tunes were found to have L* and L*+H accents either in the head *or* nucleus, which are the phonological opposites of the more frequent H* and H*+L categories. With respect to tune, Inis Mór is the most divergent of the three varieties analysed. Connemara has fewer non-default tunes and Gaoth Dobhair the fewest. In the Donegal variety the exclusions involve either the presence of some atypical H*+L% nuclei, or the presence of L% affecting a specific aspect (e.g. H alignment in the nuclear data). To sum up, all the less frequent tunes which could not be included in the quantitative results were gathered into one group, so that the reader would not be distracted from the main patterns. A short note in the experimental chapters will explain exactly which tunes were excluded in each dataset.

3.4 F0 parameterisation with Fujisaki model

As explained above, the Fujisaki model was chosen as the phonetic model for this dissertation for two reasons. It was intended as an analytical tool to quantify the intonation of Connemara and Donegal Irish, while also being tested for its adequacy in describing the f0 contours in a linguistically meaningful way. To this end, the modelling was guided and constrained by the IViE analysis, so that the model match would yield parameters which could be easily related to intonation phenomena such as phrasing and accentuation.

The remainder of Section 3.4 demonstrates how the Fujisaki model was used in the present work. Sections 3.4.1 to 3.4.3 provide the details about the choice of parameter settings for each of the model's three components: the base frequency, the phrase component and the accent component. Section 3.4.4 presents the modelling procedure. Section 3.4.5 illustrates what are here called 'remedy settings' for two frequent contour types in Connemara and Donegal Irish. The final section (3.4.6) discusses weaknesses of the Fujisaki model which emerged in the process of modelling of some less frequent contours of Connemara Irish.

Before discussing the three components separately, let us recap on the main features of the Fujisaki model. It consists of three components superposed on a natural logarithmic f0 scale. Base frequency (Fb) serves as the reference line for adjusting phrase and accent commands which in the present approach correspond to declination and accentuation in an IP (Figure 3.6). For a more detailed coverage of the Fujisaki model and its components the reader is referred to Chapter 2.

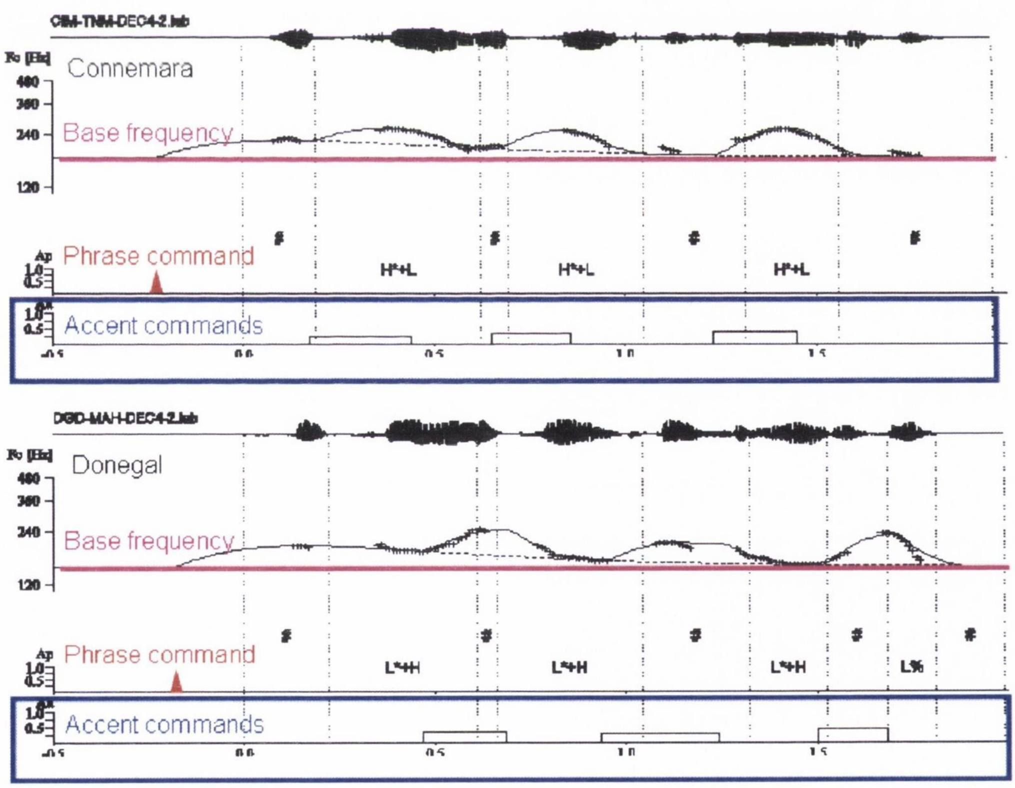

Figure 3.6 Examples of the Fujisaki model parameterisation of the same utterance in Connemara Irish (upper panel) and Donegal Irish (lower panel) carried out with the FujiParaEditor editing tool. The three model components, the base frequency, phrase command and accent commands are shown.

3.4.1 Base frequency settings

The base frequency of the Fujisaki model can be interpreted as the equivalent of register level. In this work Fb set to 0.5 semitones below the global f0 minimum in each contour, so that the global f0 minimum rests on the decaying tail of the phrase command. The overall f0 minimum is typically found in the trailing L tone of the nuclear H*+L in the Connemara contours, and in the starred L tone of the nuclear L*+H in the Donegal contours.

The base frequency in the Fujisaki model is expressed in Hertz [Hz]. To enable comparison with the contour-measured register level (described in Section 3.5) Fb is converted to semitones [ST] relative to the speaker's baseline in each dataset.

3.4.2 Phrase command settings

The phrase component of the Fujisaki model corresponds to declination in the phrase. In this work it is explicitly interpreted as the equivalent of baseline declination, as the phrase command is fitted through a sequence of the L tones in the phrase (provided that these are present in the contour). This approach only allows one phrase command per IP, so that the model component reflects the phrasing structure of an utterance.

The α constant, which controls the response of the phrase command, is set to the value of 3.0, which follows the setting recommended by Fujisaki and colleagues (Fujisaki, 1981, 2004; Fujisaki, Hirose, & Ohta, 1979). Negative phrase commands for modelling the f0 drop in the utterance-final position (Möbius, 1993) are not used.

3.4.3 Accent command settings

The accent component of the Fujisaki model corresponds to a local f0 movement. In this work the accent command is understood to model accents and high pitch at phrase boundaries. The excursion size of an f0 movement is expressed through the amplitude, Aa, while its timing is captured with the onset and offset parameters, T1 and T2. The present approach allows only one positive accent command per pitch accent. An accent command is also used for high IP-initial and IP-final boundaries, %H and H%.

The beta constant, which controls the response of the accent command, is set to 20.0, the value recommended by Fujisaki and colleagues (Fujisaki, 1981; Fujisaki et al., 1979; Fujisaki & Ohno, 1995). Negative accent commands are allowed only in one particular instance, i.e. to model the IP-final low-rising accents (L*+H) in the Donegal data. The details on how negative accent commands are fitted in this tonal context are provided in Section 3.4.5 on 'remedy settings' (with an explanation of the term therein).

3.4.4 Fujisaki modelling procedure

The Fujisaki modelling was carried out on the three corpora outlined in Section 3.2.2 with the use of FujiParaEditor (Mixdorff, 2006), an interactive computer program for carrying out the model parameterisation. The f0 trace and the tonal transcription are read in from the .Pitch and .TextGrid files created in Praat (Boersma & Weenink, 2011), which works in conjunction with FujiParaEditor. The initial part of the analysis involved automatic parameter fitting, which needed to be further optimised for the majority of the data. Next, each file was edited and manually corrected in accordance with the imposed constraints. Both FujiParaEditor and the associated version of Praat 4.0 are enclosed on the CD-ROM attached to the thesis.

The linguistically-motivated modelling in this work is carried out in the following order: base frequency, phrase command and accent command fit. First, the base frequency is fitted to the f0 contour (step (1) in Figure 3.7). Fb is set to 0.5 semitones below the global f0 minimum, which complies with the concept of an asymptote. The calculation of Fb from the contour-measured minimum was done with the help of a freely available online semitone calculator written by J. R. de Pijper (2004).

The next stage of the Fujisaki modelling involves optimising the phrase command match (step (2) in Figure 3.7). Only one phrase command is allocated to a simple IP. Any additional phrase commands (either positive or negative) which are inserted in the automatic parameterisation purely for improving the fit are deleted. The phrase command onset (T0) is set about 330 ms before the IP onset, which at alpha = 3.0 allows the phrase command to reach its maximum amplitude exactly at this location (Pätzold, 1991). The final adjustment of the phrase command involves the amplitude (Ap). In order to maintain correspondence between Ap and baseline declination, the phrase command is fitted through the overall course of the L tones in the contour if such are present. The IP onset and the IP-final low are prioritised in setting Ap, as they are more stable in terms of scaling than the IP-medial troughs.

The final stage of the Fujisaki modelling involves optimising the accent command match (step (3) in Figure 3.7). An accent command is allocated only to a pitch accent or a high boundary tone (%H or H%).[17] Any automatically-generated accent commands (positive or negative) which do not meet this criterion are deleted. The accent command time-points are determined by the f0 inflections pertaining to a pitch accent. Thus, the onset (T1) is set at the start of a rising f0 movement, while the offset (T2) at the start of a falling f0 movement. The β constant of 20.0 results in the accent command reaching its maximum amplitude at about 194 milliseconds from T1. The final adjustment of the accent command involves its amplitude (Aa), whose value is dependent on the phrase command match. In simple terms, Aa models the f0 interval between the local peak and the course of the phrase command.

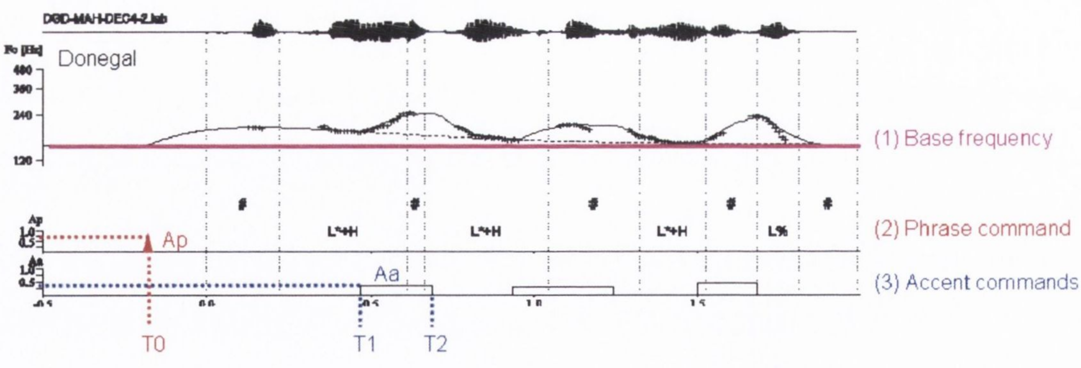

Figure 3.7 Illustration of the step-by-step Fujisaki modelling procedure on a Donegal example.

[17] In accordance with this principle, the f0 of an unaccented IP-medial syllable is not modelled with an accent command. Post-focal deaccentuation in the focus data is modelled only with the decaying slope of the phrase command (after the focal H*+L); also, T2 of the accent command which models the focal accent may be delayed to support the initial part of the post-focal contour, while the remaining part rests on the phrase command slope (after the focal L*+H).

3.4.5 Remedy settings for two contour types

This section briefly introduces 'remedy settings' for two major contour types. The term covers specific additional settings for the Fujisaki model which had to be introduced where the standard settings were either not meaningful or descriptively insufficient. The first contour type which required a special fitting strategy occurs in the Connemara data, while the second one is related to a group of contours in the Donegal data. The remedy settings differ slightly from the standard settings outlined in Sections 3.4.2 and 3.4.3. The modifications specified below were necessitated by the lack of linguistic meaning, or a degree of inaccuracy if the standard strategy were used.

The Connemara contour which required a customised fit is a particular case of the non-downstepped linked pattern (introduced in Section 3.3.3). It features a high phrase onset in the anacrusis syllables (%H H* H*+L%, example in Figure 3.8), or an IP-initial high accent with no anacrusis (H* H*+L%). In these particular cases of the linked contour, the absence of the IP-medial L tones, which would normally outline the course for the phrase command, poses a problem to the Fujisaki model match. The only f0 candidate for setting Ap is the IP onset, which in this case is high.

In the standard setting (Figure 3.8a) the phrase command amplitude (Ap) is set to the maximum at the IP onset, and no accent command is assigned to the %H boundary. In a linguistically-motivated interpretation of the %H H* H*+L% contour this Ap setting appears meaningless. The high amplitude of the phrase command and near-zero amplitude of the first accent command would suggest steep declination and near-absence of accentuation on the first H* accent. Such a reading runs counterintuitive to what one would expect from this contour type (i.e. some degree of implicitly present declination and some degree of accentuation).

An already available proposition for modelling flat high contours was taken into account but deemed unsatisfactory. The suggestion by Fujisaki and collaborators (1998) involves the use of a sequence of phrase commands of substantial amplitude, whose position is motivated purely by the principle of best fit. In the present linguistically-driven approach, the use of additional phrase commands whose function is not linked to the phrasing structure of an utterance appeared unjustified, and was therefore rejected.

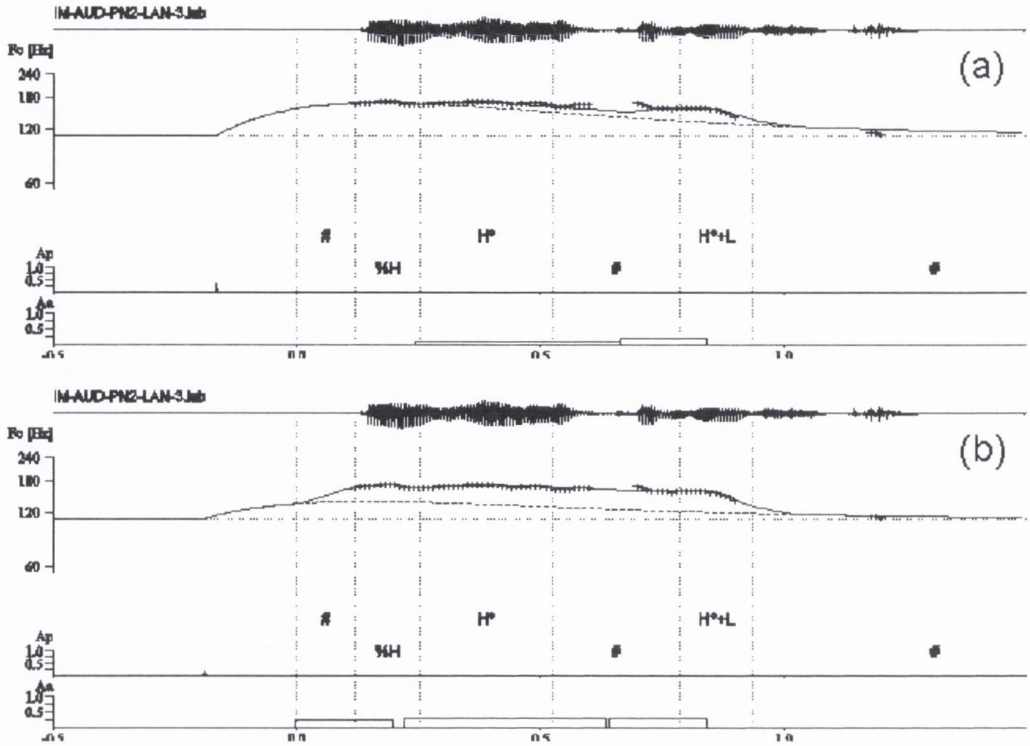

Figure 3.8 Rejected (a) and adopted (b) solution for modelling the Connemara linked contours containing a high IP onset (%H H* H*+L%).

This very problem with modelling flat f0 contours is noted in Leemann's work using the Fujisaki model on data from four dialects of Swiss German (2009). He also rejects the above proposition given by Fujisaki and colleagues, and opts for the use of one phrase command with a sequence of accent commands which increase in amplitude along the phrase.

In the present approach a third alternative to modelling high flat contours is proposed. As there are no f0 reference points for setting the phrase command unambiguously, in principle Ap could be assigned any value between zero and the maximum value delimited by the height of the IP onset. The adopted solution (Figure 3.8b) is based on the observation of regular (%) H* H*+L% contours in which the f0 at the IP onset is usually in the mid-range. Therefore, the remedy setting used here recommends that Ap be set to *half* its maximum value, so that the phrase command exhibits a moderate declination slope and the first H* accent (or the %H boundary tone) is modelled with an accent command of a usual amplitude. This setting appears a reasonable attempt at estimating the potential contribution of declination and IP-initial accentuation to the f0 course of the linked contour.

A case analogous to the flat hat Connemara contour is found in short (two-accent) IPs of the H* L*+H% contour in which the anacrusis syllables are absent, or carry no f0 trace due to reduction and/or devoicing. In this instance the L tones are absent, thus offering virtually no single reference point for setting Ap. The solution follows the same approach used for the Connemara flat hat contour, where Ap is set to *half* its maximum value (Figure 3.9).

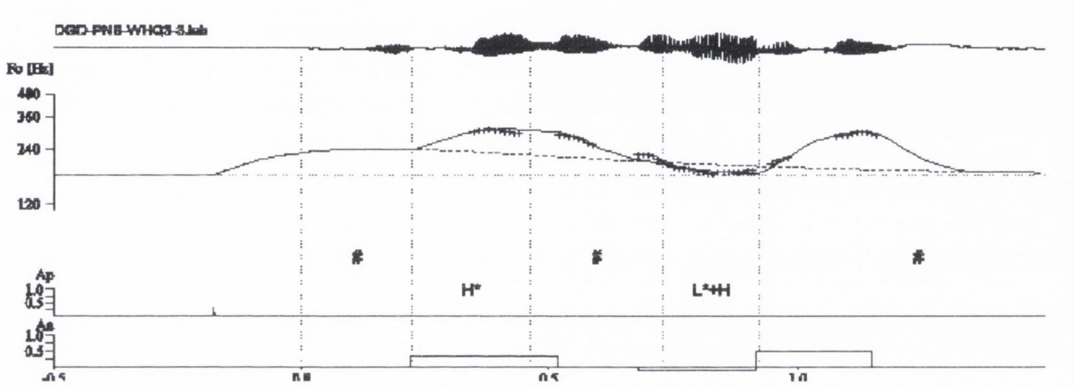

Figure 3.9 Adopted solution for modelling the Donegal H* L*+H% contours with no available f0 trace at the IP onset.

The Donegal group of contours for which remedy settings were formulated has the rising L*+H nucleus as the common denominator (introduced in Section 3.3.3). The problem for the Fujisaki model lies in an inadequate modelling of the IP-final scoop when a single positive accent command is used. This standard setting was tested on the Gaoth Dobhair data, but both the visual match and the resynthesis frequently gave an unsatisfactory outcome. The resulting rise lacked the depth of the low, which is characteristic of the Donegal scooped nuclei. As a rule of thumb, the curtailment of the low portion of the rise in the Fujisaki model match occurs more frequently in shorter (two-accent) phrases.

The adopted solution for the Donegal contours with an IP-final L*+H accent involves a principled use of a pair of accent commands of opposite polarity (Figure 3.10, also Figure 3.9). The proposed setting involves adjusting the negative and positive command so that the offset of the former overlaps with the onset of the latter. Additionally, when the positive command is sufficient, the amplitude of the negative command is set to zero. This setting appears to model the phrase-final rise adequately.

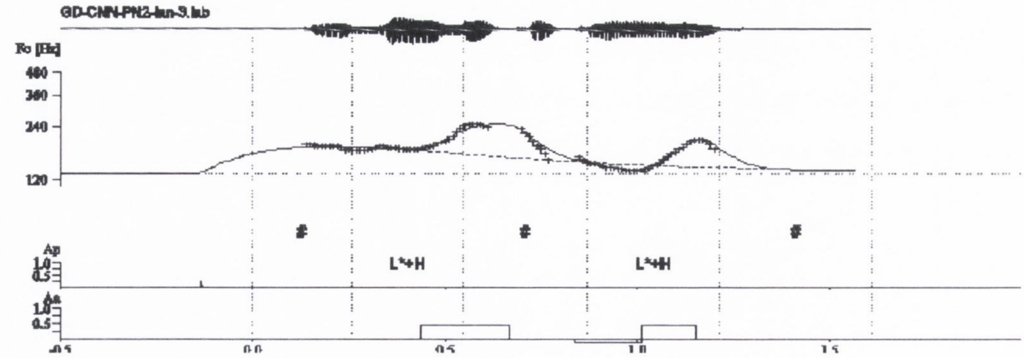

Figure 3.10 Adopted solution for modelling the Donegal contours with a nuclear L*+H accent.

3.4.6 Two problematic aspects for the Fujisaki model

Sections 3.4.1 to 3.4.5 suggest that a combination of the standard and additional remedy settings makes it possible to model the majority of the frequently occurring contours in Connemara and Donegal Irish. This section discusses two groups of the less frequent contour types of Connemara Irish (mainly Inis Mór) which cannot be satisfactorily approximated with the Fujisaki model in its current configuration.[18]

The first group of Connemara contours with which the model deals poorly involves a nuclear rise, in most cases L*H% or H*H%. Both contour types are shown in Figure 3.11. The problem lies in the need for a negative accent command whose assignment appears dictated purely by the overall contour shape. While the use of a negative command in Figure 3.11a can be partly justified (it can be related to the stressed syllable), the one in Figure 3.11b bears no affinity with the stressed syllable (the negative command occurs before the relevant nuclear H*H%).

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[18] These less frequent contours constitute a large proportion of the excluded contours in the Connemara data.

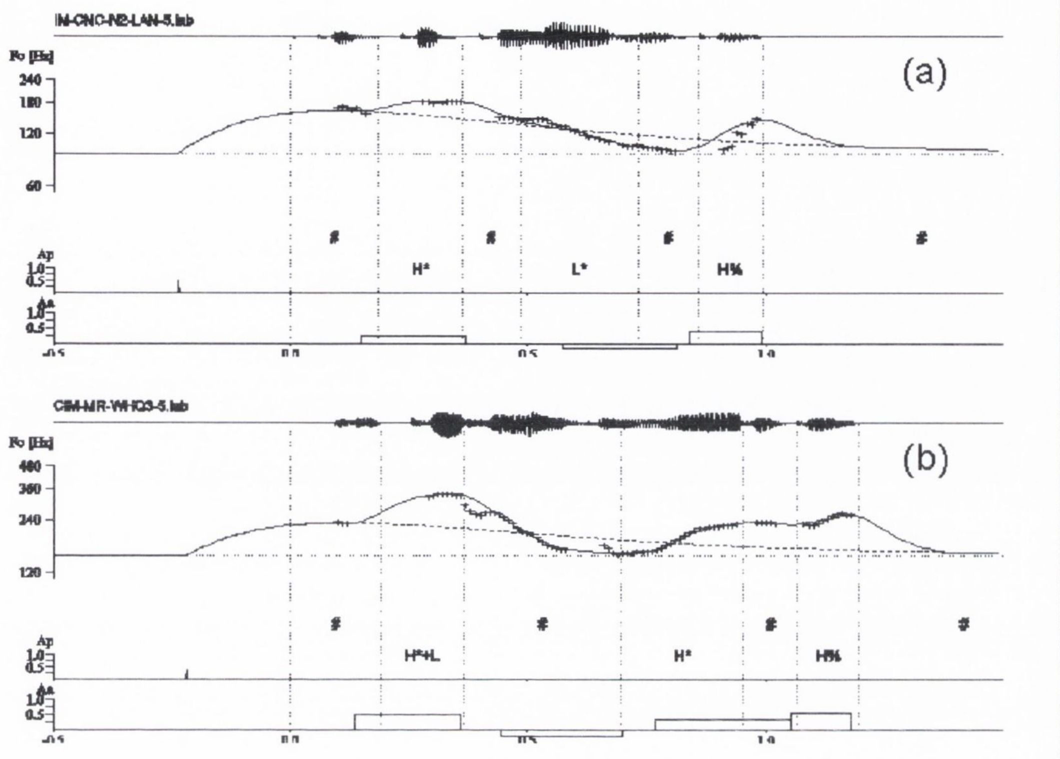

Figure 3.11 Modelling of the Connemara contours with a final rise: L*H% (a) and H*H% (b).

It is proposed that IP length poses the main challenge to the exclusive use of positive accent commands in general, regardless of dialect. One may note that the problem with modelling the IP-final Connemara rises resembles the case of the Donegal rises covered in Section 3.4.5. Testing this proposition in detail is beyond the scope of this dissertation; however, this issue can be adequately illustrated. Let us assume that the need for negative accent commands is conditioned exclusively by IP length.[19] This possibility is tested in Figure 3.12. In the original three-accent phrase (panel (a), IP duration = 1.26 s) a positive command is sufficient to model the nuclear L*+HH%. However, in the clipped two-accent version (panel (b), IP duration = 0.93 s) the final rise clearly requires a negative command. Conducting spot checks of this type, as well as observation of the available data lead to the conclusion that this statement has substantial foundations.

[19] The need for an IP-final negative accent command in the Donegal contours containing a nuclear L*+H may be determined by short IP duration, as well as the relationship between the initial and the nuclear low. If the f0 drop between the initial and final L tones is large, then Ap is fairly high, which exposes the need for a negative command. Also the two effects (IP duration and a relative L drop) may be combined, resulting in the negative accent command requiring an even higher negative value.

An alternative way of looking at the negative accent command problem is to view it as the inadequacy of the phrase component in short phrases. In short IPs (e.g. Figure 3.12b, where the phrase duration is less than 1 second), Ap has not yet substantially decayed to near zero. The rigidity of the phrase command having a constant duration was already identified by Liberman and Pierrehumbert (1984). This problem also evokes remarks of Taylor (1992), who observed the Fujisaki model's inability to model low accents and gradual rises in his English data, unless radical changes were introduced to it.[20]

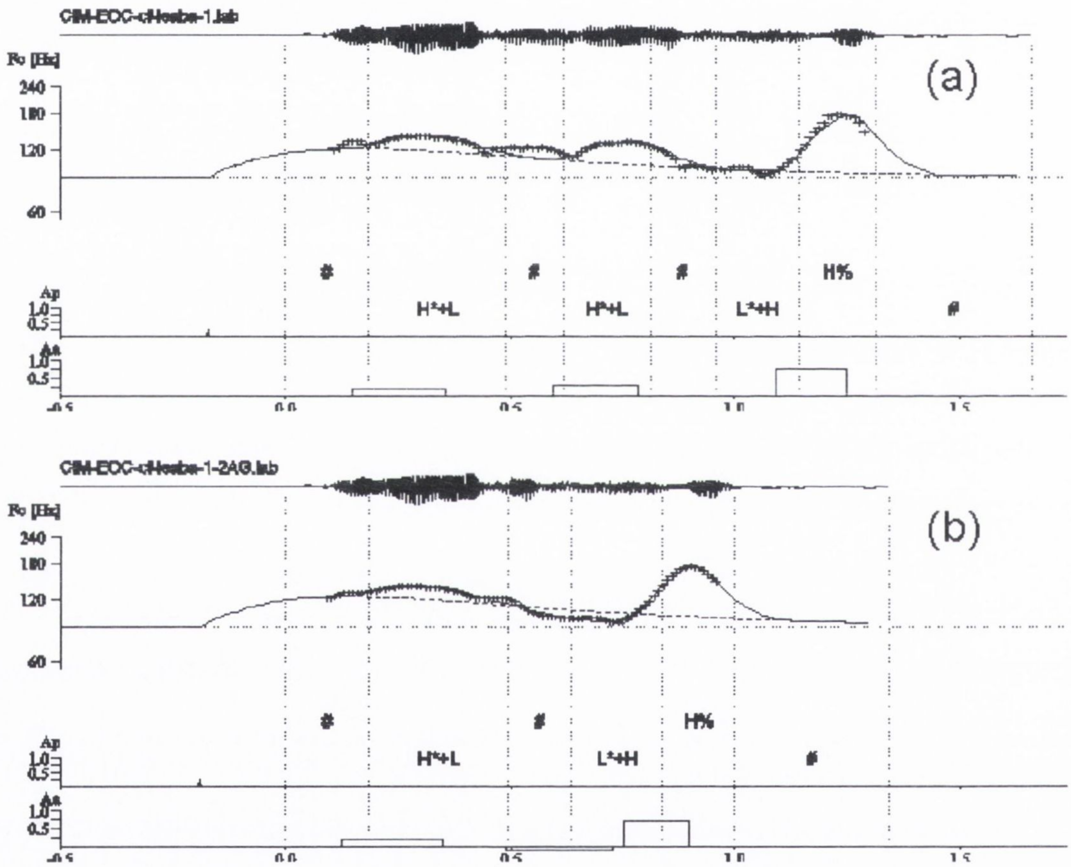

Figure 3.12 An example of the phrase "Bhí Meabh (ina luí) ar an leaba" by speaker IM3 as the original three-accent group phrase (a) and with the medial chunk removed (b).

The conflated problems of the slow phrase command decay and the need for negative accent commands in short IPs could be resolved by adjusting alpha according to the actual duration of the IP. The phrase component would then be a more accurate marker of

[20] Taylor's solution to modelling L* accents also involved the use of a negative accent command; however, it was pointed out that the position of the command was phonologically unjustified, i.e. not related to the accented syllable.

declination. However, changing the alpha constant would complicate the intended simplicity of the model and impair the comparison of phrase command amplitudes across different alpha settings. Interestingly, up till now there have been no suggestions in the literature as to how this problem can be remedied other than the use of additional negative accent or phrase commands. It is likely that no other possible solutions exist.

The second group of Connemara contours which pose a challenge to the accent component of the Fujisaki model contain an H*+L or L*+H accent featuring what is here called a slow f0 movement (i.e. an f0 movement which substantially exceeds 194 ms in duration). Both accent types are shown in Figure 3.13a (IP-final H*+L, H-to-L movement duration = 325 ms) and Figure 3.13b (IP-initial L*+H, L-to-H movement duration = 368 ms). In the Connemara data, slow falls are usually found in the linked contour (H* H*+L%), while slow rises mostly occur IP-initially. The slow f0 movement in both accents features a relatively early onset of the movement (near the beginning of the stressed syllable) and the offset towards the end of the accent group (which usually contains at least one post-accentual syllable). Connemara slow rises differ in this respect from the typical Donegal L*+H counterpart, whose L and H are timed closer together (L usually in the stressed vowel and H in the next unaccented syllable).

The challenge with slow falls and rises lies in the accent command's inability to model the accent shape adequately due to constant beta. At the standard setting of 20.0, the accent command can accurately model f0 movements of up to 194 ms in duration. A fall or rise of a longer duration cannot be salvaged through early-shifting or delaying the respective T parameter. Leemann (2009) encounters the very same problem with the model's inadequacy in capturing slow f0 movements. He also points to constant beta as being responsible for the resulting inaccuracy of the fit.

If the accent component is to be used in its current form, the easy solution would involve adjusting beta to the actual duration of the slow f0 movement. This would make the accent component reflect the local f0 shape more accurately. However, changing the beta constant would complicate the comparison of the timing and amplitude parameters across different beta settings.

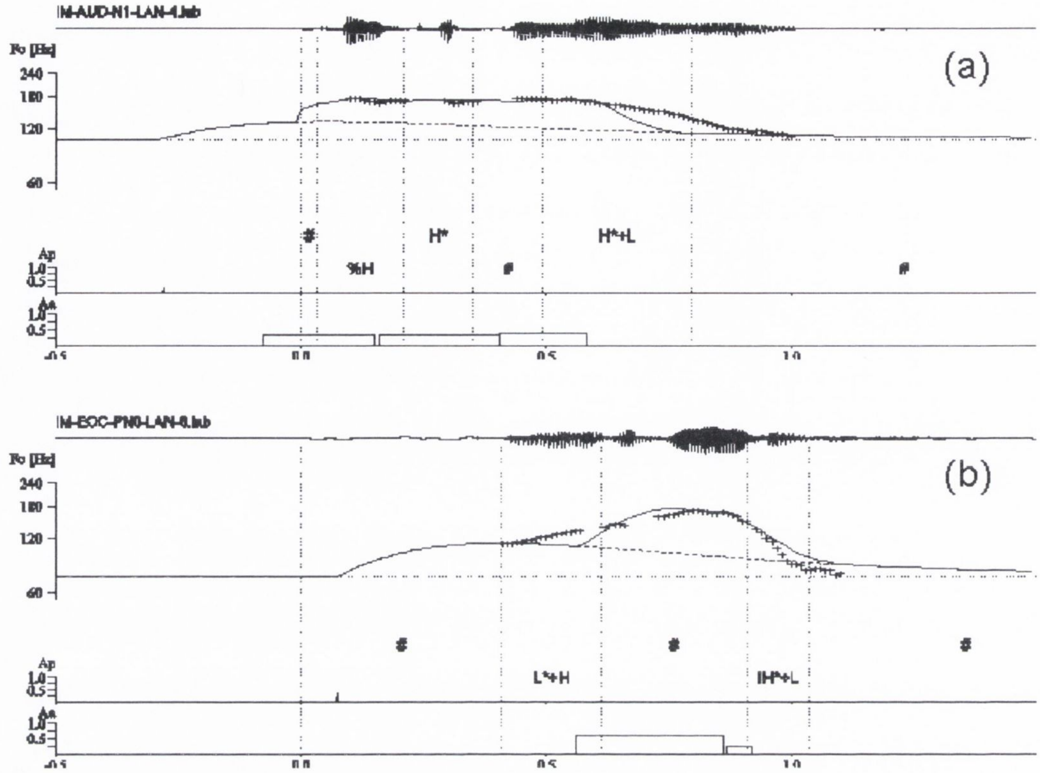

Figure 3.13 Modelling of the Connemara contours with accents involving a slow f0 movement: a nuclear H*+L (a) and a phrase-initial L*+H (b).

Summing up, the problem with modelling slow f0 movements is the exact opposite of the phrase command challenge. In simple terms, the Fujisaki model accent command is more successful at modelling shorter local f0 movements, but the phrase command performs better in longer IPs. It is left to future work to test how the model would perform on utterances with four or more accent groups (i.e. whether the number and position of additional phrase commands would be in accordance with the course of the f0 contour and the location of phrase boundaries in longer utterances).

3.5 Contour-derived and Fujisaki model-derived measurements in three topics

This section introduces the set of measurements used in this study to quantify the intonation of Connemara and Donegal Irish. The phonetic measurements are calculated following the two methods:

(1) Contour-derived metrics following the AM approach

(2) Fujisaki model parameters guided by the AM analysis

For ease of reference, the two types of measurements are presented side by side for each of the three topics investigated (sentence mode, alignment and focus in Sections 3.5.1 to 3.5.3). Firstly, it makes more sense to illustrate the two measurement types in parallel, as one can discern how the contour metric and the equivalent Fujisaki parameter correspond to one another. Secondly, not every measurement is used for every topic: for example, peak height is discussed in relation to all three topics, while declination is covered only in relation to sentence mode. Finally, because of the comparative nature of this study, the total number of parameters in each topic is nearly double that of a stand-alone AM-based or Fujisaki model-based work.

In order to give a comprehensive description of intonation in the sentence mode, alignment and focus data, the choice of particular f0 metrics was motivated by their relevance to each topic. An attempt was made to retain maximal comparability between the contour-derived metrics and the corresponding Fujisaki model parameters. Full comparability is maintained for register level and Fb, as these are identical. Partial comparability is found for the lower declination slope (calculated by linear regression) and Ap of the phrase command (matched to Ls in the contour). Also accent scaling and Aa of the accent command can be said to partially overlap. More precisely, Aa is fully compatible with the f0 excursion size of an accent, but in the contour-based method it is also possible to measure scaling of a tone (usually H) independently; in the Fujisaki model only the excursion size is available to measure.[21]

It may already be apparent to the reader that the contour-based method allows a wider array of f0 metrics than the Fujisaki model. Some of the selected f0 metrics have no analogue in the Fujisaki model, and are consequently discussed on their own. For instance, scaling of the IP onset could potentially be compared with the phrase command amplitude but only in the hand-picked cases where the two coincide. However, doubling up Ap as a parameter which models declination *and* IP onset scaling is not desirable. The remaining contour metrics for which there is no equivalent in the model include scaling of H and L tones, and register span (unless the sum of Ap and Aa of the first accent command is used as an estimator).

[21] This is because H scaling is made up of two components, Aa and Ap, and the amplitude of the latter at a given time-point in an utterance is not available.

Before we proceed with the presentation of measurements, a note is due on how the potential problem with gender balance in the data was resolved. A suitable f0 normalisation procedure was required for the following reasons: (1) a different number of male and female speakers were recorded for each variety; (2) the obtained measurements were to be averaged for each group of speakers so that compact variety-specific trends could be portrayed. The adopted solution involves conversion of all contour-derived metrics from Hertz to semitones.[22] The semitone scale (along with ERB) has been shown to be suitable for use in intonation research (Hermes & Gestel, 1991; Nolan, 2003). The improved semitone conversion method applied in this work uses a speaker-specific baseline, defined as the lowest value found in a given dataset, instead of a generic reference value (e.g. 100 Hz). The main advantage of this method is that each speaker's results are in the positive semitone range, and can be averaged and plotted for the variety rather than separately for each speaker. Considering the usefulness of this approach, it is surprising that relatively few studies up to date have employed it (Frazier, 2010; Local, 2005; Odé, 1988).

3.5.1 Measurements in sentence mode data

Sentence mode, presented in the first experimental chapter, involves the largest number of measurements, all of which belong to the f0 domain. For ease of interpretation, the parameters are grouped into local (at the accent level, Figure 3.14) and global (at the phrase level, Figure 3.15). The measurements are illustrated on examples from Connemara and Donegal Irish. For each dialect the contour-based metrics are shown in the upper panel and the Fujisaki model-derived parameters in the lower panel. The Praat- and FujiParaEditor-generated displays are time-aligned, so that correspondences between the two measurement types can be easily noted. The abbreviations for each measurement are also included, both in the description and in the figure captions.

The local f0 metrics in sentence mode data (Figure 3.14) include scaling of the IP onset (f0-IP onset), IP-initial peak (f0-HPN) and IP-final peak (f0-HN). The PN and N

[22] The Fujisaki amplitude parameters, Ap and Aa, are measured on a unit scale and are therefore not subject to conversion. Fb, however, is measured in Hertz, and is thus converted to semitones following the same method. The transformed value is coded as 'Fb(base)'.

abbreviations for accent position refer to the British School tradition of treating an f0 contour as composed of the non-final, i.e. prenuclear (PN) accents and the main, IP-final, i.e. nuclear (N) accent. Scaling of the IP onset and the PN and N peaks is measured as the f0 maximum at the specified f0 landmark and calculated relative to the speaker-specific baseline. In cases where the f0 in the IP onset syllable was ambiguous the value was taken at the intensity peak in the vowel.

Within the local Fujisaki model parameters, the f0 excursion size[23] of the IP-initial and IP-final accents was measured with the accent command amplitude (Aa-PN and Aa-N). The excursion size of an accent is represented in the model as the f0 interval between the accentual peak and the declination slope delineated by the phrase command (Figure 3.14). In the case of nuclear rises in the Donegal data where a positive-negative pair of accent commands is used, Aa-N is calculated as the sum of the absolute values of both commands. Scaling of the IP onset is treated as a missing parameter (n/a), as Ap is reserved for measuring baseline declination.

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[23] Terms 'f0 excursion', 'register span' and 'register level' are used throughout this work in accordance with terms 'pitch excursion', 'pitch span' and 'pitch level' as defined by Nolan (2006).

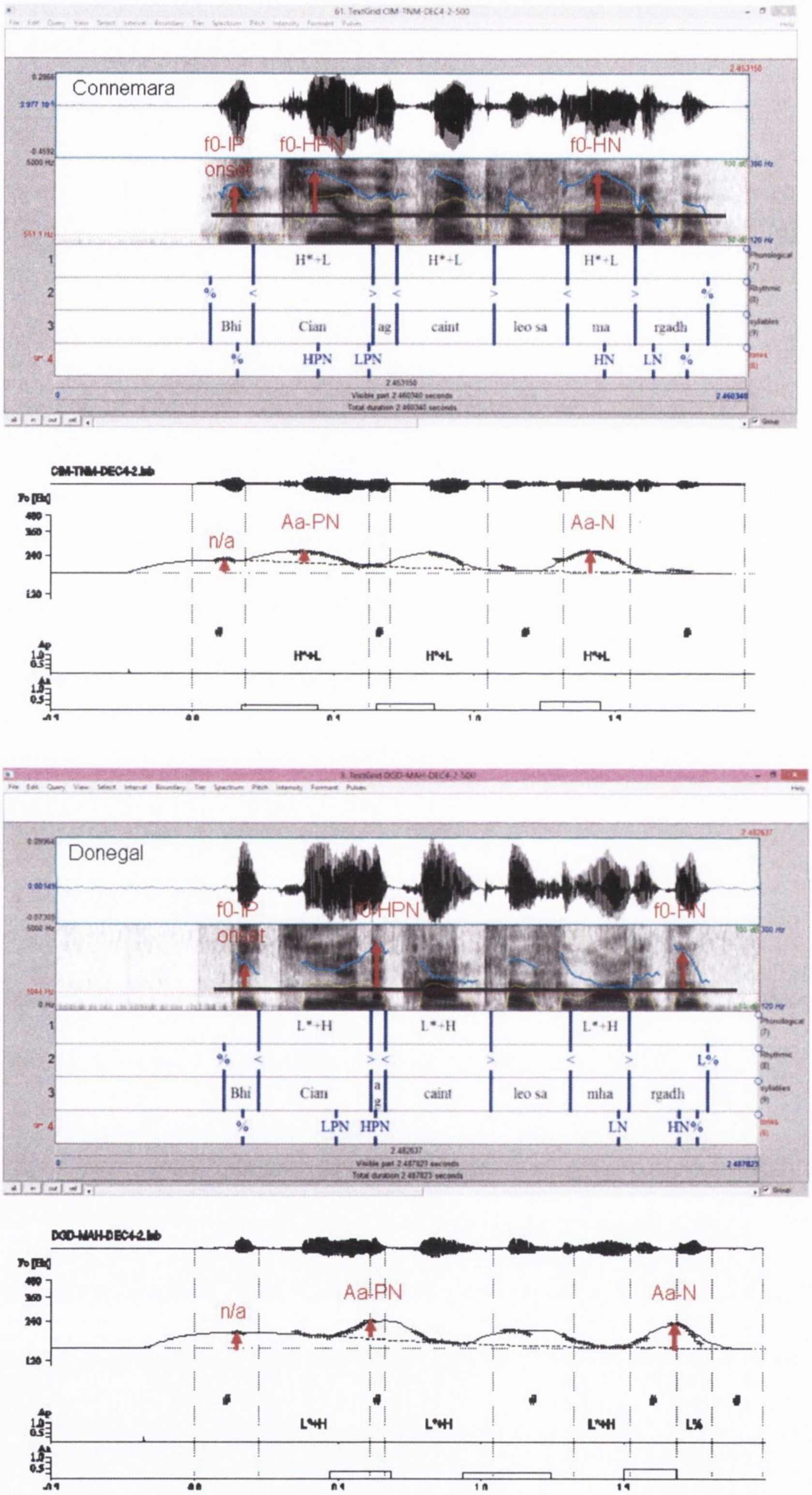

Figure 3.14 Local measurements in the sentence mode data for Connemara and Donegal. Contour metrics: scaling of the IP onset (f0-IP onset), IP-initial peak (f0-HPN) and IP-final peak (f0-HN). The Fujisaki model parameters: the amplitude of the IP-initial (Aa-PN) and IP-final (Aa-N) accent commands.

The global f0 metrics in the sentence mode data (Figure 3.15) include register level, register span and declination slopes. The first two are simple measures. Register level, which stands for the f0 floor of an utterance, was found in the Connemara data mostly in the nuclear trailing L. In the Donegal data it was consistently taken in the leading nuclear L*; to maintain the same setting for all data this was done also for the contours ending with L*+HL% even when the f0 at L% was lower. Register span was calculated as the f0 difference between the global f0 maximum and minimum in the phrase.

Declination was measured following the approach suggested by Gussenhoven (2002b) and applied to Dutch by Haan (2002). In this method declination slopes are calculated separately for the upper and lower parts of the f0 contour. The calculation of the upper and lower regression lines is based on setting the middle regression line which splits the f0 contour into the upper and lower parts. This method acknowledges the possibility of mutual independence of the upper and lower trends, as the two do not necessarily have to descend in parallel.

The calculation of declination slopes was performed with a set of Praat scripts written and kindly shared by Jos J. A. Pacilly of the Leiden University Centre for Linguistics. First, the beginning and the end of the phrase were marked in .TextGrid files. Second, .Pitch files were created and manually corrected for spurious f0 values (creak or segmental perturbations). In order to make the measurements uniform across all sentence mode data, the f0 in the pre-head was excluded, since (1) the vast majority of wh- questions carried no f0 trace in this location; (2) the f0 in the pre-head in the Connemara data was too variable – anywhere from low to high. The f0 at the IP-final boundary was removed for two nuclear contour types: H*+LH% in Inis Mór and L*+HL% in the Gaoth Dobhair data. These f0 movements at the boundary were interpreted as local f0 events which do not belong to declination proper: H% would superficially *decrease* the upper declination slope of the first, while L% would *increase* the lower declination slope of the second contour type. Once IP duration was marked and .Pitch files edited, regression scripts were run on the data. The original formula which performs the calculations in ERB (Equivalent Rectangular Bandwidths) was replaced with a semitone formula so that all contour-derived measurements are expressed in the same frequency unit throughout the work.

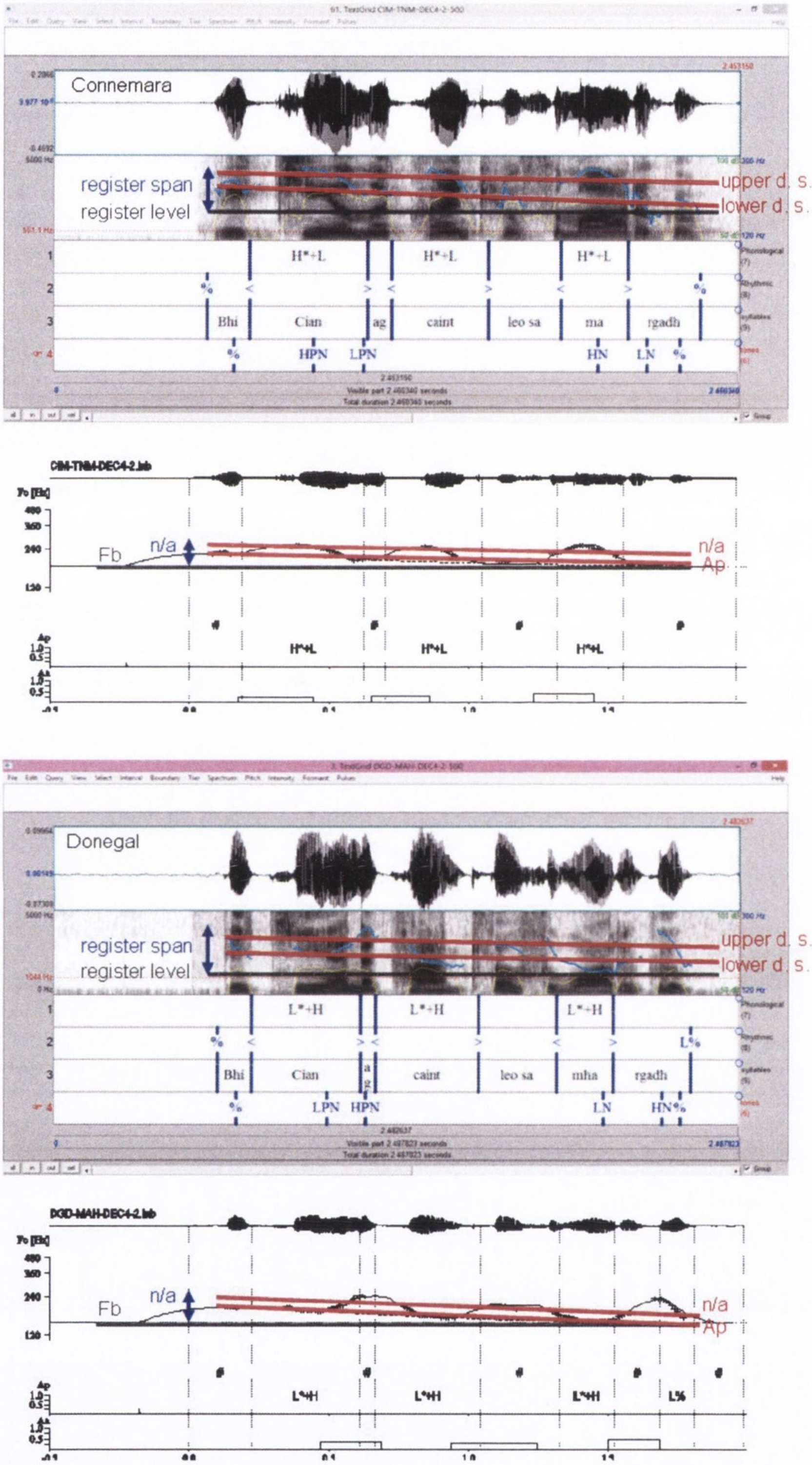

Figure 3.15 Global measurements in the sentence mode data for Connemara and Donegal. Contour metrics: register level, register span, upper (upper d. s.) and lower (lower d. s.) declination slopes. The Fujisaki model parameters: the base frequency (Fb) and the phrase command amplitude (Ap).

The analogous global Fujisaki model parameters (Figure 3.15) include the corresponding measures of register level and the lower declination slope. Register level is captured with the base frequency (Fb), and the lower declination slope is measured with the phrase command amplitude (Ap). The equivalents of the upper declination slope and register span are not available (n/a). Fb was assigned the value of 0.5 semitones below the global f0 minimum (i.e. register level), and converted from Hertz to semitones relative to the speaker baseline. To depict baseline declination, the phrase command was fitted to the L tones and, where possible, the IP onset. It is important to note that while contour-measured declination reflects the true concept of slope (change in f0 over a time unit), the phrase command amplitude (Ap) only expresses the f0 change, while the time unit remains unaffected due to the alpha constant.

3.5.2 Measurements in alignment data

Alignment, presented in the second experimental chapter, involves only three measurements which describe the realisation of pitch accents occurring either in the IP-initial prenuclear (PN), or nuclear (N) position. Figure 3.16 illustrates the measurements on examples from Connemara and Donegal Irish. Although the parameterisation was carried out on two separate datasets, the figure shows both the PN and N measurements in one plot, as these were calculated in the same way. The contour-based metrics are presented along with the corresponding Fujisaki model-derived parameters and the two displays are time-aligned. The abbreviations for each measurement are also included (see text and the figure captions).

The contour-derived metrics chosen for the alignment data include timing of the f0 elbow, duration of the f0 movement and f0 excursion size of the accent (Figure 3.16). Timing is considered the paramount measure for the alignment data. The elbow location is defined here as the onset of the relevant f0 event: onset of the fall in H*+L (PN and N position, see N in Figure 3.16), onset of the H plateau in H* (only PN, see PN in Figure 3.16), and onset of the rise in L*+H (PN and N, both in Figure 3.16). Elbow timing (t) was chosen over timing of the absolute peak/valley to allow the accuracy of the T parameter to be tested. Elbow timing was calculated in relative terms as a proportion of the accented syllable duration. The duration of each segment in the 'lán' target syllable was measured and also converted to the proportional duration of the syllable to allow plotting of segment boundaries.

F0 movement duration in the alignment data was simply calculated as the time interval between the H and L turning points in the falling (H*+L) accents in Connemara and the rising (L*+H) accents in Donegal. F0 movement duration is expressed in milliseconds.

The incorporation of f0 movement duration deserves a more detailed explanation, as this metric does not feature regularly in alignment studies. The first reason was to gain an insight into the timing relationship between the target and trailing tones in the H*+L and L*+H pitch accents of Irish. The possible accent realisations would exhibit either timing stability of both tones (cf. 'segmental anchoring' in Atterer & Ladd, 2004; Ladd, Faulkner, Faulkner, & Schepman, 1999), or relative freedom of the trailing tone in relation to the starred tone. If the trailing tone is dislocated rightwards under a suitable rhythmic context (anacrusis in PN, and tail in N), then the f0 movements will vary in duration. Since pitch accents in Irish involve left-headed rhythmic feet, the possible change in f0 movement duration can be expected mainly due to tail, and not so much for anacrusis.

The analysis of f0 movement duration is also motivated by the need to assess the extent to which data in the three varieties of Irish is modelled adequately with the slopes of the Fujisaki model accent command. The alignment dataset provides a suitable testing ground, as the number of anacrusis and tail syllables is systematically varied. From the AM standpoint, the H and L turning points in a pitch accent can be timed independently, while in the Fujisaki model they are tied together through the rising and falling slopes of the accent command. The accent component precisely matches f0 movements of up to 194 ms in duration at the standard $\beta = 20.0/s$ setting. Should the results show that duration of the f0 movement increases with longer anacrusis/tail, then the model's accuracy in capturing the accent 'shape' will gradually decrease.

F0 excursion size is of interest in testing for the possible truncation effect in the absence of post-nuclear syllables, as well as to assess the performance of Aa. F0 excursion size was calculated as the frequency interval between the H and L turning points found in a rising (L*+H) or falling (H*+L) accent.

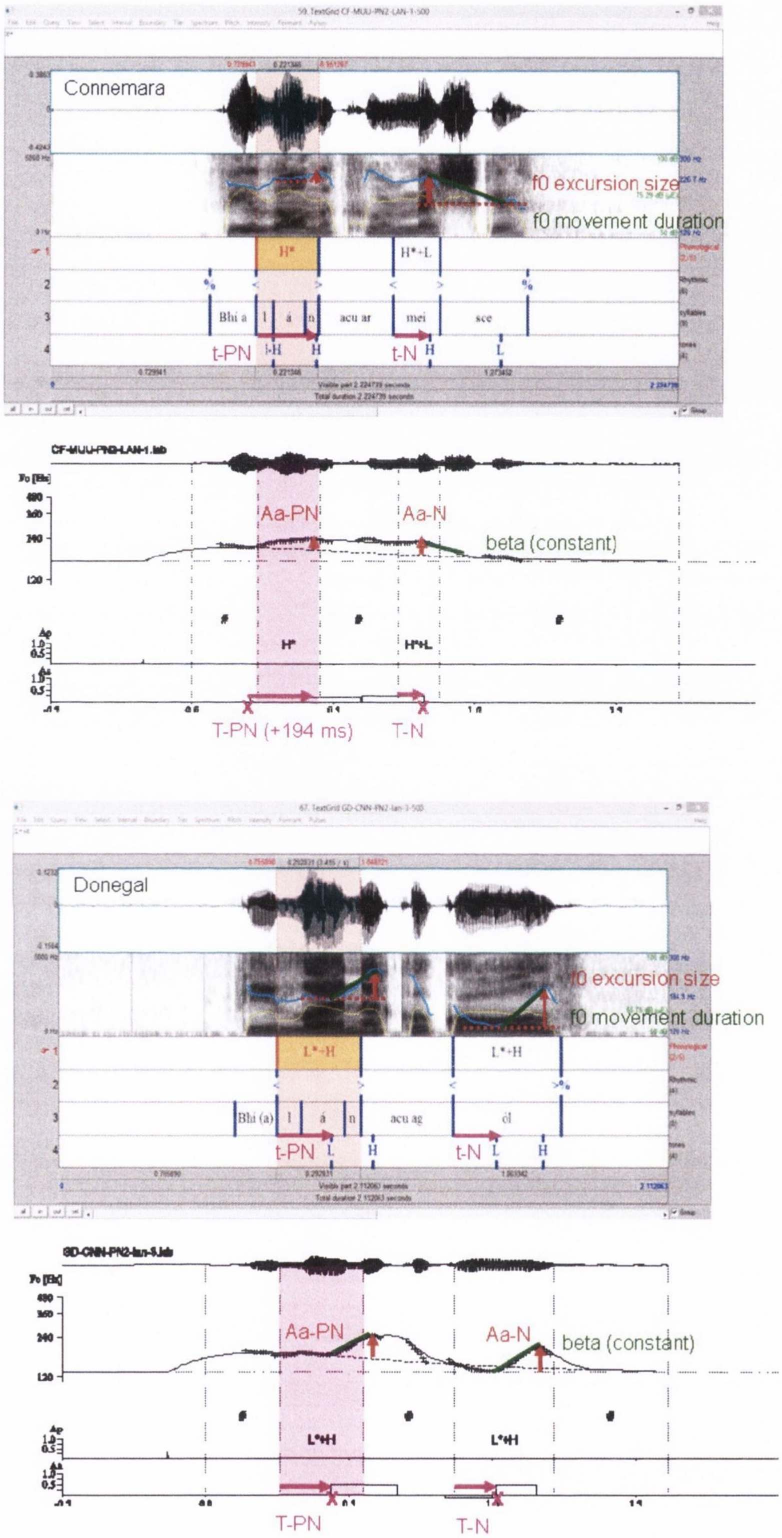

Figure 3.16 Measurements in the alignment data for Connemara (PN = H*, N = H*+L) and Donegal (PN = L*+H, N= L*+H). Contour metrics: elbow timing in prenuclear (t-PN) and nuclear (t-N) accents, f0 excursion size and f0 movement duration. The Fujisaki model parameters: elbow timing in prenuclear (T-PN) and nuclear (T-N) accents, the amplitude of prenuclear (Aa-PN) and nuclear (Aa-N) accent commands, beta (constant).

The equivalent measurements for the alignment data in the Fujisaki model include timing of the f0 elbow expressed through the accent command onset (T1) or offset (T2), and f0 excursion size through the amplitude (Aa). The elbow location is captured by the accent command onset (T1) for L*+H and H*, and by its offset (T2) for H*+L accents (note the 'x' marks over the relevant T locations in Figure 3.16). Timing of T was calculated as a proportion of the accented syllable duration. The f0 excursion size is represented by Aa, which measures the f0 interval between the accentual peak and the decaying slope of the phrase command. Duration of the f0 movement is treated as constant, as it is controlled by β.

3.5.3 Measurements in focus data

Focus, presented in the third experimental chapter, involves four f0 measurements. Two are related to the realisation of the focal accent, while the other two describe the global level (also used in the analysis of the sentence mode and alignment data). Additionally, the duration measurements of the accented syllable and accent group were taken. The displays of the contour-based metrics and the corresponding Fujisaki model-derived parameters are time-aligned. The abbreviations for each measurement are also included, both in the description and in the figure captions.

Figure 3.17 illustrates the f0 measurements on examples of IP-medial contrastive focus from Connemara and Donegal Irish. The two local contour-derived metrics include scaling (f0-H) and timing (t-H) of the focal peak. H scaling was measured as independent peak height (i.e. the f0 maximum) relative to the speaker baseline using a semitone scale, while H timing was calculated as a proportion of the accented syllable duration. The two global metrics, register level and span are calculated in the same way as in the sentence mode data (see Section 3.5.1).

Notably, the timing measure in the focus data differs from the one used in alignment. In the latter, *elbow timing* denoted the right edge of the plateau of the target tone, thus H in Connemara and L in Donegal. In the focus data, on the other hand, only *peak timing* (t-H) is of interest in both dialects. Defining the peak in the focus dataset was generally unambiguous. In Gaoth Dobhair, L*+H is the main accent type used in broad focus in all IP positions, and in contrastive focus. In Cois Fharraige, H*+L is mainly used for contrast as well as in broad focus (in the typical sequence of H*+L accents). Only one speaker, CF3, used the H* H*+L% pattern in broad focus, where the nuclear peak effectively denotes the elbow (i.e. the right edge of the H plateau).

The corresponding local level parameters of the Fujisaki model comprise the f0 excursion size, i.e. the amplitude of the focal accent (Aa), and timing of the focal peak (T-H). Aa is a straightforward measure which incorporates the f0 interval between the accentual peak and the decaying slope of the phrase command.

Timing of the focal H in the Fujisaki model was picked up with different accent command time-points in the Connemara and Donegal data (note the 'x' marks over the relevant T locations in Figure 3.17). In Connemara, the focal H is measured with T2 which detects the fall onset. In the case of well-defined peaks, the fall onset coincides with the peak itself (T-H = T2). In Donegal, since we are dealing with rising accents, the interest is in how early the f0 maximum is reached (i.e. the *onset* of the H plateau). As T2 would have picked up the H *offset,* timing of the focal H in the Gaoth Dobhair focus data is estimated from the accent command onset instead. Thus, the modified formula (T-H = T1 + 194 ms) estimates H timing from the preceding L elbow (cf. the location of T-H (top of the arrow) relative to T1 (the 'x' mark) in the Donegal example of Figure 3.17). Timing of the focal H is calculated in relative terms, i.e. as a proportion of the accented syllable duration.[24]

For the global level metrics in the Fujisaki model, only register level was measured with Fb; register span is not available (n/a, Figure 3.17). The base frequency is set 0.5 semitones below the global minimum in each f0 contour, and subsequently converted from Hertz to semitones relative to the speaker baseline.

[24] Timing and scaling of the focal L, as well as the slope of the rise (Y. Chen & Gussenhoven, 2008; Xu & Wang, 2001) were also considered, especially for the predominantly rising Gaoth Dobhair variety. The examination of these metrics is, however, left to future work.

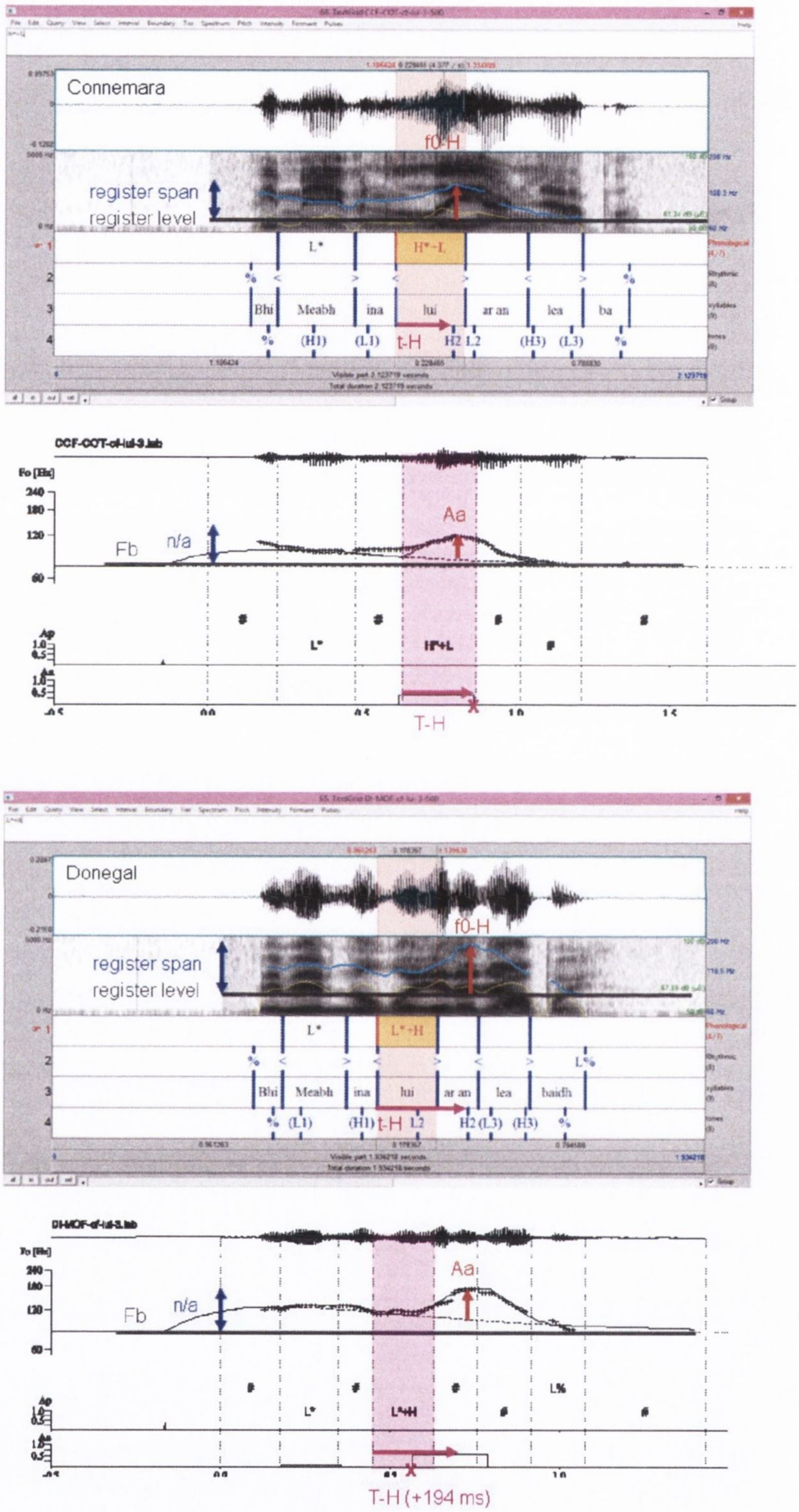

Figure 3.17 Measurements in the focus data for Connemara and Donegal. Contour metrics: scaling of the focal peak (f0-H) and timing of the focal peak (t-H); register level and register span. The Fujisaki model parameters: the accent command amplitude of the focal accent (Aa) and timing of the focal peak (T-H); the base frequency (Fb).

3.6 Statistical methods

Statistical analysis of the results was conducted with the JMP Statistical Package Version 10.0 (Copyright © 2012 SAS Institute Inc.). As the first step, the results are presented with descriptive statistics: for the sentence mode data the parameters are shown mostly in terms of means and the 95% confidence intervals (CI), while for the alignment and focus data means and standard deviations are used. These methods appeared to be the most suitable considering the amount of useable data (after exclusions) in each experimental set. The sentence mode set is the most uniform (i.e. the vast proportion of data is included in the quantitative analysis). Even though the experimental design for the sentence mode set is the most complex (Dialect, Mode and Length as control variables), the available number of samples is about 20 per combination of factors in each variety. Consequently, the 95% confidence intervals were considered to be the most suitable descriptor. On the other hand, the focus and particularly the alignment data suffered sample loss due to considerable variation at the tune level. Confidence intervals were foregone because of sensitivity to sample size; instead the focus and alignment results are shown in terms of either means and standard deviations, or percentiles (the median and the upper and lower quartiles).

The results are validated by appropriate statistical tests whenever the amount and structure of the data allows it. A mixed-design ANOVA is performed in JMP as a Linear Mixed Model with repeated measures (i.e. the same subjects are being tested in a set of conditions) on the sentence mode as well as the IP-initial and IP-final focus data. Speaker is specified as a random variable nested within Dialect. The post-hoc analysis is conducted with the Tukey HSD (Honestly Significant Difference) test.

Finally, careful consideration was given to accounting for multiple repetitions in ANOVA. Notably, pseudoreplication is a frequently encountered problem in phonetic studies, and occurs when multiple samples from one subject or one experimental condition are treated as independent (Lazic, 2010; Winter, 2011). Pseudoreplication leads to obtaining erroneously significant results. To avoid this problem averaging within subject was chosen as the preferred remedy.[25] This method improves the precision of measurement (i.e. the averaged measure is closer to the 'true value' for the subject).

3.7 Summary

This chapter provided an overview of the materials (the informants, corpora and the recording procedure) followed by the analysis methods used in this work. The core of the chapter was devoted to presenting the application of the IViE and the Fujisaki model platforms to the melodic contours of Connemara and Donegal Irish. The IViE method of analysis covered the established tonal inventory and the prosodic transcription with the use of tiers. The most frequent tunes in Connemara and Donegal Irish were presented to illustrate how the main contour types are realised in each dialect before showing how the Fujisaki model was applied to these contours. The Fujisaki model parameterisation included the settings for the base frequency, the phrase component and the accent component adopted in this work; the step-by-step modelling procedure was also described. Additionally, two problematic aspects for the Fujisaki model encountered in the present data were illustrated on examples of lesser used tunes. A separate section was devoted to explaining the combined analysis approach, where the direct contour measurements and the Fujisaki model measurements are taken in parallel in each experimental dataset (sentence mode, alignment and focus). Finally, the statistical methods used in this work were described. The following three experimental chapters unravel the characteristics of the intonation of Connemara and Donegal Irish in the context of sentence mode, alignment and focus.

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[25] Treating repetition as another fixed factor was not possible here due to a varying number of repetitions after excluding data with different, less frequent tunes.

Chapter 4

Intonation of sentence mode in Connemara and Donegal Irish

4.1 Introduction

Chapter 4 treats the expression of sentence mode through intonation in Connemara and Donegal Irish. The three sentence modes under scrutiny are statements, i.e. declaratives (DEC), and two question types, wh- questions (WHQ) and yes-no questions (YNQ). Declarative, or echo, questions are not included, as they may not feature frequently in Irish.[26] The data for each mode includes phrases of two different lengths (two and three accent groups in the IP) to test the effect of phrase length on declination.

This chapter examines the role of intonation in conveying sentence mode in the three varieties. The differentiation between statements and questions can be done either at the categorical level (tune composition), the phonetic level (f0 metrics), or both. The initial null hypothesis regarding the sentence mode data proposes limited use of f0 in Irish, as the question/statement distinction is already marked in the syntax.

This chapter is composed of three parts (background, results and discussion); this structure is also followed in the experimental chapters on alignment and focus. First, the background on the intonation of sentence mode in Irish and other languages is given (Section 4.2). Then, the tune inventory (Section 4.3) and stylised f0 contours (Section 4.4) in the sentence mode data are presented. The quantitative findings on the phonetic f0 correlates of sentence mode at the local (Sections 4.5 to 4.7) and global (Sections 4.8 to 4.11) levels are discussed. The chapter concludes with a discussion of the quantitative findings, comparison of the results for Irish with those for the selected languages introduced in the background section of 4.2.3, as well as an assessment of the suitability of the Fujisaki model for capturing the f0 characteristics of sentence mode in Irish.

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[26] Although Irish is well supplied with compulsory question markers, it is nevertheless possible to echo a statement from another speaker, with raised intonation, to express surprise for instance.

4.2 Background on intonation of sentence mode

Section 4.2.1 introduces a broad overview of sentence mode encoding through intonation. Sections 4.2.2 and 4.2.3 look at the existing findings on the intonation of sentence mode in Connemara and Donegal Irish, as well as those in selected studies of other languages. The latter provide a useful starting point for establishing which prosodic devices can be utilised in conveying sentence mode.

4.2.1 General features of sentence mode encoding

Conveying illocutionary acts such as making a statement or asking a question is considered to be one of the basic functions of intonation (Hirst & Di Cristo, 1998; Katamba, 1989). Although there is no one-to-one correspondence between a tune and a particular sentence type, there is a general tendency in languages to use high or rising pitch on questions and low or falling pitch on statements. This tendency is interpreted by Gussenhoven (2002a, 2003, 2004) to be a grammaticalization of Ohala's Frequency Code (1984, 1994), whereby the general association of high pitch with smallness/submissiveness is extended to convey uncertainty (i.e. questioning). Conversely, low pitch is associated with dominance and can be interpreted as a marker of certainty (i.e. assertion) (cf. finality vs. non-finality in Bolinger, 1998).

The feature most frequently reported for conveying interrogativity is the presence of a final rise in questions (in the AM interpretation, the rise may pertain to the nuclear pitch accent or just the boundary tone). Yes-no questions tend to feature a high terminal or overall higher pitch more often than wh- questions whose intonation is more like that of statements (Hirst & Di Cristo, 1998). It needs to be borne in mind, however, that this feature is not universal. First, the tendency to use high final pitch varies between individual languages/varieties. For instance, Polish makes particularly heavy use of a final rise in yes-no questions compared to its mild use in Cambridge English (Grabe & Karpiński, 2003). Second, a rise may not denote interrogativity in a particular language/variety, e.g. Belfast English uses mainly L*+H% in both statements and questions (Grabe & Post, 2002; Jarman & Cruttenden, 1976); American and Australian

English can use High Rising Terminals in statements (e.g. Bolinger, 1998; Fletcher, Grabe, & Warren, 2005).

Other features which are frequently associated with questions include f0 events at the so-called local (related to a pitch accent or phrase boundary) and global (related to a part of or an entire contour) effects. The local effects used for marking interrogativity include raising of the IP onset and the accentual peaks. The global effects involve higher overall pitch such as observed in register level and span, as well as changes in the f0 trend understood as the absence of the downstepping pattern, or suspension of declination (depending on the theoretical assumptions of the intonation model).[27] The use of the above-stated fundamental frequency effects in conveying sentence mode will be given a more detailed overview with respect to six selected languages in Section 4.2.3.

4.2.2 Existing findings for Irish

The non-AM accounts of the intonation of Connemara Irish include those of de Bhaldraithe (1945), Blankenhorn (1982) and Bondaruk (2004), with the latter two using the classification scheme proposed by O'Connor and Arnold (1973).

In his study of Cois Fharraige, de Bhaldraithe (1945) notes that the most common tune starts relatively low and rises towards the first accent, then reaching high pitch on the first accent and descending towards the last accent from which the pitch drops to a low. This tune appears to occur commonly in statements as well as in questions, with the characteristic falling pitch on the last accent. In the IViE classification, this tune would be transcribed as % H* (!)H*+L%.

In the Blankenhorn (1982) study of Connemara Irish from Carna, following the approach of O'Connor & Arnold, the nuclear tunes are discussed with reference to meaning/attitude rather than specifically sentence mode. She distinguishes three types of falls, three types of rises and two falling-rising glides. Blankenhorn's description suggests that the falling

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[27] As a general rule, the AM-based approaches refer to the concept of downstep (e.g. Beckman & Pierrehumbert, 1986; Liberman & Pierrehumbert, 1984), whereas the phonetic models employ the concept of declination (e.g. 't Hart, Collier, & Cohen, 1990; Fujisaki & Hirose, 1984; Grønnum, 1992).

glides are used in a 'neutral sense' (in answer to questions and in questions), whereas the rise and fall-rise tend to have an air of markedness about them (incompleteness, incredulity). This interpretation would agree with the present data for Connemara (Section 4.3 and henceforth), with the fall constituting the default nuclear pattern, and the non-falling patterns also being used, but to a lesser extent.

Bondaruk's (2004) account of Connemara Irish from Rosmuck proposes eleven nuclear tunes, including types of falling, rising, rising-falling, falling-rising and level glides which are discussed solely with respect to the presence or absence of emotion. Naturally, this approach obscures connecting the nuclear contours to specific modes. The overall picture emerging from Bondaruk's study would suggest that Connemara Irish employs a large inventory of nuclear tunes depending on the pragmatic and paralinguistic context. A valuable observation is made about the f0 distribution of pitch events in relation to the accent group structure. 'Pitch movements' are found in monosyllabic words, whereas 'pitch jumps' are typically associated with polysyllabic words.

Only brief accounts are available on the intonation of Donegal in the pre-AM tradition. In Quiggin's segmental study (1906), Torr Irish is remarked on as being similar to English and German in terms of its falling intonation at the end of statements. This observation does not reflect the sing-song impression of northern Irish. Adams's account of a variety of South Donegal English from the Donegal Bay area (1950), on the other hand, contains succinct observations. Three main tonemes are listed, among which 'inverted circumflex' is specified as the default pattern characterised by a drop from high pitch onto low (on-fall) in the stressed syllable and rising from there on. The 'rising' toneme occurs in the first stress group of yes-no questions and differs from 'inverted circumflex' in that the on-fall is absent. The 'falling' toneme occurs in commands and statements implying finality. Translating the three tonemes into the IViE classification, South Donegal would appear to have two variants of a rise (L*+H) and a fall (H*+L) in its basic tonal inventory. This description, although based on a variety of Donegal English, reflects closely what will be observed in the Donegal Irish data of Gaoth Dobhair (Section 4.3 onwards).

The recent accounts of Dalton (2008) and Dalton & Ní Chasaide (2003, 2007b) offer the classification of tunes in Irish in the Autosegmental-Metrical approach with the IViE transcription system. Their work provides coverage of accents and boundary tones in declaratives and questions in a number of varieties of Irish.

In the earlier description of Connaught Irish including Connemara (Dalton & Ní Chasaide, 2003), the most frequent pattern reported for declaratives is H* !H* !H*+L% with optional downstep of the nuclear accent. In a subsequent account (Dalton, 2008) three declarative tunes are listed (i.e. H*+L H*+L H*+L%, H*+L H* H*+L% and H* H* H*+L%), and H* is noted as the prevalent prenuclear accent type in declaratives. Both wh- and yes-no questions mostly exhibit the same accent types as declaratives, i.e. prenuclear H* and H*+L, and nuclear H*+L (Dalton, 2008).[28] Some occurrences of the IP-final high boundary tone (H%) in questions are also reported (Dalton & Ní Chasaide, 2003), and they are more frequent in YNQ than in WHQ (Dalton, 2008).

Donegal Irish most frequently exhibits prenuclear and nuclear L*+H accents with the 0% boundary (i.e. L*+H L*+H L*+H%); some L*% and L*+HL% nuclei are also reported (Dalton & Ní Chasaide, 2007b). In wh- questions, prenuclear H* or H*+L accents frequently (nearly half of PN accents) occur (Dalton, 2008). Yes-no questions typically feature prenuclear and nuclear L*+H accents, with either 0% or H% boundary tones. 'Final falls' (L*+HL%) were not found in either question type (Dalton, 2008).

The only quantitative studies for Irish which combine the phonological and phonetic description of sentence mode have been done on Inis Mór and Donegal Irish (Dorn, O'Reilly, & Ní Chasaide, 2011; O'Reilly & Ní Chasaide, 2010). As the Inis Mór data is also used in this dissertation, let us just briefly summarise the findings. In relation to mode, Inis Mór was shown to use dynamic changes in a number of f0 metrics, but hardly any changes at the tune level (the declarative H*+L H*+L% pattern is used in questions as well; IP-final rises can occur, but their use is not limited to questions).

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[28] In the earlier account (Dalton & Ní Chasaide, 2003), a frequent occurrence of L*+H !H*+L% was reported for yes-no questions.

4.2.3 Findings in selected studies on other languages

Section 4.2.3 provides a more detailed overview of the phonetic correlates of encoding sentence mode on the basis of six selected studies. All six examine the relative changes in the f0 contour used in conveying interrogativity, and share a similar experimental design with the present study. The results are reported only for the two relevant question types, WHQ and YNQ (declarative questions are left out). Some of the findings will be referred to in a brief comparison with the present results in Section 4.12.2.

The findings regarding the particular f0 metrics chosen in this study are reported in Table 4.1. The measurements have been classified into local and global. The local level metrics include scaling of the IP onset (IP onset), scaling of the first prenuclear peak (HPN), and scaling of the nuclear peak (HN). Additionally, the presence of an IP-final rise (final rise) is also included. The global level metrics include register level, register span, the f0 difference between the first prenuclear and the nuclear peak (HPN-HN difference), and the upper and lower declination slopes. For an explanation on how the measurements for the sentence mode data were performed the reader is referred to Chapter 3.

Examination of Table 4.1 leads to two main observations. With respect to the measurements, the majority of the f0 metrics listed in the table show an increase in questions. The only two metrics which may show a relative drop are declination and the declination-related HPN-HN peak difference. With respect to language, all six make varying use of the f0 metrics to convey interrogativity (bearing in mind that some studies are more exhaustive than others). At one end, German and Dutch appear to employ a particular f0 strategy in either one or both question types. On the other hand, languages such as Estonian or the Drogheda variety of Irish English rarely or never use special pitch to mark questions.

On the basis of the trends shown in the languages presented in Table 4.1 one may conclude that languages form a continuum on the interrogativity scale, from few or no f0 cues to using most in one or both question types. Assuming a trade-off between pitch and the syntactic marking of interrogativity, the presence of the latter would suggest that the use of special pitch for questions in Irish is optional. The remainder of Chapter 4 explores to what extent Irish uses intonation for conveying interrogativity.

Table 4.1 Summary of the results for wh- and yes-no questions in six selected studies on sentence mode. All f0 metrics are grouped as related to the local or global level (see text). Symbols: (↑) f0 boost/increase, (↓) f0 reduction/decrease, (x) no effect found, empty field = parameter was not reported on.

		Peruvian Spanish (O'Rourke, 2009)	Estonian (YNQ) (Asu, 2004)	German (Brinckmann & Benzmüller 1999)	Standard Danish (Thorsen, 1983)	Dutch (Haan, 2002)	Drogheda English (Kalaldeh, 2011)
Local level	IP onset		↑YNQ			↑WHQ ↑YNQ	x
	HPN	↑WHQ ↑YNQ					x
	HN						↑YNQ
	Final rise	WHQ YNQ		YNQ		WHQ YNQ	x
Global level	Register level		x			↑WHQ ↑YNQ	x
	Register span		x	↑WHQ			x
	HPN-HN difference		x*				↑WHQ
	Upper declination slope			↓WHQ	↓long ↓WHQ? ↓YNQ?	↑WHQ ↓YNQ	x
	Lower declination slope			↑YNQ	↓WHQ ↓YNQ	↑WHQ	x
	* Results were obtained for H drop between consecutive prenuclear H tones.						

4.3 Tune inventory in sentence mode data

Figure 4.1 presents the distribution of tunes in the sentence mode data for Cois Fharraige, Inis Mór and Gaoth Dobhair. The tune is presented as a combination of the IP-initial accent, the nuclear accent and the boundary tone. The medial accent is omitted in the summary of results, as (1) it most frequently repeats the pattern of the IP-initial accent or is left unaccented, and (2) since the dataset includes phrases with two and three accents, the results would have to be presented separately for each length condition. This would not be advisable, since the interest is in the total frequency of the leading tunes in statements and questions. Secondly, length is not expected to affect the tune at the structural level. The colour coding scheme corresponds to the overall tune: variants of the underlying H*+L sequences are marked in blue; those of L*+H in red. All tunes listed under 'tune type' (with the exception of 'excluded') are included in the subsequent comparison of the phonetic correlates of sentence mode.

Before proceeding with the tune results for the sentence mode data, let us explain what the 'excluded' tunes in Figure 4.1 entail. In order to yield sensible quantitative results, comparability of measurements must be ensured. For this reason the main tunes and their variants were established first, and subsequently selected for further phonetic measurements. The less frequent tunes which could not be used in the quantitative analysis were subsumed under 'excluded'. Thus, in Connemara the exclusions involve any tune which contains a low (L*) or a low-rising (L*+H) prenuclear accent, or an IP-final rise (i.e. L*H%, L*+H% and H*H%). In Gaoth Dobhair, the exclusions involve any tune which is infrequent in a given mode, mainly due to the IP-initial accent (i.e. L*+H in WHQ, and H* in YNQ). The occurrence of L% in the L*+HL% nucleus found in some of the DEC data (all from speaker GD4) was treated as a local boundary effect which had no impact on the preceding part of the f0 contour.

Inspection of Figure 4.1 suggests that Connemara does not use a special tune type in questions. Cois Fharraige uses sequences of falling accents[29] in all three modes (DEC = 95%, WHQ = 98%, YNQ = 98%). Inis Mór mostly uses the all-falling (DEC = 70%, WHQ = 68%, YNQ = 63%), or the linked (DEC = 15%, YNQ = 11%) pattern regardless of mode; contours ending with a nuclear fall-rise (H*+LH%) are also encountered (DEC = 4%, WHQ = 17%, YNQ = 11%). Some rising nuclear tunes (grouped under 'excluded') were found in the Inis Mór data, but their occurrence was not limited to questions (DEC = 11%, WHQ = 15%, YNQ = 15%).

[29] The H*+L H*+L% in the Connemara data subsumes some long IPs with the H* H*+L H*+L% full pattern. Linking of the H tones of the first and second accent is most likely conditioned by the presence of only one intervening unstressed syllable in the first accent group in the long IPs.

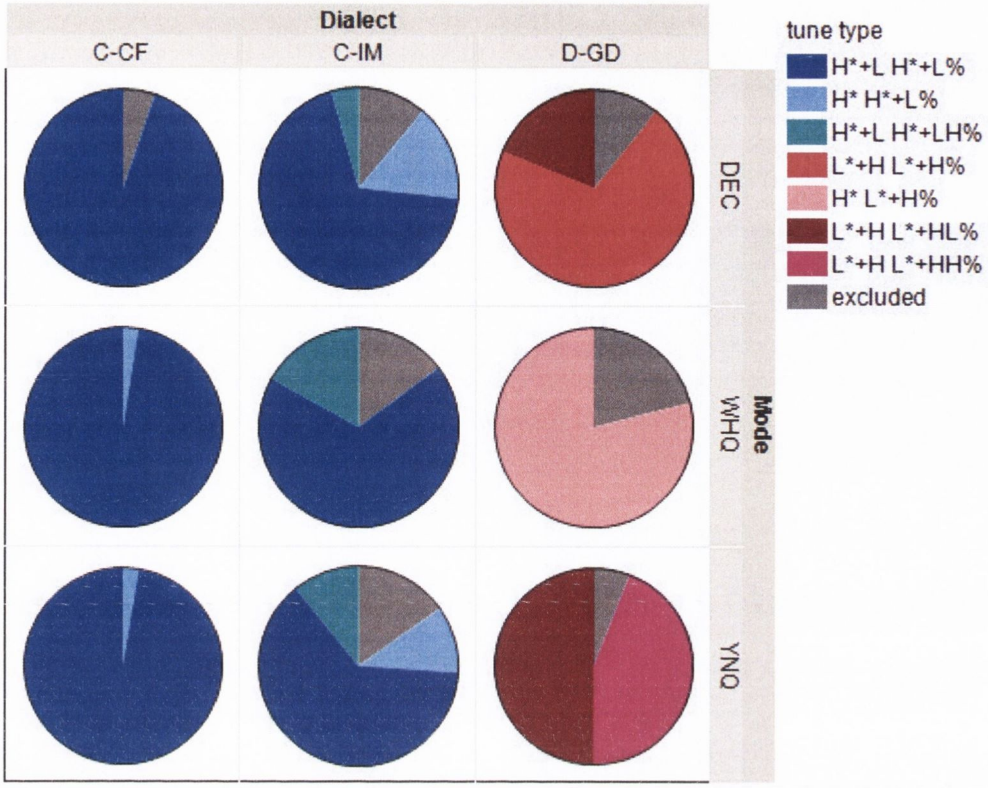

Figure 4.1 Distribution of tune types in the sentence mode data in declaratives (DEC), wh- questions (WHQ) and yes-no questions (YNQ).

Gaoth Dobhair differs from Connemara in that it exhibits a preference for certain tunes related specifically to question type (Figure 4.1). In declaratives, the most frequent tune (70%) contains an IP-initial L*+H accent and a nuclear rise-plateau (L*+H%). In wh- questions, an IP-initial H* accent on the wh- word combined with the 'declarative' rise-plateau nucleus is strongly preferred (79%). In yes-no questions, however, the 'declarative' prenuclear L*+H occurs along with either the L*+HH% (50%) or L*+HL% (44%) nuclear tune. Though structurally identical, the L*+HL% contour sounds different, more like a question tune, in YNQ than in DEC (i.e. the L and H tones of the rise are shifted upwards in the local register).[30]

[30] The L*+HL% transcription conflates three realisations: (a) a rising-falling nucleus with a low boundary tone, (b) a rise-slump and (c) a rise-plateau with a boundary fall. Based on the observation of the IP-initial and IP-medial focus data (in Chapter 6), where longer tails are available, Gaoth Dobhair appears to favour pattern (b), although (c) was also used (mainly by speaker GD1).

4.4 General overview of sentence mode results – stylised contours

Section 4.4 is devoted to the presentation of stylised f0 contours for the main tunes in the sentence mode data. Stylised contours are provided to give a brief overview of the actual realisation of the statement and question tunes specified in Section 4.3. They also help in visualising the directionality of the complex contour-derived f0 metrics such as declination trends.

The Connemara contours in Figure 4.2 suggest some effect of sentence mode on the f0 contour. In both varieties the change is seen mainly in the prenuclear region, where the IP onset and the peak are raised in both question types. The more observable difference between the two varieties involves an f0 boost of the nuclear peak in questions in Cois Fharraige, which is not found in Inis Mór. Length does not generally affect the scaling of the f0 landmarks, except HPN in Inis Mór questions, and LN in short Cois Fharraige and long Inis Mór questions.

The Gaoth Dobhair contours in Figure 4.2 show rather marked differences across the three modes. The relative f0 shifts in questions affect both the prenuclear and nuclear regions; additionally, remarkable differences are observed between the two types. In WHQ, the HPN peak is notably higher, while HN is also somewhat raised. The nuclear L*, however, remains at the same level as in DEC. In YNQ, on the other hand, the major relative shift happens in the nuclear region, where both HN and LN are considerably higher. No differences in scaling of the H and L turning points are found between long and short IPs, with the exception of YNQ, where the height of HPN and also of HN is affected.

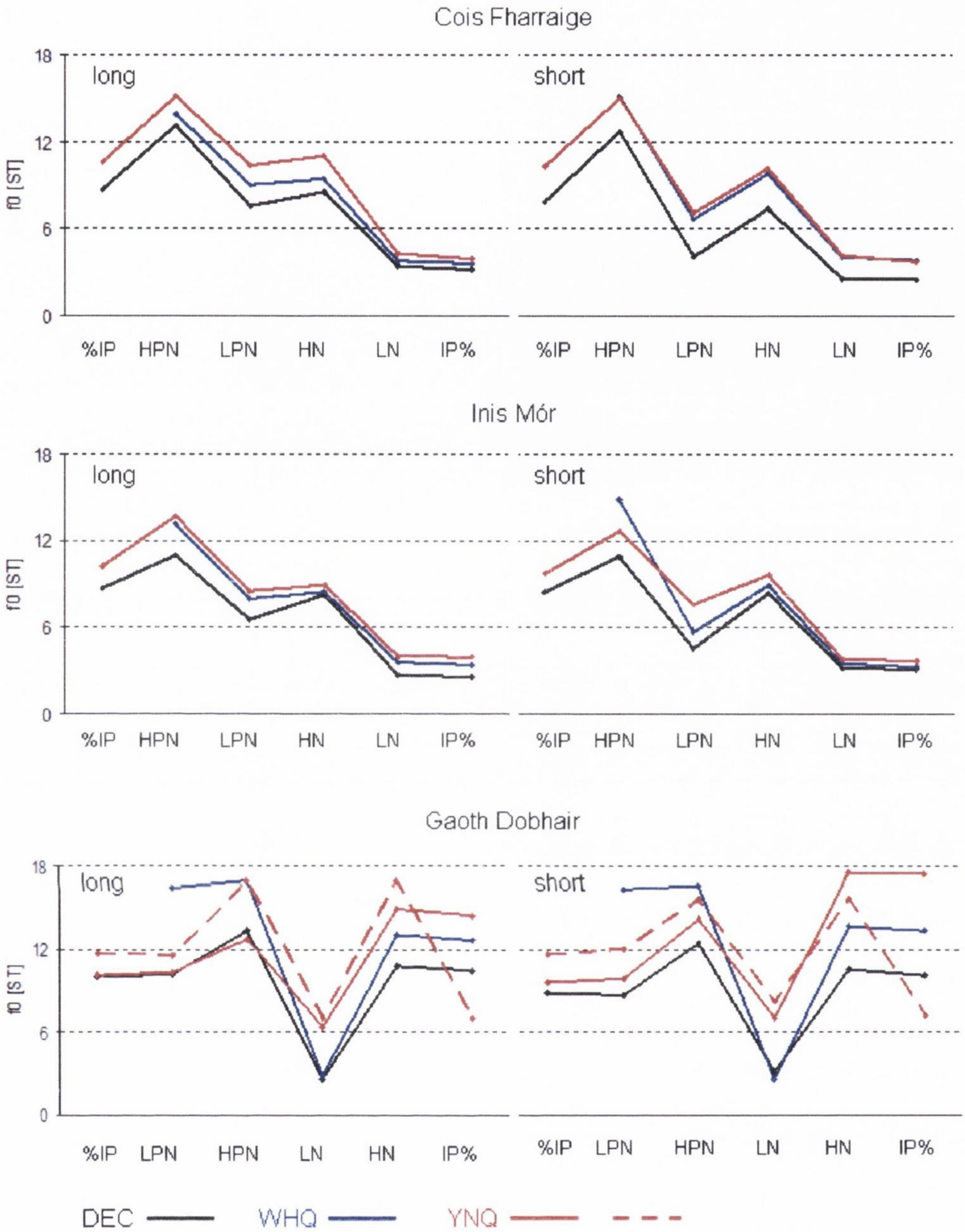

Figure 4.2 Mean stylised f0 contours in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short). Contours include the H and L turning points pertaining to the IP-initial (HPN, LPN) and IP-final (HN, LN) accents, and the left- (%IP) and right-edge (IP%) boundaries. Contour types: Cois Fharraige and Inis Mór: H*(+L) H*+L% in all modes; Gaoth Dobhair: DEC = L*+H L*+H%, WHQ = H* L*+H%, YNQ = L*+H L*+HH% (red solid line), L*+H L*+HL% (red dashed line).

4.5 Scaling of IP onset

Figure 4.3 illustrates the results for scaling of the IP onset in the sentence mode data for the three varieties. Both Connemara varieties follow a similar trend: the IP onset is raised nearly equally in long and short YNQ (relative boost of +1.0 to +2.4 ST). In Gaoth Dobhair the raising is slightly less in long YNQ (relative boost of +0.7 ST in long YNQ vs. +2.2 ST in short YNQ).

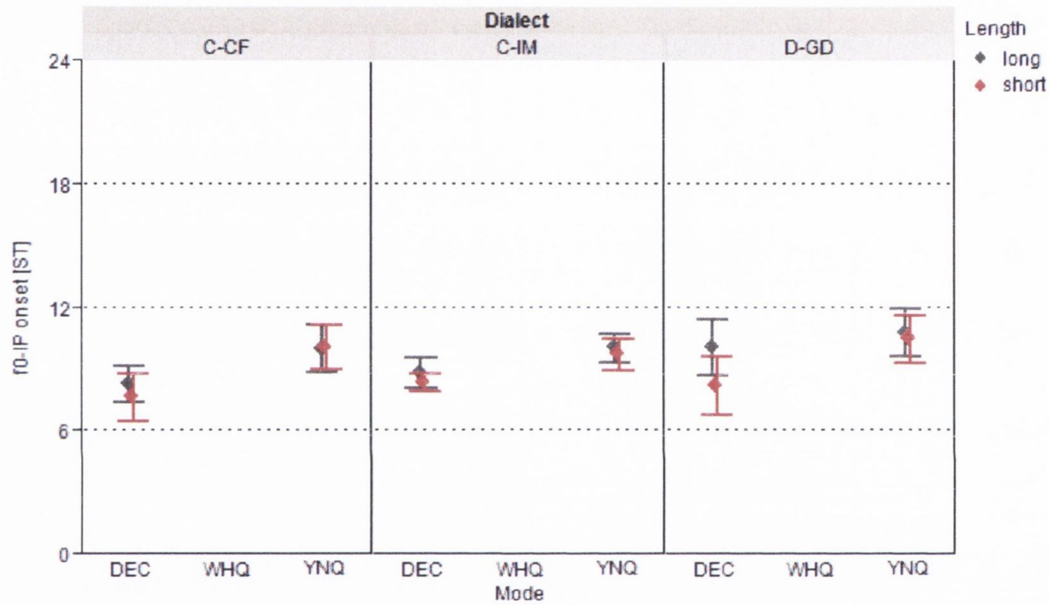

Figure 4.3 Means and 95% confidence intervals for contour-measured IP onset scaling (f0-IP onset, y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

A three-way ANOVA with factors Dialect, Mode and Length for IP onset scaling indicates the effect of Mode in the three varieties ($F(1, 30) = 29.90$, $p < .001$). The post-hoc Tukey HSD (Honestly Significant Difference) test confirms an average increase of +1.7 ST for IP onset scaling in YNQ compared to declaratives ($p < .05$). Length is found to have no influence on this f0 metric ($F(1, 30) = 2.65$, n.s.).

4.6 Scaling of IP-initial peak

Section 4.6 covers scaling of the first prenuclear H measured as independent peak height from the contour, and its Fujisaki model equivalent, i.e. the f0 excursion size of the first prenuclear accent measured with the accent command amplitude (Aa).

4.6.1 Contour-measured scaling of prenuclear H

Figure 4.4 presents the contour-measured peak scaling (f0-HPN) in the sentence mode data in the three varieties. One can clearly observe a nearly equal f0 boost in both question types with little influence from IP length in Cois Fharraige (mean relative increase ranging from +1.5 to +2.8 ST) and Inis Mór (mean relative increase ranging from +1.6 to +3.7 ST). In Gaoth Dobhair, however, the raising of HPN is more in WHQ than in YNQ; within the DEC baseline condition HPN is higher in long IPs.

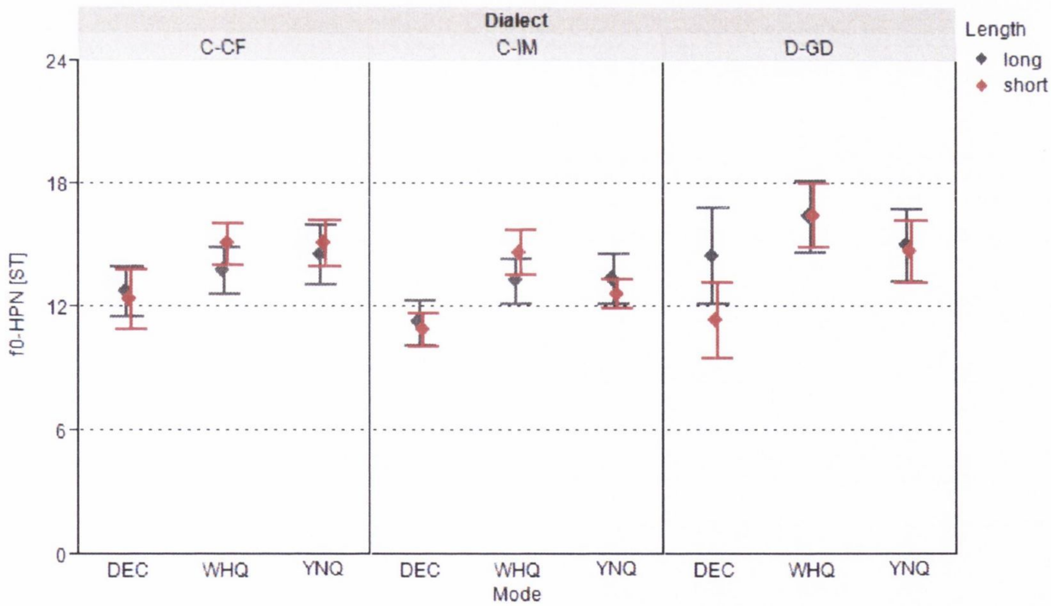

Figure 4.4 Means and 95% confidence intervals for contour-measured scaling of the IP-initial peak (f0-HPN, y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

A three-way ANOVA with factors Dialect, Mode and Length for HPN scaling gives significant results for Mode ($F(2, 50) = 30.61$, $p < .001$) and Dialect*Mode ($F(4, 50) = 3.01$, $p = .026$). The post-hoc Tukey HSD test of the significant interaction confirms that

Cois Fharraige (significant at $p = .071$) and Inis Mór ($p < .05$) maintain the WHQ > DEC and YNQ > DEC distinctions. In Gaoth Dobhair the relative HPN increase is significant ($p < .05$) only for wh- questions. Length has no influence on the height of the IP-initial prenuclear peak ($F(1, 50) = 0.05$, n.s.).

4.6.2 Fujisaki model excursion size of prenuclear accent

Figure 4.5 presents the f0 excursion size of the first prenuclear accent (Aa-PN) for sentence mode data measured with the Fujisaki model accent command. Observation of Figure 4.5 suggests differences between the f0 excursion of Aa-PN and peak scaling (f0-HPN) in Figure 4.4. Recall that the general trend in the latter involved the raising of the prenuclear peak in both question types with very little influence of length. Aa-PN, however, shows an increase mainly in short WHQ. In Cois Fharraige and Inis Mór, Aa-PN is very similar in all data with the exception of short wh- questions (C-CF means: WHQ short = 0.49 vs. all others = 0.29 to 0.41; C-IM means: WHQ short = 0.52 vs. all others = 0.30 to 0.36). In Gaoth Dobhair, Aa-PN is higher in both WHQ (means: WHQ long = 0.50 and WHQ short = 0.60 vs. all others = 0.38 to 0.44).

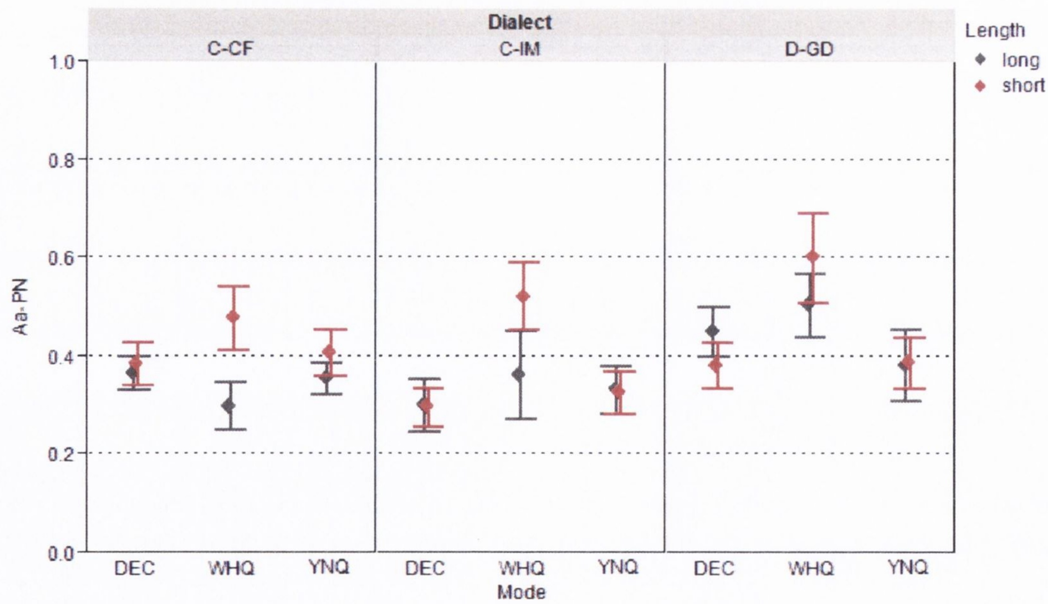

Figure 4.5 Means and 95% confidence intervals for Fujisaki model f0 excursion size of the IP-initial accent (Aa-PN, y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

On the basis of these differences it can be concluded that the f0 excursion size and peak scaling of the prenuclear H in the sentence mode data are not fully compatible. This divergence in Aa-PN and f0-HPN results can be attributed to the intrinsic difference between the two metrics. Peak scaling captures H height independently, i.e. the scaling of the surrounding L tones and declination do not play any role in the calculation of peak height. The f0 excursion of the accent command, on the other hand, is dependent on the peak height *and* the phrase command amplitude (Ap), whose course is implicitly outlined by the L tones.

Let us briefly consider the likely reasons why the IP-initial accent command would exhibit a larger f0 excursion in short wh- questions. In Connemara the increase seems to be the result of a small raising of the H tone (cf. Figure 4.4) of the prenuclear H*+L accent combined with presumably some lowering of the trailing L. This conjecture appears to agree closely with the HPN and LPN results of the mean stylised f0 contours (Figure 4.2), where LPN in both Cois Fharraige and Inis Mór is scaled lower in short WHQ compared to long WHQ.

In the case of the Gaoth Dobhair short WHQ data, the estimation of Aa depends largely on the phrase command remedy setting. Note that the initial prenuclear H* accents in WHQ carry no accentual L tone (cf. L*+H in DEC and YNQ), and the anacrusis syllable was mostly devoiced or clipped, therefore the contour provides no L reference points for the phrase command. In this case the half-maximum-Ap setting described in the methodology was used (see Section 3.4.5 of Chapter 3 on remedy settings for the H* L*+H% contour in the Donegal data).

4.7 Scaling of nuclear peak

Section 4.7 presents the results for the nuclear accent in the sentence mode data as measured from the contour (peak scaling), and obtained with the amplitude (Aa) of the Fujisaki model accent command.

4.7.1 Contour-measured scaling of nuclear H

Figure 4.6 illustrates the results for the contour-measured scaling of the nuclear peak (f0-HN) for the sentence mode data. The first trend common to all three varieties is that length is of no consequence to the height of the nuclear H in any of the three modes (note that the means and 95% CI values for long and short IPs virtually overlap). With respect to mode, however, there is a noticeable difference across the three varieties. Cois Fharraige mildly raises HN in both question types to a comparable degree (means merged for short and long IPs: DEC = 7.7 ST, WHQ = 9.5 ST, YNQ = 10.3 ST). Inis Mór shows largely similar f0-HN values across all three modes (merged means: DEC = 8.6 ST, WHQ = 9.1 ST, YNQ = 9.3 ST). Gaoth Dobhair, however, raises the nuclear H in wh-questions, and even more so in yes-no questions (merged means: DEC = 10.4 ST, WHQ = 12.8, YNQ = 16.5 ST).

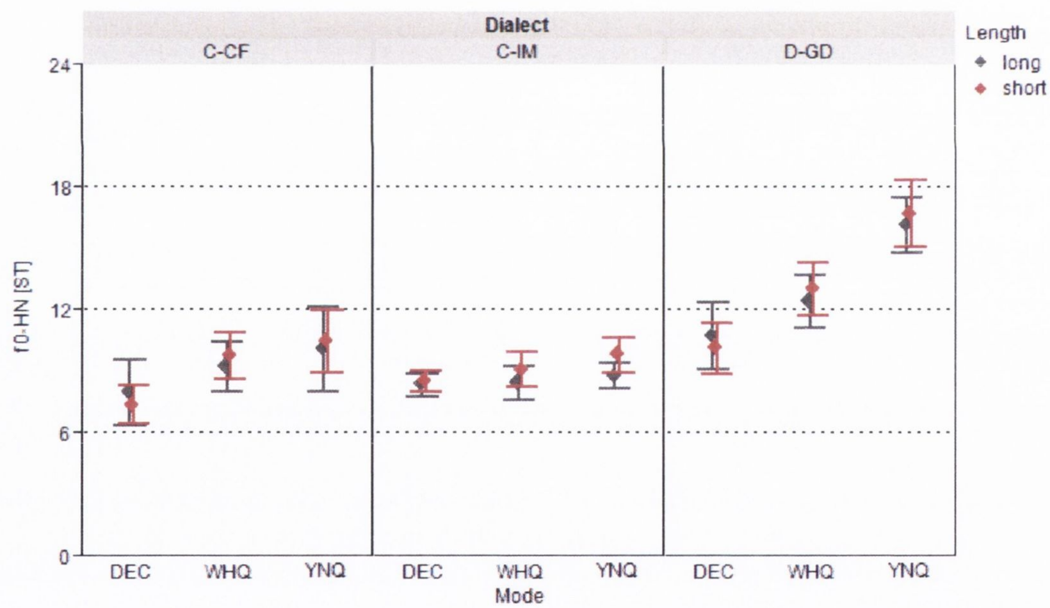

Figure 4.6 Means and 95% confidence intervals for contour-measured scaling of the nuclear peak (f0-HN, y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

A three-way ANOVA with independent factors Dialect, Mode and Length was performed on f0-HN as the dependent factor. Significant results were obtained for Dialect ($F(2, 10) = 6.15$, $p = .018$), Mode ($F(2, 50) = 44.32$, $p < .001$) and Dialect*Mode ($F(4, 50) = 9.45$, $p < .001$). The post-hoc Tukey HSD pairwise comparisons of the significant interaction point to a three-way distinction in Gaoth Dobhair, where the nuclear peak in WHQ is significantly higher from DEC (+2.7 ST, $p < .05$), and in YNQ it is significantly higher from both DEC (+5.9 ST, $p < .05$) and WHQ (+3.2 ST, $p < .05$).[31] In Cois Fharraige only the YNQ nuclear peak is significantly higher than in DEC (+2.6 ST, $p < .05$). Length is found to have no effect on the height of the nuclear H ($F(1, 50) = 0.04$, n.s.).

4.7.2 Fujisaki model excursion size of nuclear accent

Figure 4.7 illustrates the f0 excursion size of the nuclear accent (Aa-N) in sentence mode data obtained by means of the accent command amplitude. When the Aa-N results are compared with those for the nuclear peak height in Figure 4.6 one notes a general similarity between the two measures in Cois Fharraige and Inis Mór data.

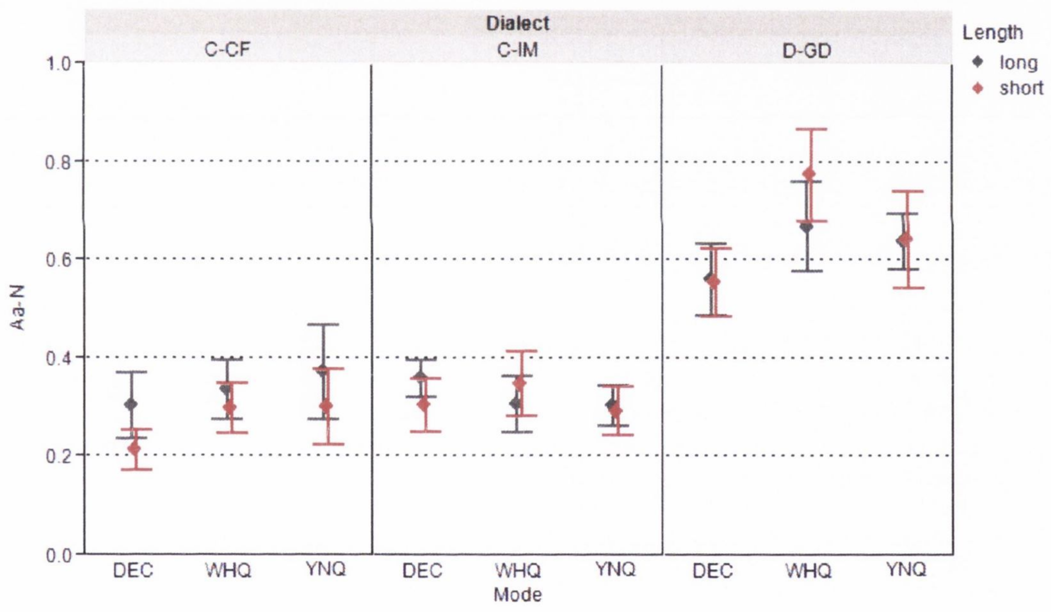

Figure 4.7 Means and 95% confidence intervals for Fujisaki model f0 excursion size of the nuclear accent in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

A considerable discrepancy between f0-HN (Figure 4.6) and Aa-N (Figure 4.7) is found in the Gaoth Dobhair data. While the nuclear H measured as an independent peak was shown to increase in the DEC < WHQ < YNQ order, Aa-N results indicate that the nuclear f0 excursion size is highest in short WHQ (mean = 0.77) and somewhat expanded

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[31] The nuclear H in YNQ of Gaoth Dobhair is raised in both contours, i.e. L*+H L*+HL% and L*+H L*+HH% (see stylised f0 contours for Gaoth Dobhair YNQ in Figure 4.2, Section 4.4).

in both YNQ (mean = 0.64) and long WHQ (mean = 0.67). This difference is conditioned, similarly to that found for the prenuclear accents, by the divergence between independent peak scaling and f0 excursion size. Comparison of the mean stylised f0 contours (Figure 4.2) in Gaoth Dobhair WHQ and YNQ confirms this: in WHQ only the nuclear peak (HN) is raised, while in YNQ both HN and LN are elevated. The size of the nuclear *rise* is not expanded, hence the similarity in Aa-N values for WHQ and YNQ.

4.8 Register level

Section 4.8 presents the results for register level in the sentence mode data for the three varieties of Irish. The findings for contour-measured register level are covered in Section 4.8.1, while the results for the base frequency of the Fujisaki model are included in Section 4.8.2. The results for both metrics are presented in terms of means.

4.8.1 Contour-measured register level

Figure 4.8 presents the results for register level measured from the f0 contour. The effect of mode is most pronounced in Gaoth Dobhair YNQ (long = 6.7 ST, short = 7.5 ST), for which the pitch floor is raised considerably compared to both DEC (2.6 ST). In the Connemara data, the relative raising of register level is mild overall in Cois Fharraige (means: DEC long = 2.7 ST, short = 1.9 ST vs. WHQ long = 3.0 ST, short = 3.2 ST, both YNQ = 3.3 ST), as well as in Inis Mór (both DEC = 2.4 ST, WHQ long = 3.1 ST, WHQ short = 2.5 ST, both YNQ = 3.5 ST).

A three-way ANOVA with independent factors Dialect, Mode and Length was conducted for register level. Significant results were obtained for Mode ($F(2, 50) = 44.40$, $p < .001$) and Dialect*Mode ($F(4, 50) = 15.41$, $p < .001$). The post-hoc Tukey HSD of the interaction reaches significance only for the YNQ > DEC difference in Gaoth Dobhair (+4.7 ST, $p < .05$). Length is found to have no influence on register level ($F(1, 50) = 0.02$, n.s.).

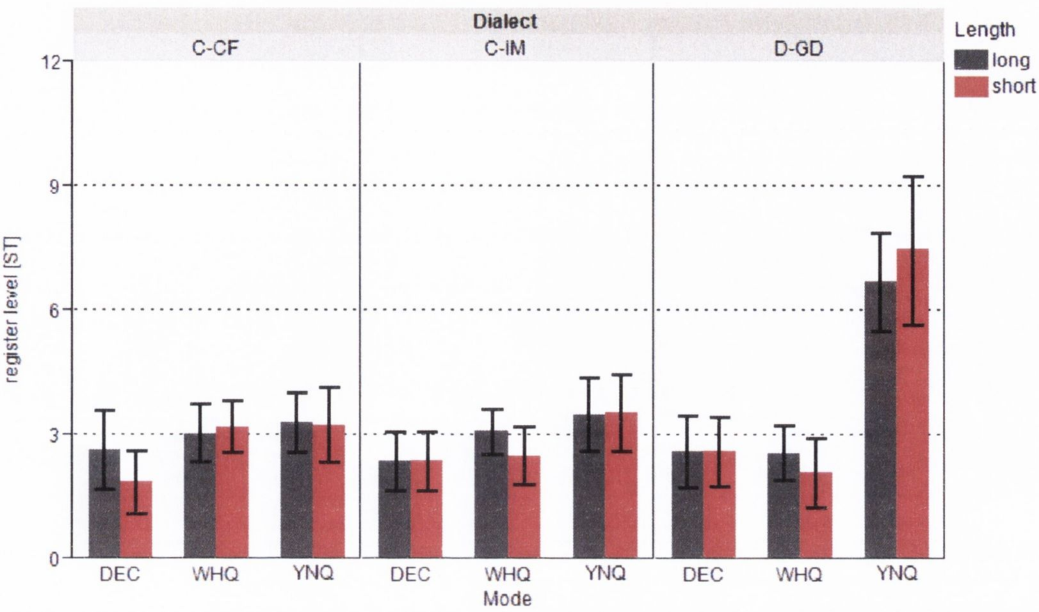

Figure 4.8 Means and standard deviations for contour-measured register level (y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

4.8.2 Fujisaki model base frequency

Figure 4.9 presents register level results for the sentence mode data obtained with the base frequency of the Fujisaki model. The Fb results shown herein closely resemble the register level results in Figure 4.8. The large upward shift of the f0 floor in Gaoth Dobhair YNQ is faithfully conveyed through Fb. This accuracy in the base frequency match stems from the component not being dependent on the phrase and accent components.

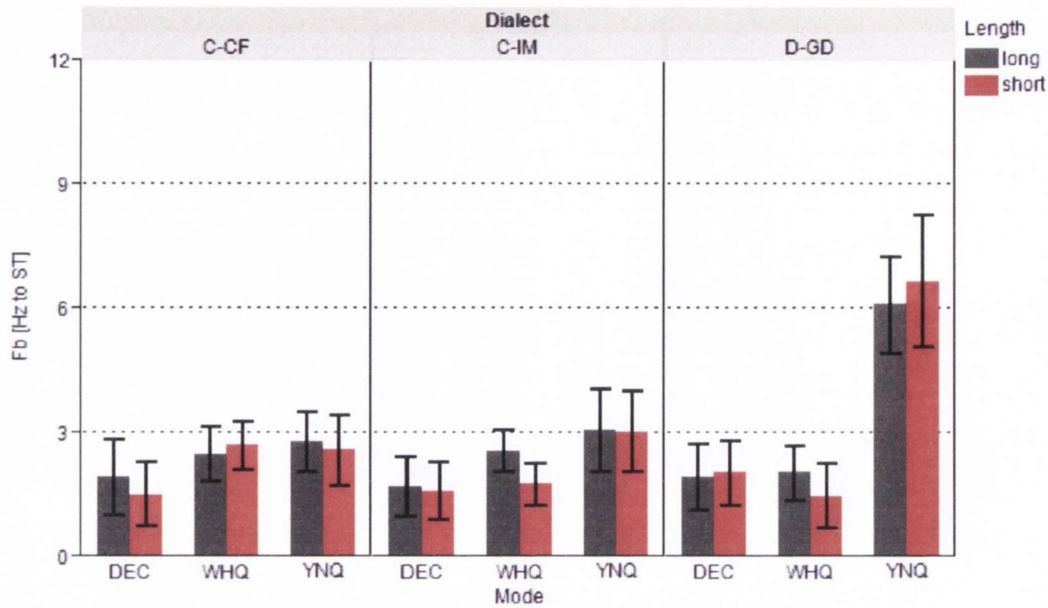

Figure 4.9 Means and standard deviations for the Fujisaki model base frequency (Fb, y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

4.9 Register span

Figure 4.10 presents the results for contour-measured register span. Note that in Cois Fharraige, span in questions (means ranging from 10.7 to 11.9 ST) is much the same as in declaratives (long = 10.2 ST, short = 10.5 ST). However, in Inis Mór some increase is observed in WHQ (long = 10.5 ST, short = 12.7 ST) compared to DEC (long = 9.1 ST, short = 8.6 ST). The same trend is found in Gaoth Dobhair (DEC: long = 12.6 ST, short = 9.5 ST; WHQ: long = 14.1 ST, short = 14.5 ST).

A three-way ANOVA with factors Dialect, Mode and Length for register span gives significant results for Mode ($F(2, 50) = 15.63$, $p < .001$) and Dialect*Mode ($F(4, 50) = 8.73$, $p < .001$). The post-hoc Tukey HSD of the interaction shows that the expansion of span in WHQ compared to DEC is significant ($p < .05$) for Gaoth Dobhair (+3.4 ST) and Inis Mór (+2.3 ST). As was the case for all the other contour-measured metrics discussed so far (the IP onset, the PN and N peaks and register level), register span is also found not to be affected by Length ($F(1, 50) = 0.02$, n.s.).

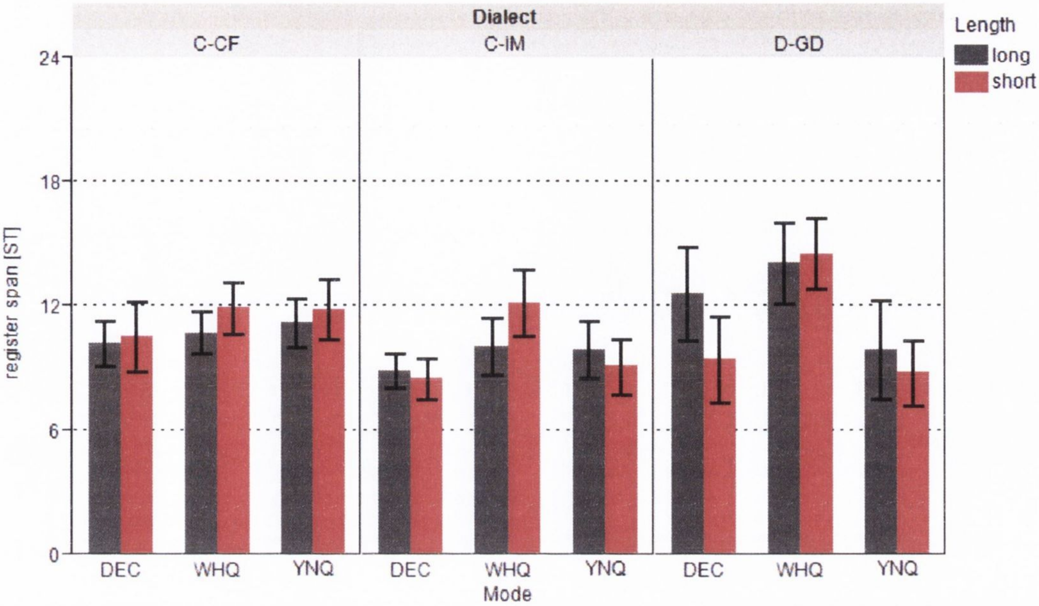

Figure 4.10 Means and standard deviations for contour-measured register span in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

4.10 F0 difference between IP-initial and nuclear peaks

This metric quantifies the relationship between the IP-initial prenuclear (HPN) and nuclear (HN) peaks, and is illustrated in Figure 4.11. The DEC example (left panel of Figure 4.11) has the nuclear peak slightly lower than the prenuclear peak – here the HPN-HN difference is positive. The YNQ example (right panel of Figure 4.11) shows a raised nuclear peak – in this instance the HPN-HN difference is negative. This metric is expected to be related to the upper declination slope (Section 4.11.2). The two will not be identical, as the HPN-HN difference does not account for time elapsed over the IP as declination does, but it should show a similar trend (except for the opposite sign).

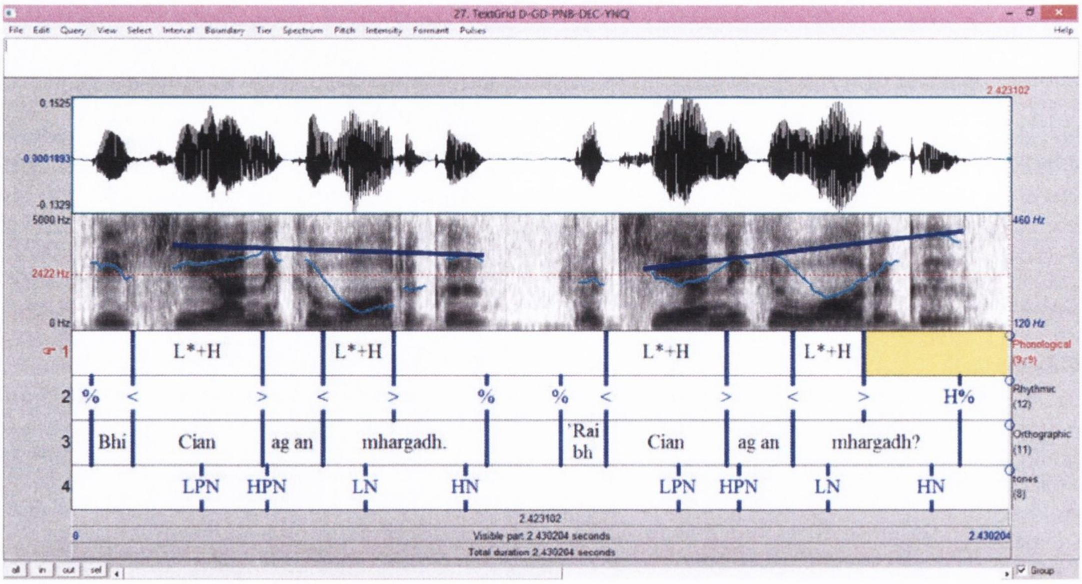

Figure 4.11 Examples of a short DEC and a matching short YNQ in the Gaoth Dobhair data. The blue lines connecting the first prenuclear and nuclear peaks indicate the HPN-HN difference. HPN and HN are marked on the bottom ('tones') tier in the transcription.

Figure 4.12 presents the results for the HPN-HN difference measured from the f0 contour in the sentence mode data. The most striking effect is found in Gaoth Dobhair YNQ, which is the only mode where the nuclear H is higher than the prenuclear H (note the negative means in YNQ: long = -1.2 ST, short = -2.1 ST). In DEC and WHQ the relative H drop is similar except for short declaratives (DEC: long = 3.7 ST, short = 1.2 ST; WHQ: long = 4.0 ST, short = 3.4 ST).

In the Connemara data, the HPN-HN difference is positive in all three modes, suggesting that the prenuclear peak is higher (Figure 4.12). There is, however, a difference across the modes between the two varieties. Cois Fharraige exhibits striking regularity across all modes and lengths in that the HPN-HN difference is nearly identical (all means ranging from 4.4 to 5.3 ST). Inis Mór, on the other hand, employs a larger relative f0 drop in all questions except short YNQ (means: DEC: long = 2.9 ST, short = 2.4 ST, WHQ: long = 4.8 ST, short = 5.5 ST, YNQ: long = 4.6 ST, short = 2.7 ST). Recalling the Inis Mór stylised f0 contours in Figure 4.2, the increase in the HPN-HN drop is due to a raised prenuclear H in questions (except in short YNQ). Scaling of the nuclear H seems to have little influence on the HPN-HN difference in the Inis Mór data, since it occupies a similar f0 space in all three modes regardless of length (see the f0-HN results for C-IM in Section 4.7.1).

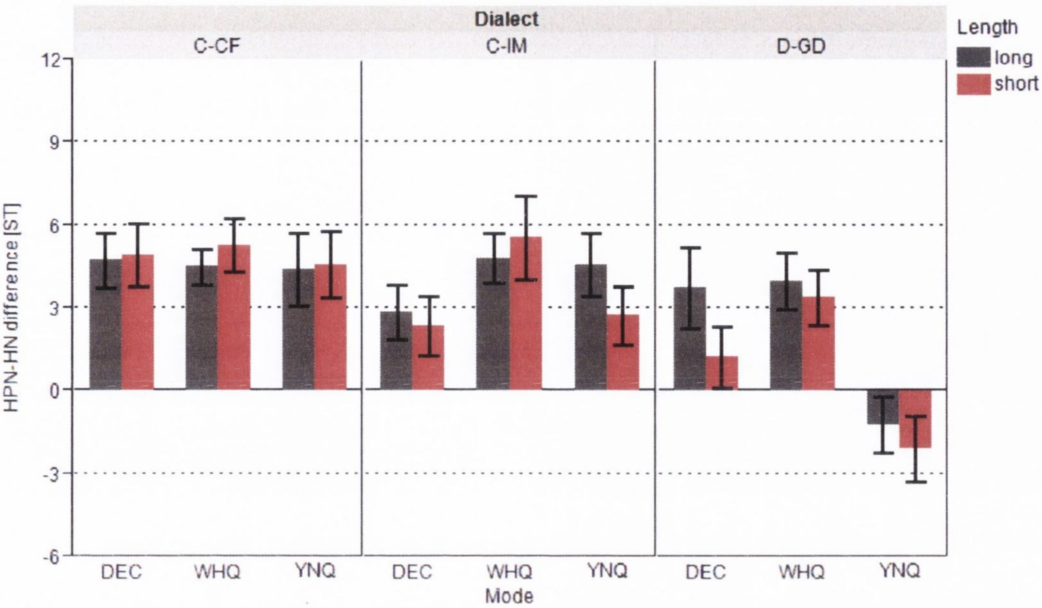

Figure 4.12 Means and standard deviations for the f0 difference between the IP-initial and nuclear peaks in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

A three-way ANOVA with Dialect, Mode and Length as independent factors was carried out on the HPN-HN difference as the dependent variable. Significant results were obtained for Mode ($F(2, 50) = 15.41$, $p < .001$) and Dialect*Mode ($F(4, 50) = 11.87$, $p < .001$). The post-hoc Tukey HSD test of the significant interaction indicates a significant difference ($p < .05$) between Gaoth Dobhair yes-no questions and all Connemara modes (LS means differences for D-GD YNQ < all C-CF modes range from 6.0 to 6.4 ST; for D-GD YNQ < all C-IM modes range from 4.1 to 6.7 ST). The Gaoth Dobhair YNQ are also significantly different from Gaoth Dobhair's own DEC and WHQ (LS means differences: 4.1 and 5.5 ST, respectively, at $p < .05$).. In the Connemara data, only the WHQ > DEC difference in Inis Mór is significant (2.6 ST, $p < .05$). As was the case with all parameters discussed so far, Length is found to have no influence on the HPN-HN difference ($F(1, 50) = 0.14$, n.s.).

4.11 Declination slopes

Declination is defined as the tendency for the fundamental frequency to drop along the course of an utterance (Ladd, 1983; Nolan, 1995). The concept was introduced by Cohen & 't Hart (1967). In a broad sense, declination is modelled as a sort of a reference line from which scaling of individual tones (usually H) is calculated. Ladd (1983) proposes a division into two distinct approaches to modelling declination: the zero-line view represented by e.g. Pierrehumbert (1980), and the regression-line view (e.g. Cooper & Sorensen, 1981; Gårding, 1983; Thorsen, 1980, 1983). In the first, accent peaks are scaled with reference to the preceding accent, while in the second they are calculated relative to a reference line (cf. the discussion of 'Tone Sequence' and 'Contour Interaction' models in Nolan, 1995).

This section focuses on two specific ways of representing declination with a reference line. The contour-based method involves the break-up of an f0 contour by means of a middle regression line from which two separate (upper and lower) declination trends are calculated (Haan, 2002). The upper and lower slopes (1) abstract away from the H and L extremities (and thus are more objective) and (2) include the measure of IP duration (and therefore are time-dependent). The Fujisaki model estimates declination with the decaying slope of the phrase command.[32] In the present approach the strategy for setting the phrase command slope is explicitly stated: baseline declination is fitted on the basis of reference L tones in the contour. When these are absent, the 'remedy settings' (Section 3.4.5 of Chapter 3) proposed by the author are used. As the alpha parameter of the phrase control mechanism is set to a constant, baseline declination slope is expressed solely through the phrase command amplitude (Ap), and does not change according to the actual duration of the intonation phrase.

4.11.1 Upper and lower declination slopes

Before presenting the numerical results for the contour-measured upper and lower declination slopes, Figure 4.13 is provided to illustrate the course of declination in the sentence mode data of Cois Fharraige, Inis Mór and Gaoth Dobhair. As will become apparent in the results, the declination slopes are relatively steep, because the IP durations in the data are generally very short, with the two-accent (short) IPs usually not longer than 1 s, and three-accent (long) IPs less than 1.5 s in duration (Table 4.2).

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[32] In the works by Fujisaki and colleagues the physiological motivation for the model components is typically emphasised. With respect to the linguistic interpretation, the phrase component is broadly defined as '(...) correspond[ing] to the gradually decaying baseline' (Fujisaki & Hirose, 1984).

Table 4.2 Means and standard deviations for IP duration in the sentence mode data expressed in milliseconds.

Descriptive statistics – IP duration (sentence mode data)							
		DEC		WHQ		YNQ	
		long	short	long	short	long	short
C-CF	M	**1234**	**876**	**1305**	**891**	**1281**	**904**
	S.D.	95	55	80	78	98	55
C-IM	M	**1506**	**1081**	**1517**	**1104**	**1529**	**1112**
	S.D.	130	77	108	98	107	84
D-GD	M	**1515**	**1120**	**1538**	**1106**	**1549**	**1113**
	S.D.	124	82	130	86	161	119

Figure 4.13 presents the upper and lower declination slopes in declaratives and wh- and yes-no questions in the three varieties of Irish. The upper and lower slopes will be discussed with respect to mode and length in more detail in separate sections (4.11.2 and 4.11.3), therefore here only a few general observations are given.

The main impression emerging from Figure 4.13 is that there is a noticeable cross-dialect difference in declination trends. First of all, Gaoth Dobhair is the only variety which exhibits a non-declining upper slope in YNQ. Also, Gaoth Dobhair exhibits more pronounced differences in the slopes depending on question type. The upper declination slope is more downward in WHQ but flat or upward in YNQ, while the lower declination slope is much more downward in WHQ and less so in YNQ. In Cois Fharraige and Inis Mór, on the other hand, both the upper and lower declination slopes are falling for all modes. Length demonstrates a more uniform effect in Connemara than in Donegal (crossing of the lines for the short and long conditions, with more sloping of the red lines implying steeper declination slopes in short IPs), but mode-wise, the possible differences in slopes between declaratives and questions are not as apparent.

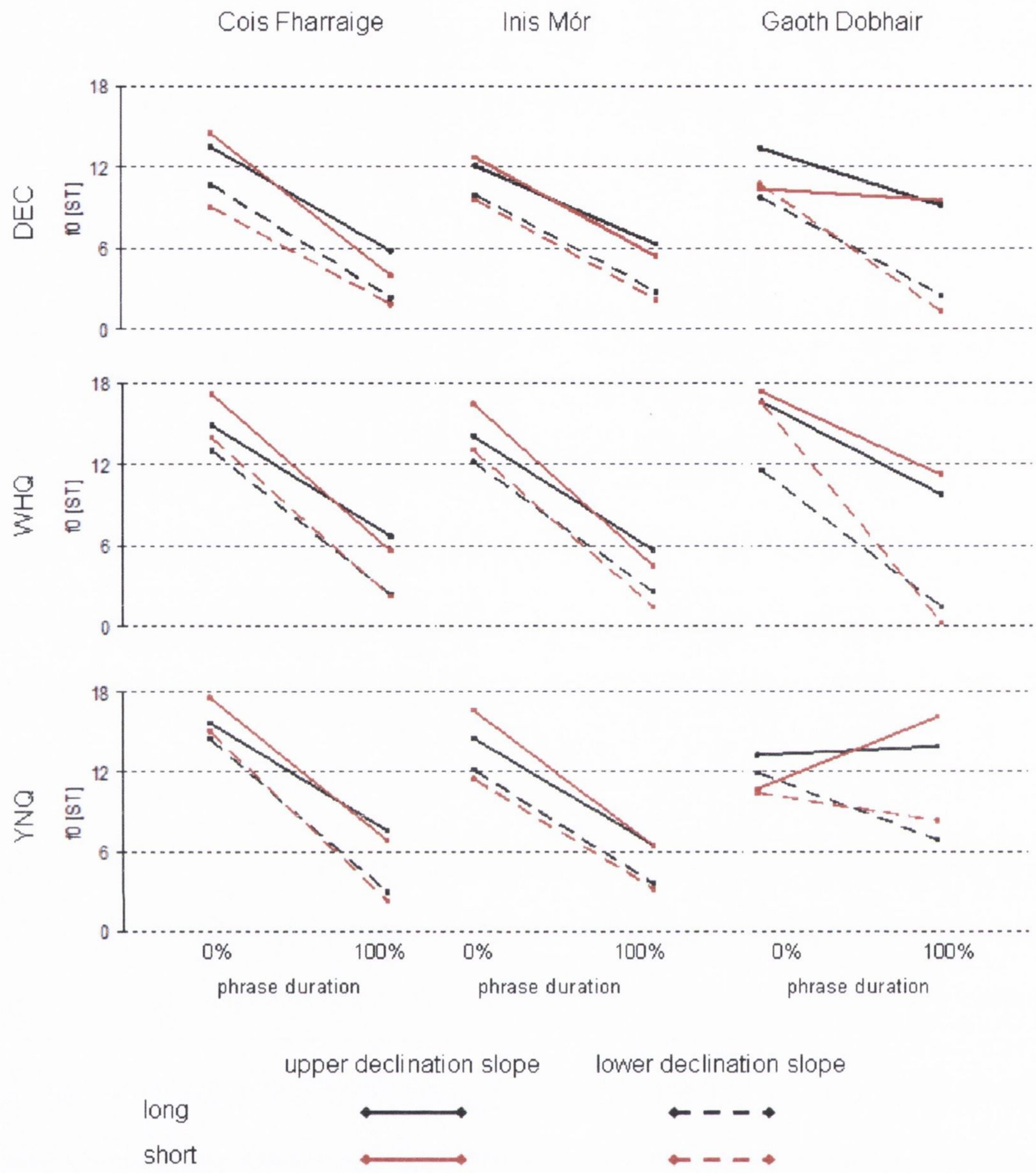

Figure 4.13 The upper and lower declination slopes in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short). The slopes are shown on a time-normalised scale (phrase duration = 0% to 100%, x axis).

4.11.2 Contour-measured upper declination slope

The results for the upper declination slope in the sentence mode data are shown in Figure 4.14. As already noted, a difference is found between the two Connemara varieties and Gaoth Dobhair in that the latter (1) shows overall shallower upper declination slopes, and (2) is the only variety to exhibit rising declination slopes in yes-no questions.

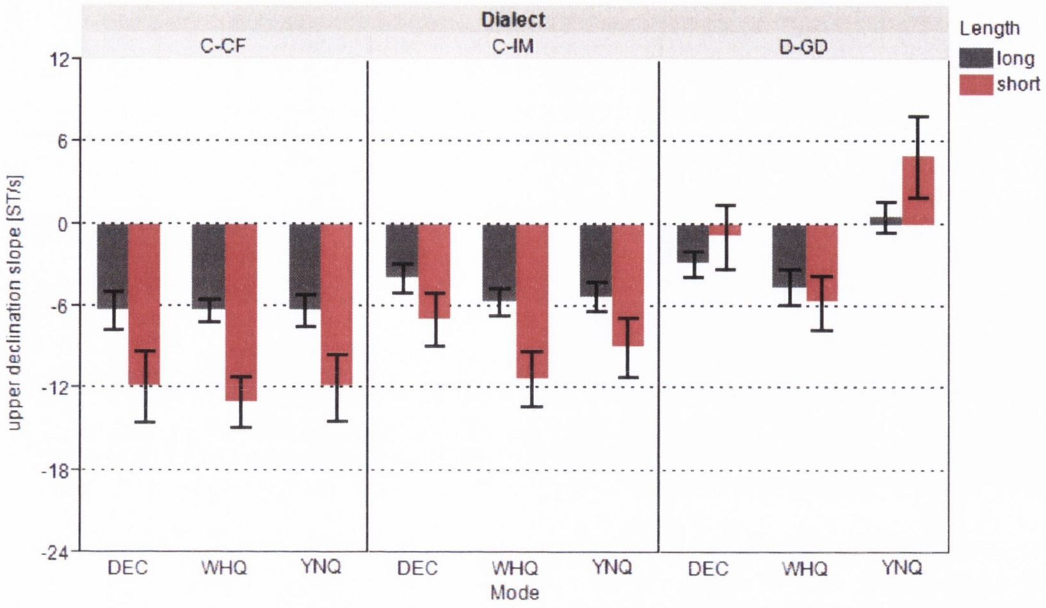

Figure 4.14 Means and standard deviations for the upper declination slope (y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

In the two Connemara varieties phrase length has a similar impact on declination: short IPs exhibit one and a half to twice the rate of long IPs (mean slopes in short IPs between -7 and -12 ST/s vs. between -4 and -6 ST/s in long IPs).[33] Cois Fharraige exhibits a uniform declination rate across modes but shows differences due to length (means for long DEC, WHQ and YNQ = -6.3 ST/s; short DEC and YNQ = -11.9 ST/s, short WHQ = -12.9 ST/s). In Inis Mór length is also largely responsible for the change in slope, while mode plays a comparatively lesser role (means for long IPs: DEC = -4.2 ST/s, WHQ = -5.7 ST/s, YNQ = -4.7 ST/s; short IPs: DEC = -6.9 ST/s, WHQ = -11.2 ST/s, YNQ = -8.9 ST/s).

The upper declination slopes in the Gaoth Dobhair data differ from those in the Connemara data in that larger differences are found across modes than across lengths. The upper slope is steeper in WHQ compared to DEC, but shallower in YNQ, where *in*clination of the upper slope is observed. Declination rate increases for short IPs in questions (means for WHQ: short = -5.7 ST/s, long = -4.5 ST/s; YNQ: short = 4.9 ST/s,

[33] These appear to be considerably high declination coefficients. To ensure that no error occurred in the calculation process, the declination rates were also calculated in ERB and compared with the ST results. For comparison, the -6.3 and -11.9 ST/s average slopes for long and short IPs in Cois Fharraige correspond to -1.3 and -2.5 ERB/s, respectively. The -1.3 ERB/s upper declination slope in long IPs in Cois Fharraige would correspond closely to that found for wh- questions in Dutch (-1.0 ERB/s) by Haan (2002).

long = 0.6 ST/s) but not in declaratives, where overall *de*creased declination in short IPs is observed (means for DEC: short = -0.9 ST/s, long = -2.9 ST/s).[34]

The results of the three-way ANOVA (with independent factors Dialect, Mode and Length) of the upper declination slope are the most complex to interpret among all the f0 metrics presented so far, as this measure is affected by all three factors. Significant results were obtained for the following five factors/factor combinations: Dialect ($F(2, 10) = 14.20$, $p < .001$, Mode ($F(2, 50) = 10.78$, $p < .001$, Dialect*Mode ($F(4, 50) = 7.69$, $p < .001$), Length ($F(1, 50) = 27.90$, $p < .001$) and Dialect*Length ($F(2, 50) = 12.94$, $p < .001$).

Let us first analyse the results of the post-hoc Tukey HSD test of the Dialect*Mode interaction. The vast majority of the significant pairwise comparisons involve Gaoth Dobhair YNQ which exhibit lesser declination slopes not only compared to the Connemara varieties, but also within the variety. Thus, Gaoth Dobhair yes-no questions have significantly less upper declination than all modes in Cois Fharraige (LS means differences from 11.7 to 12.2 ST/s, $p < .05$), all modes in Inis Mór (LS means differences from 7.8 to 10.5 ST/s, $p < .05$) and Gaoth Dobhair's own DEC and WHQ (LS means differences: 5.2 and 8.5 ST/s, respectively, $p < .05$).

The results of the post-hoc Tukey HSD of the Dialect*Length interaction indicate a Connemara vs. Donegal opposition. The upper declination slopes in both Connemara varieties exhibit significantly higher values in short IPs compared to the rest of the data. Thus, Cois Fharraige short IPs are significantly more declining than short and long IPs in Gaoth Dobhair (LS means differences: 11.1 and 10.2 ST/s, $p < .05$), and Cois Fharraige's own long IPs (6.5 ST/s, $p < .05$). Inis Mór follows exactly the same pattern: declination slopes in short IPs are significantly higher than those in short and long IPs in Gaoth Dobhair (LS means differences: 7.0 and 6.1 ST/s, $p < .05$), and Inis Mór's own long IPs (3.6 ST/s, $p < .05$). These findings combined with those for Dialect*Mode lead towards a broad cross-dialect distinction between Connemara and Donegal in terms of the upper

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[34] Note that standard deviations in the upper declination slope results for long IPs in Figure 4.14 are half of those found in short IPs (for all three varieties). This trend could be interpreted as evidence of better tonal control in long IPs (regular distancing of the H and L extremities from the middle regression line would effectively produce less variability in the slope results).

declination trends. Cois Fharraige and Inis Mór generally do not produce mode-specific slopes, whereas Gaoth Dobhair does.

Before we move on to the lower declination trends, let us briefly consider the relationship between the HPN-HN peak difference (Section 4.10) and the upper declination slope. Comparison of the HPN-HN results in Figure 4.12 and the upper declination results in Figure 4.14 confirms that the two show identical trends with respect to mode (recall that the HPN-HN difference disregards IP length). Both measures point to Gaoth Dobhair YNQ as the only case of HN upscaling relative to HPN in all of the sentence mode data.

A side question prompted by the HPN-HN and declination results presented here concerns the downstep/declination (or 'Tone Sequence' vs. 'Contour Interaction', see the introduction in Section 4.11) debate. If downstep and declination are two distinct phenomena in non-tonal languages such as Irish, then marking the sequential lowering of H tones in the transcription should be obligatory. A series of simple correlations run on the HPN-HN difference vs. the upper declination slope grouped for each dialect with respect to length (Table 4.3) suggest that the two metrics may not be entirely independent. On the contrary, the correlations yield considerably high values (r of at least .83 up to .97). These results add a point to the discussion of what each of these processes involves, and whether downstep and declination may be two model-dependent ways of looking at an underlyingly singular phenomenon.

Table 4.3 Pearson correlations of the relative f0 drop between the IP-initial and IP-final peaks (HPN-HN) and the upper declination slope (upper d.s.) for Cois Fharraige, Inis Mór and Gaoth Dobhair collapsed over IP length.

Pearson product-moment correlation coefficient r ($p < .001$)

	C-CF		C-IM		D-GD	
HPN-HN Upper d.s.	*r*	N	*r*	N	*r*	N
IP length: long	.87	53	.96	54	.87	51
IP length: short	.96	55	.83	54	.97	48

4.11.3 Contour-measured lower declination slope

Figure 4.15 presents the results for the lower declination slope in the sentence mode data. Here the differences in declination trends between Connemara and Donegal are not as extreme as what was observed in Section 4.11.2 (Gaoth Dobhair rarely exhibits positive, i.e. rising, lower declination slopes). Generally, both mode and length seem to contribute to the slopes in all three varieties.

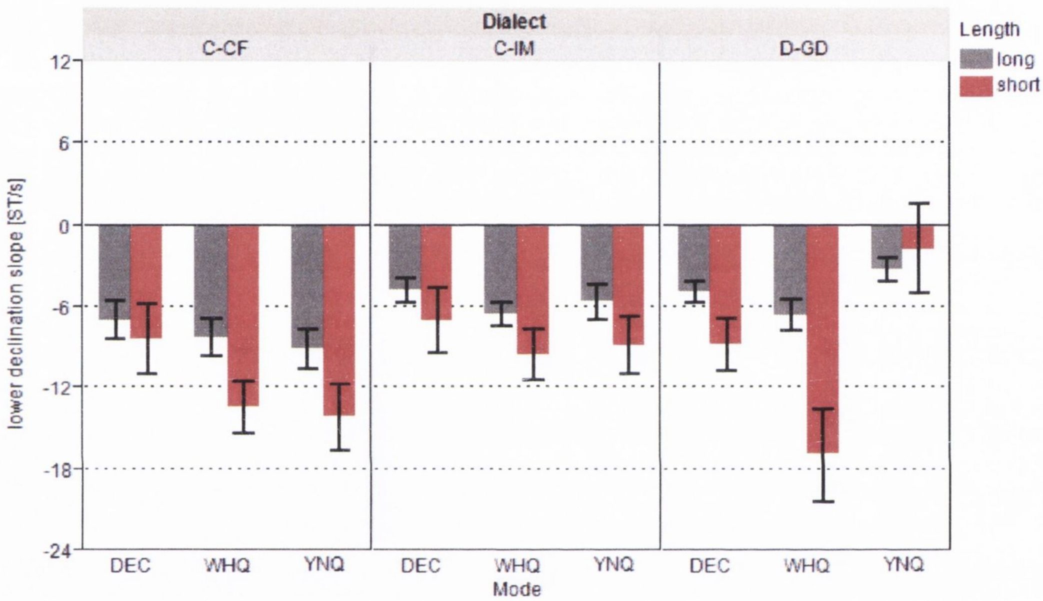

Figure 4.15 Means and standard deviations for the lower declination slope (y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

The two Connemara varieties feature similar lower declination trends (Figure 4.15). Cois Fharraige shows more declination in the two question types, where length seems to affect the slope more than in declaratives (C-CF means: DEC: long = -6.9 ST/s, short = -8.3 ST/s; WHQ: long = -8.2 ST/s, short = -13.4 ST/s; YNQ: long = -9.1 ST/s; short = -14.1 ST/s). Inis Mór also shows increased slopes in questions, although less than Cois Fharraige; the influence of length is also observed (C-IM means: DEC: long = -5.1 ST/s, short = -7.0 ST/s; WHQ: long = -6.9 ST/s, short = -9.4 ST/s; YNQ: long = -6.0 ST/s; short = -8.7 ST/s).

In Gaoth Dobhair, the lower declination slopes are steeper in WHQ and shallower in YNQ compared to DEC. Length additionally affects the slopes: short IPs in DEC and

WHQ exhibit higher values (means: DEC: long = -4.9 ST/s, short = -8.6 ST/s; WHQ: long = -6.6 ST/s, short = -16.9 ST/s). The effect of length in YNQ is not as clear due to perceptible variation in slope values for the short condition (means and standard deviations for YNQ: long = -3.2 ST/s, +/- 1.6; short = -1.6 ST/s, +/- 5.9). Notably, the overwhelmingly high values in Gaoth Dobhair short WHQ make the influence of mode and length on declination slopes less appreciable in the rest of the sentence mode (within Gaoth Dobhair and Connemara as well).

To verify the above observations statistically, a three-way ANOVA with independent factors Dialect, Mode and Length was performed on the lower declination slope as the dependent factor. Along with four other factors, the highest order interaction was found significant (Dialect*Mode*Length: $F(4, 50) = 4.36$, $p = .004$). As was already apparent from the visual inspection of the lower slope results, Gaoth Dobhair short WHQ overshadowed the other differences observed in Figure 4.15 (the majority of significant pairwise comparisons in the post-hoc test involved D-GD short WHQ). As a consequence, a decision was made to run separate tests for Connemara and Donegal.

The same design three-way ANOVA was conducted for Cois Fharraige and Inis Mór. The results confirmed similar behaviour of the two varieties with respect to the lower declination slope. Significant results were found for Mode ($F(2, 35) = 9.01$, $p < .001$) and Length ($F(1, 35) = 25.18$, $p < .001$). The post-hoc Tukey HSD test for Mode showed that the lower slopes in both WHQ and YNQ are steeper than in DEC (LS means differences: 2.6 and 2.5 ST/s, $p < .05$). The Tukey HSD comparison of Length confirms a significant increase in the slope for short IPs (2.8 ST/s, $p < .05$).

For the Gaoth Dobhair data two separate two-way ANOVAs with independent factors Mode and Length were performed on the lower declination slopes. The first ANOVA tested declaratives and yes-no questions. Here only Mode was significant ($F(1, 9) = 9.75$, $p = .012$). The Tukey HSD comparison points towards a significant decrease of lower declination in YNQ compared to DEC (LS mean difference = 4.3 ST/s, $p < .05$). The second ANOVA compared declaratives and wh- questions. In this test Mode ($F(1, 9) = 8.05$, $p = .019$) was found significant along with Length ($F(1, 9) = 17.61$, $p = .002$). The Tukey HSD comparison of Mode shows an average increase of 5.5 ST/s for the lower declination slope in WHQ compared to DEC, while the comparison of Length indicates significantly steeper slopes in short IPs (LS mean difference = 8.1 ST/s, $p < .05$).

4.11.4 Fujisaki model baseline declination

This section completes the overview of the f0 parameters in the sentence mode data of Cois Fharraige, Inis Mór and Gaoth Dobhair. The results for baseline declination modelled with the phrase command amplitude (Ap) of the Fujisaki model are presented. The main interest is in assessing what information the phrase component conveys about declination.

Figure 4.16 presents the phrase command amplitude (Ap) results for the three varieties of Irish. Note that Ap is presented on a reversed scale so that it can be more readily compared with the lower declination slope results in Figure 4.15.

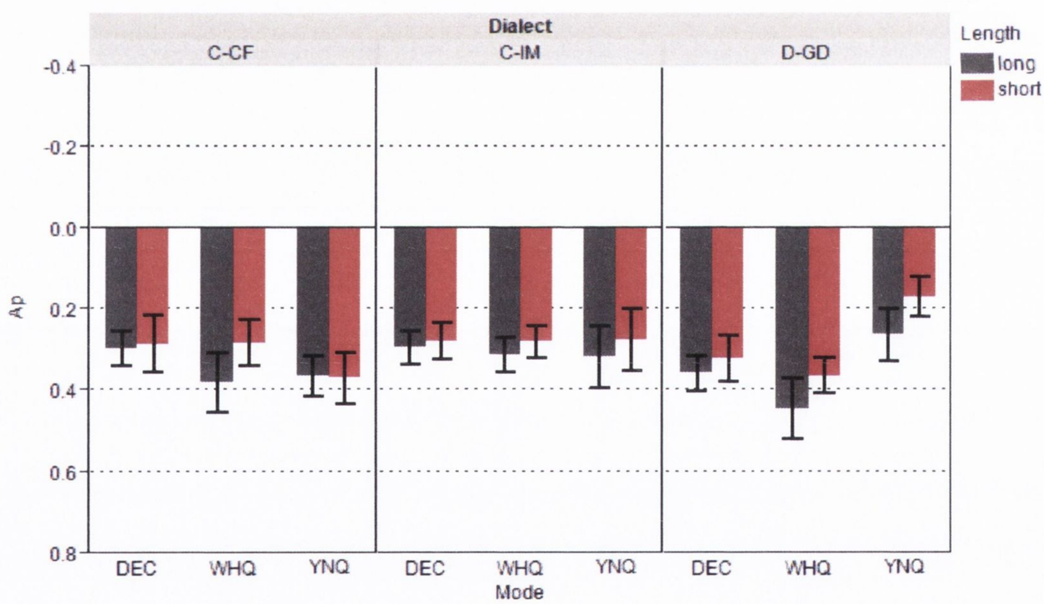

Figure 4.16 Means and standard deviations for Fujisaki model baseline declination (Ap, y axis) in declaratives (DEC) and two question types (WHQ, YNQ) in two IP lengths (long, short).

The overall impression from Figure 4.16 is that baseline declination in all three varieties is overall similar. First, with respect to mode, Ap in Cois Fharraige and Inis Mór is found around the 0.3 mark across all data (mean Ap values: C-CF = 0.28-0.38, C-IM = 0.27-0.32). A mode-related difference is only observed in the Gaoth Dobhair data, with short

WHQ exhibiting mildly steeper (long = 0.44, short = 0.36) and YNQ shallower (long = 0.26, short = 0.17) Ap compared to DEC.

Secondly, observation of the results in Figure 4.16 suggests little influence of length on the Ap parameter. The baseline declination slopes are only marginally higher in long IPs. First, this mild trend is the opposite of what was found for the lower declination slope, i.e. short phrases exhibited steeper declination slopes, with the exception of D-GD YNQ (cf. Figure 4.15). Second, the average Ap differences between short and long IPs within each mode are very small (generally not exceeding 0.05 in all data except for C-CF WHQ = 0.10, D-GD WHQ = 0.08 and D-GD YNQ = 0.09). This trend suggests a near-constancy of the Ap parameter under changes in the actual length of the utterance.

Let us consider the reasons for divergence between the contour-measured lower declination slope and baseline declination of the Fujisaki model. First, the two measures are rather different in nature: the regression-based lower slope abstracts away from the L extremities, while the phrase component explicitly relies on them in this work (which would be expected from a baseline declination approach). Thus, L tones placed relatively high in the f0 register will require the phrase command amplitude to be set higher (more 'declination'), while low Ls will call for Ap to be reduced (less 'declination'). If the Ls are scaled similarly across utterances, near-constant phrase command slopes will result. The effect of L scaling also affects the Aa measurement of the f0 excursion in pitch accents: when the H tones are scaled similarly across utterances, Aa will then depend only on the L tones. Second, unlike the regression method, the phrase component is not truly time-dependent, and hence not a measure of declination in the strict f0-over-time sense. As the phrase component is controlled by the α constant, the decay from the time-point of maximum amplitude to near-zero remains the same.

One ultimately needs to bear in mind that the superficial inability of the Fujisaki model to *measure* declination is not tantamount to its inability to *model* declination. From the visual match point of view, the phrase command fits in the present data are in most cases accurate. The phrase component may not fall fast enough in the two-accent (short) phrases, but in the three-accent (long) IPs the matches are generally unproblematic (Figure 4.17). In retrospect, it was perhaps too hard a task for the model to do what it was likely not designed for.

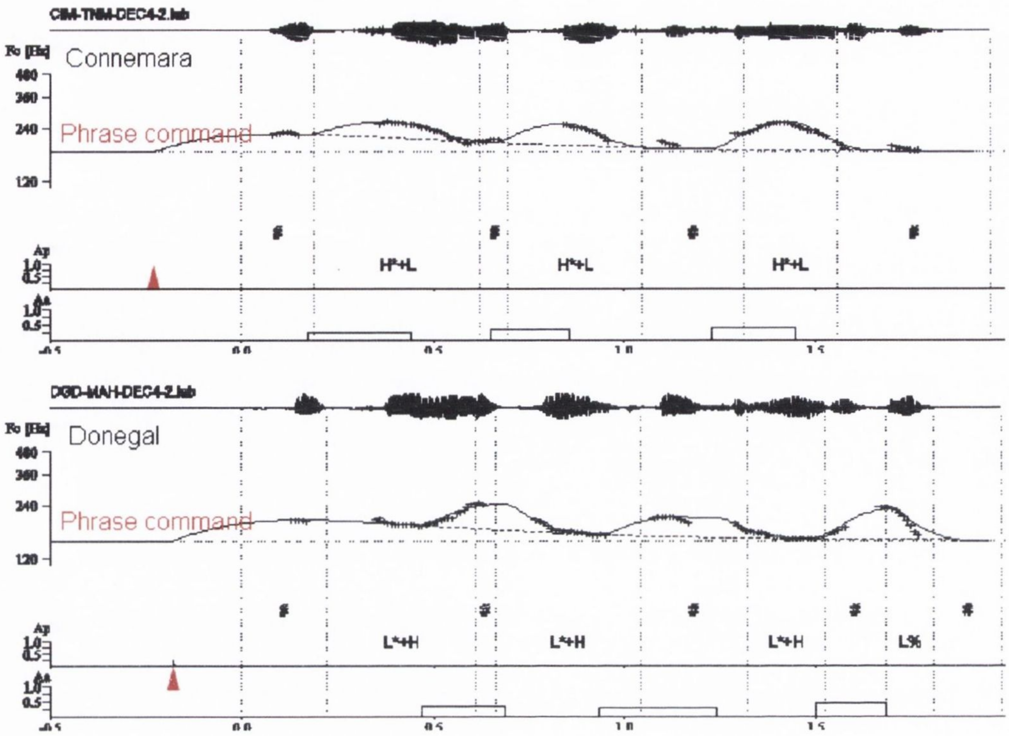

Figure 4.17 Examples of phrase command matches in three-accent IPs in Connemara and Donegal.

4.12 Discussion

This section provides a summary of the present findings on the intonation of sentence mode, a comparison with the findings for the six selected languages presented in Section 4.2.3, and comments on the performance of the Fujisaki model on sentence mode data in Cois Fharraige, Inis Mór and Gaoth Dobhair Irish.

4.12.1 Summary of present sentence mode results for Irish

As was shown in Section 4.3, the cross-dialect difference at the tune level was confirmed in the sentence mode data. Both Connemara varieties use mainly the same tune for declaratives and questions (a sequence of underlying H*+L accents with possible H tone linking). Donegal, on the other hand, appears to use certain tonal markers for questions: it frequently uses the H* accent on the question word in WHQ, while in YNQ it exploits the nuclear L*+HH% (rise) or L*+HL% (rise-fall); the latter tune also occurs in some DEC, but the question and declarative realisations are not identical in terms of scaling of the respective L and H tones.

Table 4.4 Summary of the results for the f0 metrics in the sentence mode data. Symbols: (↑) f0 boost/increase, (↓) f0 reduction/decrease, (x) no effect found.

		Cois Fharraige	Inis Mór	Gaoth Dobhair
Local level	IP onset	↑YNQ	↑YNQ	↑YNQ
	HPN	↑WHQ ↑YNQ	↑WHQ ↑YNQ	↑WHQ
	HN	↑YNQ	x	↑WHQ ↑YNQ
	Final rise	x	x	YNQ
Global level	Register level	x	x	↑YNQ
	Register span	x	↑WHQ	↑WHQ
	HPN-HN difference	x	↑WHQ	↓YNQ
	Upper declination slope	mode: x length: ↓long	mode: x length: ↓long	↑WHQ ↓YNQ mode*length
	Lower declination slope	↑WHQ ↑YNQ length: ↓long	↑WHQ ↑YNQ length: ↓long	↑WHQ ↓YNQ mode*length

The results for the f0 metrics in the sentence mode data are summarised in Table 4.4. The coding system used here is the same as in Table 4.1. As can be readily observed, Donegal makes the most use of the measured f0 metrics, where all nine are used to mark at least one question type. In comparison, the two Connemara varieties do not necessarily fall back on the f0 devices for the expression of interrogativity. Inis Mór and Cois Fharraige are found to exploit only half of the f0 metrics in questions. Interestingly, the upper f0 region in the Connemara contours appears quite tightly controlled. This is particularly visible in the Cois Fharraige results: the upper declination slope is only affected by length, and the HPN-HN difference does not change due to mode or length. These two features may suggest a steady proportional f0 drop between the IP-initial and nuclear peak regardless of whether or not an intervening medial accent group is present.

4.12.2 Comparison with findings for other languages

A direct comparison with the languages presented in Section 4.2.3 is not possible, since the studies summarised in Table 4.1 vary in the number of the f0 metrics studied. Perhaps the closest comparison can be made to the studies on Dutch by Haan (2002) and on Drogheda English by Kalaldeh (2011), which give the most comprehensive coverage of the f0 metrics involved in the production of questions.

In terms of the use of f0 metrics for marking interrogativity, Donegal Irish is perhaps more like Dutch in that it also makes frequent use of the available intonational devices. A peculiar similarity is noted for upper declination, which in both languages is steeper in WHQ and decreased in YNQ. Connemara Irish, on the other hand, is only somewhere mid-way on the interrogativity scale. Cois Fharraige and Inis Mór employ comparatively more f0 metrics in questions than Drogheda English which hardly uses pitch marking in questions.

4.12.3 Suitability of Fujisaki model for characterising sentence mode data

The combined findings for the accent command amplitude (Aa) and the phrase command amplitude (Ap) of the Fujisaki model point towards divergence between the model's matching accuracy and the linguistic interpretation of its amplitude parameters. It has been shown that while Aa and Ap generally *fit* the sentence mode contours with reasonable accuracy (including the 'remedy settings' contours discussed in Chapter 3), an easy-to-interpret *linguistic meaning* cannot be drawn directly from the model's amplitude parameters. Because of superposition of the phrase and accent components, Ap and Aa both add up to the total amplitude at any given f0 point in the contour. The difficulty lies in having to relate Ap and Aa back to the original f0 contour in order to understand their individual contribution (e.g. an increase in the Aa parameter can be due to lowering of the L tones, upscaling of the H tones, or both). Thus, while the Fujisaki model is generally suitable for synthesis of the melodic contours of Connemara and Donegal Irish, using it as an analytical tool *in the f0 dimension* is not an equally promising approach.

Finally, in the broader context, a question remains over how declination should be measured. Gussenhoven (2004) notes that if declination is purely a time-dependent process, then other processes such as downstep, initial peak raising and final lowering should be factored out first. The regression method used by Haan appears an objective method in that it acknowledges the independence of the upper and lower trends, and does not rely on the f0 extrema (cf. the criticism of the 'visually abstracted' declination not being replicable across experimenters by Lieberman, 1986). From this perspective, the course of the f0 troughs (L tones) may not be the most appropriate place to measure declination.

4.13 Summary

This chapter investigated the effect of sentence mode and phrase length (expressed as the number of stress groups in the IP) on the f0 contours in Connemara and Donegal Irish. The qualitative results showed that while Cois Fharraige and Inis Mór normally employ the standard H*+L H*+L% pattern in declaratives and questions, Gaoth Dobhair tends to alter the tune composition of the typical L*+H L*+H% declarative pattern with a change in the IP-initial accent (H*) in WHQ, and in the nuclear tune (L*+HH%) in YNQ.

The stylised f0 contours indicated that the two dialects also differ in the encoding of sentence mode at the phonetic level. Cois Fharraige and Inis Mór were found to employ f0 raising in questions mostly in the prenuclear region, while Gaoth Dobhair used it both in the nuclear and prenuclear regions. These trends were further confirmed by the detailed analysis of each individual f0 metric.

The Fujisaki model was assessed for its accuracy and usefulness in describing the f0 contours in the sentence mode data of Connemara and Donegal Irish. Only the frequency dimension was investigated through the amplitude parameters of the phrase and accent components; command timing was not tested. It was shown that the Fujisaki model can be satisfactorily used for synthesis of the intonation of Irish, but drawing meaningful inferences about time-dependent declination and peak scaling is obscured due the fact that the model is only capable of modelling the time-independent baseline declination trend and f0 excursions of pitch accents, respectively. The next chapter will examine how the

Fujisaki model performs on the pitch accent level with respect to elbow timing and the f0 excursion size.

Chapter 5

Alignment and scaling of pitch accents in Connemara and Donegal Irish

5.1 Introduction

Chapter 5 looks at the realisation of local pitch accents in the phrase-initial and phrase-final position. The leading accent types of interest are H*+L in Connemara Irish, and L*+H in Donegal Irish. Additionally, H* accents in prenuclear position are examined for possible peak delay in the absence of anacrusis (Nolan & Farrar, 1999; Silverman & Pierrehumbert, 1990). From the viewpoint of intonational phonology, H* accents are understood as a derivative of H*+L (Gussenhoven, 2004; Ladd, 2008), but in this experiment they are treated as separate entities because of their phonetic realisation.

Two questions are at the core of the alignment experiment. The principal question addresses the possible effect of the rhythmic context on timing and scaling of accents in the nuclear (IP-final) and IP-initial prenuclear position. The rhythmic context is understood here as the proximity of the accented syllable to the neighbouring phrase boundary. Thus, for nuclear accents, the effect of the tail length is examined, while for prenuclear accents the length of anacrusis is looked at. The secondary question concerns the influence of the immediate tonal context on timing and scaling in nuclear accents. The considerable degree of variation in tune choice was not expected at the experiment design stage. However, the analysis indicated that the type of preceding accent must be considered together with tail length when studying the f0 characteristics of nuclear accents.

Out of the three aspects of pitch accent realisation, most attention is devoted to alignment – defined as timing of an f0 elbow with the view to a cross-dialect comparison (Section 5.5). Additionally, f0 movement duration (Section 5.6) and f0 excursion size (Section 5.7) are studied in relation to the Fujisaki model: the accent command parameters are compared to the equivalent contour-derived metrics and evaluated for their accuracy in modelling pitch accents. More attention is given to nuclear than prenuclear data due to scarcity of one leading accent type in the latter set (except in Gaoth Dobhair).

5.2 Background on alignment

Section 5.2 begins with an introduction of tonal alignment and the factors which have been found to affect it. Then an overview of the existing findings on alignment in Connemara and Donegal Irish is provided. The section concludes with a summary of the findings in selected studies which are directly relevant to the present work (i.e. those concerned with the effect of the rhythmic context, either tail or anacrusis).

5.2.1 General characteristics of alignment

Tonal alignment is defined as temporal coordination of tonal targets with the segmental string (Ladd, 2008). The early studies on timing of f0 events relative to the segmental level involve works on Accent I and Accent II in Swedish (Alstermark & Erikson, 1971; Bruce, 1977, 1983; Erikson & Alstermark, 1972). Since then tonal alignment has been central to intonation studies, and has been studied in a multitude of languages including English (Grabe, 1998b; Ladd et al., 1999), Greek (Arvaniti, Ladd, & Mennen, 2006), Mandarin Chinese (Xu, 1999; Xu & Wang, 2001) Spanish (Prieto & Torreira, 2007), Dutch (van de Ven & Gussenhoven, 2011) and Arabic (Yeou, 2005).

A succinct classification of the factors which influence alignment of tones is provided by Bruce (1990). These incorporate (1) tonal composition of a pitch accent; (2) prosodic structure; (3) segmental context and (4) speaking rate. In (1) the aim is to establish a phonological distinction between pitch accents (D'Imperio & House, 1997; Frota, 2000; Grice, Baumann, & Jagdfeld, 2009; Kohler, 1987; Pierrehumbert & Steele, 1990). In (3) syllable structure, or type of a particular segment in the syllable, is usually considered (House & Wichmann, 1996; Kohler, 1990; Mücke et al., 2009; van Santen & Hirschberg, 1994). Studies may be devoted to one of the factors or combine them, such as (4) speech rate without (Ladd et al., 1999) or with changes in syllable structure (Prieto & Torreira, 2007) or tonal context (Xu, 2001).

Factor (2) includes a number of rhythmic and f0 aspects such as distance from the IP boundary (Steele, 1986), distance from the next accent (Silverman & Pierrehumbert, 1990) and pitch range (Knight & Nolan, 2006). This study looks solely at the effect of distance of the nuclear accented syllable from the IP-final boundary (tail) and of the phrase-initial accented syllable from the IP-initial boundary (anacrusis). Findings on this particular factor will be shown for Irish (Section 5.2.2) and other languages (Section 5.2.3).

5.2.2 Existing findings for Irish

The pioneering work on tonal alignment in Irish dialects was conducted by Dalton and Ní Chasaide (Dalton & Ní Chasaide, 2005, 2006, 2007a; Ní Chasaide & Dalton, 2006). These studies analysed the effect of tail and anacrusis on the IP-final and IP-initial accents in words containing a /CVC/ target syllable. Here are presented the findings for two varieties which are also the subject of the present study, i.e. Cois Fharraige and Gaoth Dobhair, as well as Inis Oírr as another location in the Aran Islands. The summary of results is based on the studies from 2005 and 2006.

The principal finding of Dalton and Ní Chasaide involves a typological classification of the three varieties with respect to alignment into fixed (Cois Fharraige and Gaoth Dobhair) and variable (Inis Oírr). The results for the three varieties are compiled in Figure 5.1. Cois Fharraige was shown to anchor the peak at the syllable offset in prenuclear H* accents, and at the vowel onset in nuclear H*+L accents regardless of anacrusis/tail length. Gaoth Dobhair exhibited L at the vowel offset and H on the vowel of the second post-accentual syllable in prenuclear L*+H accents. Nuclear L*+H featured earlier timing of L in the absence of tail (mid-vowel in N0) compared to the vowel offset in N1 and N2; the H tone drifted progressively rightwards with an increase in tail length. Inis Oírr differed from Cois Fharraige and Gaoth Dobhair in that peak location varied in the prenuclear as well as nuclear position. Prenuclear H* accents exhibited a late peak (outside the accented syllable) in the absence of anacrusis compared to the vowel onset in 1PN and 2PN. Nuclear H*+L accents showed a steady rightward peak drift with increasing tail length. This rather surprising difference between Cois Fharraige and Inis Oírr as essentially two varieties of Connemara Irish inspired the inclusion of Inis Mór in the present study to expand the alignment landscape of the Aran Islands.

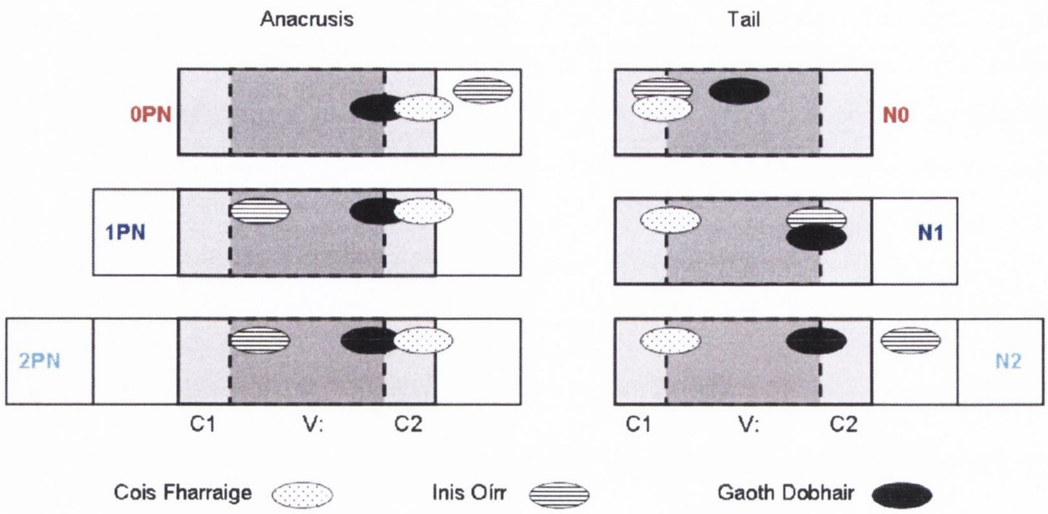

Figure 5.1 Schematic representation of the alignment findings for Cois Fharraige, Inis Mór and Gaoth Dobhair based on Dalton & Ní Chasaide (2005, 2006). The segments of the target syllable are indicated by grey boxes: the initial (C1) and final (C2) consonants = light grey, the vowel (V) = dark grey. Coding: N0-N2 = the number of tail syllables following the nuclear syllable, 0PN-2PN = the number of anacrusis syllables preceding the first prenuclear accented syllable.

5.2.3 Findings in selected studies on other languages

Six studies have been chosen for the coverage of alignment in relation to tail and anacrusis length. The results are summarised in Table 5.1. The first five studies are related to the effect of tail (Alstermark & Erikson, 1971; Gordon, 2008; House, Dankovičová, & Huckvale, 1999; Knight, 2004; Kügler, Féry, & van de Vijver, 2003), while the sixth is on anacrusis (Nolan & Farrar, 1999). Unified coding of the tonal (H*+L or H*) and rhythmic (N = nuclear, PN = prenuclear, 0-3 = the number of syllables in tail/anacrusis) condition was introduced to facilitate the interpretation of the results. These studies will also be referred to in Section 5.8.3 where a comparison of the present results with those for selected languages is made.

The studies in Table 5.1 involve two different measures of alignment, either the absolute peak, or its outer regions, peak onset and offset (referred to as plateau onset and offset in the original studies). The summary table disregards whether peak timing was expressed in absolute or relative terms, since it is of secondary importance. It should be noted, however, that alignment of a target can be measured either as the absolute distance from a particular segmental landmark (e.g. Gordon, 2008), or in relative terms as a proportion of a segmental unit, frequently the accented syllable (e.g. Knight, 2004).

Table 5.1 Summary of the alignment results with respect to tail/anacrusis in six selected studies. Coding: N0-N3 = the number of tail syllables following the nuclear syllable, 0PN-3PN = the number of anacrusis syllables preceding the first prenuclear accented syllable. Symbols: (←) peak retraction, (→) peak delay, (x) no effect found.

	Swedish (Alstermark & Erikson, 1971)	English (House, Dankovičová & Huckvale, 1999)	English (Knight, 2004)	German (Kügler, Féry & van de Vijver, 2003	Chickasaw (Gordon, 2008)	English (Nolan & Farrar, 1999)
Accent Rhythmic context	(A II) H*+L N0-N3	H*+L N0-N1	H*+L N0-N2	H*+L N0-N1	H*+L N0-N2	H*/H*+L 0PN-2PN
Peak	←N0			Tail and tune 2-peaks: ←N0 Linked: x	←N0	0PN→
Peak onset		x	x			
Peak offset		←N0	←N0			

Let us inspect the nuclear alignment patterns in the selected studies. Clearly, all of the five works point towards a leftward peak shift, i.e. retraction in the absence of post-accentual syllables. This finding is consistent regardless of whether the measurement involved the absolute peak or peak offset. The impact of the preceding tonal context along with tail length is pointed out by Kügler et al. (2003), who note H shift in the two-peaked contours but invariable early H in the linked ('flat hat') contours.

The Nolan and Farrar study on prenuclear alignment investigates the phenomenon of 'peak lag' as a function of anacrusis length. Peaks tended to be delayed at a higher rate in the absence of anacrusis than when either one or two pre-accentual syllables were present. Also, a cross-variety difference was found for a propensity to peak lag: Cambridge speakers used it least, while Leeds and Newcastle speakers used it most frequently.

The studies by Dalton and Ní Chasaide (2005, 2006) and Nolan and Farrar (1999) indicate that differences in alignment patterns across varieties of one language are very likely. The remainder of Chapter 5 tests this premise on new comparable data from Cois Fharraige, Inis Mór and Gaoth Dobhair.

5.3 Pitch accent and tune inventory in alignment dataset

Section 5.3 presents the tune inventory in the alignment data obtained through the IViE analysis. Establishing the main accent types and the tonal context in which they occur before carrying out alignment measurements is considered essential in this work. The nuclear and prenuclear accents of interest are classified according to their tonal composition, and presented on their own as well as in the full IP context. The colour-coding scheme used in all the figures is provided to facilitate visual inspection of the results. The colours correspond to the type of nuclear/prenuclear accent in isolation as well as in the full IP tonal context. An explanation is provided on which tonal contexts were selected for further quantitative analysis, as well as the grounds on which data exclusion was decided.

5.3.1 Inventory in nuclear data

Figure 5.2 demonstrates the distribution of the nuclear tunes in the Connemara and Donegal data. The combinations of H*+L and L*+H accents and the IP-final boundary tones are grouped according to the fall vs. rise distinction. It can be observed that H*+L% is the leading nuclear tune in Cois Fharraige (N0 and N1 = 100%, N2 = 94%) and Inis Mór (80% in each tail condition). L*+H% is the primary choice in Gaoth Dobhair, with at least 80% of the data in each tail condition. Only these nuclei are further covered in the alignment and scaling results.

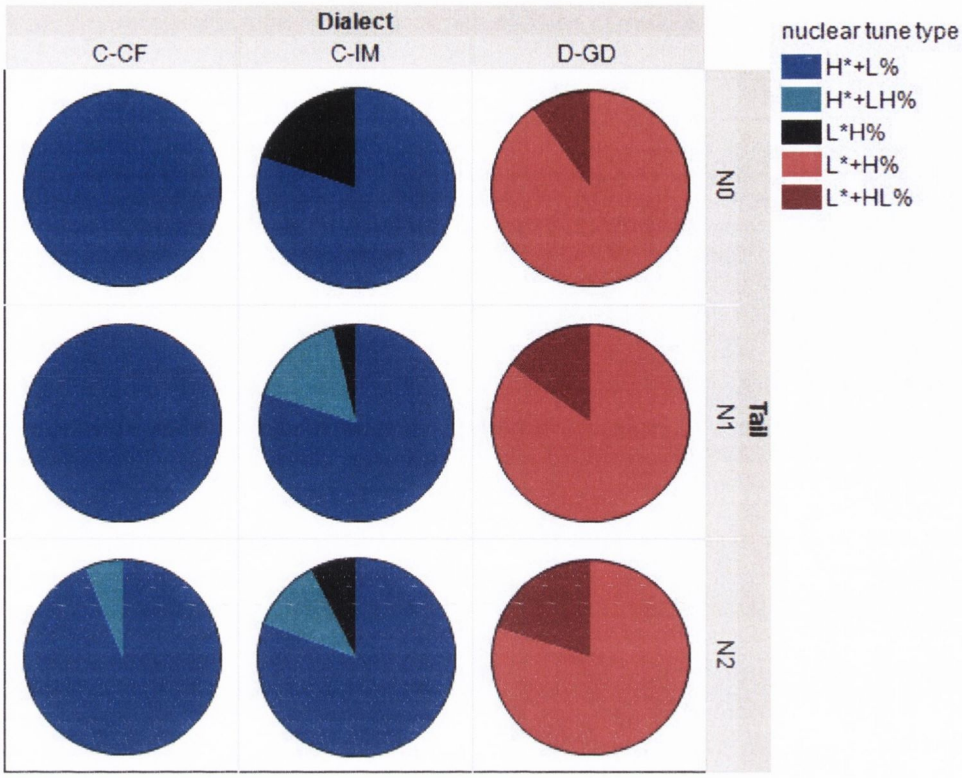

Figure 5.2 Distribution of the nuclear tune (accent plus boundary tone) types in the nuclear data. Rhythmic context: N0 = absence of tail, N1 = one tail syllable, N2 = two tail syllables.

Figure 5.3 presents the distribution of the selected nuclear accents (H*+L and L*+H) in the full IP context. The fall in Cois Fharraige is generally preceded by H*+L, but other combinations are possible depending on the tail condition. In N1 and N2 nearly 70% of the nuclear falls are preceded by H*+L and 30% by H*. In N0, however, either H* (35%), H*+L (30%) or L*+H (12%) occurs. An even more extreme trend is observed in Inis Mór. In N0 the prenuclear H*+L is completely avoided, so the nuclear falls co-occur with L*+H (52%) or H* (24%). In N1 and N2 only 55% of the nuclear falls are preceded by H*, H*+L or L*+H with nearly equal frequency (15%-20%). Some tune variation is also observed in the Gaoth Dobhair data. The nuclear rise is most frequently preceded by another L*+H in N0 (80%), but much less in N1 (45%) and N2 (30%), where prenuclear H* is quite prevalent. All in all, the tune distribution in Figure 5.3 indicates that the preceding tonal context may need to be considered along with tail.

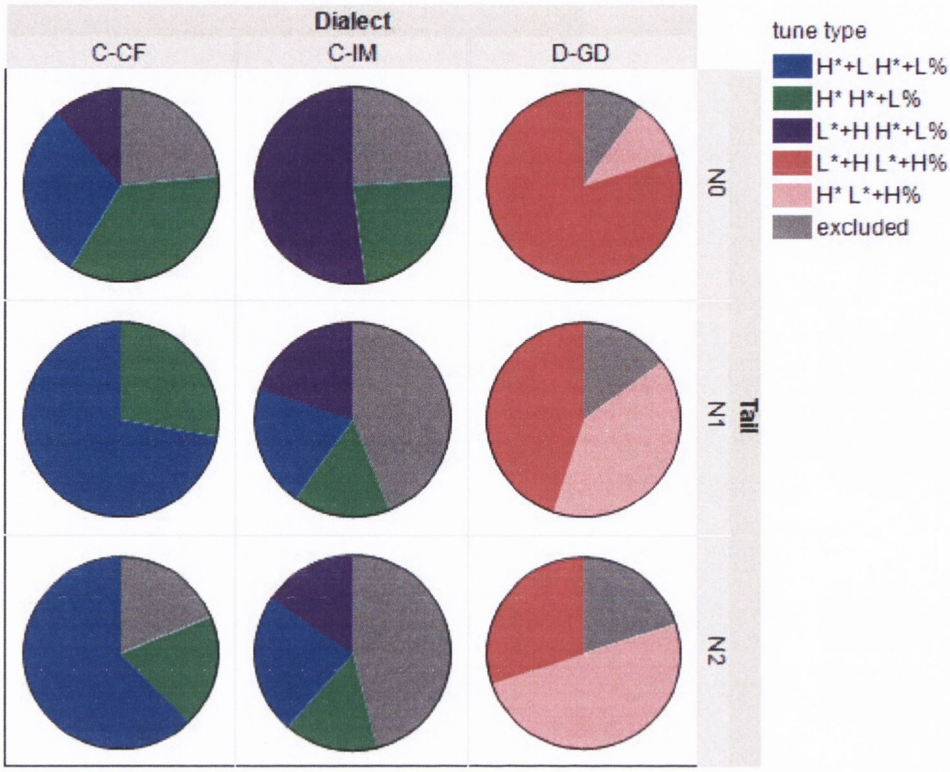

Figure 5.3 Distribution of tune types in the nuclear data. Rhythmic context: N0 = absence of tail, N1 = one tail syllable, N2 = two tail syllables.

It was mentioned that the subsequent discussion of alignment data covers H*+L and L*+H accents in specified tonal contexts. Nevertheless, a short explanation is due on the exclusions in the nuclear dataset. The excluded tunes in Figure 5.3 were subsumed under one category for transparency in the results. The exclusions in Connemara can be broadly divided into two groups: the presence of emphasis or tonal pressure from an upcoming boundary (as well as any L*H% nuclei in the Inis Mór data). The first group includes any tune which contained a prenuclear L* or an upstepped nuclear ^H*+L%, both of which suggest the presence of focus on the nuclear fall. The second group features all H*+LH% nuclei, where timing and scaling of the HL unit may be affected by the presence of the H% boundary. The Donegal exclusions comprise the L*+HL% nuclei, where L% may cause an earlier timing of L and H. All excluded samples were produced by speaker GD4, who, unlike the other Gaoth Dobhair speakers, shows a strong preference for the nuclear rise-fall across all three datasets.

5.3.2 Inventory in prenuclear data

Figure 5.4 presents the distribution of prenuclear accent types in the Connemara and Donegal data. The immediate impression is that Gaoth Dobhair again shows a propensity for L*+H accents, while the two Connemara varieties use any of the four categories in the IP-initial position. The prenuclear rises in Gaoth Dobhair occur in at least 73% of the data in each anacrusis condition, similarly to what was observed in the nuclear dataset. The remaining 25%-27% of H* accents in 1PN and 2PN, which are excluded from the phonetic results, were produced nearly exclusively by speaker GD5. On the whole, a large proportion of the Gaoth Dobhair prenuclear data lends itself to further quantification.

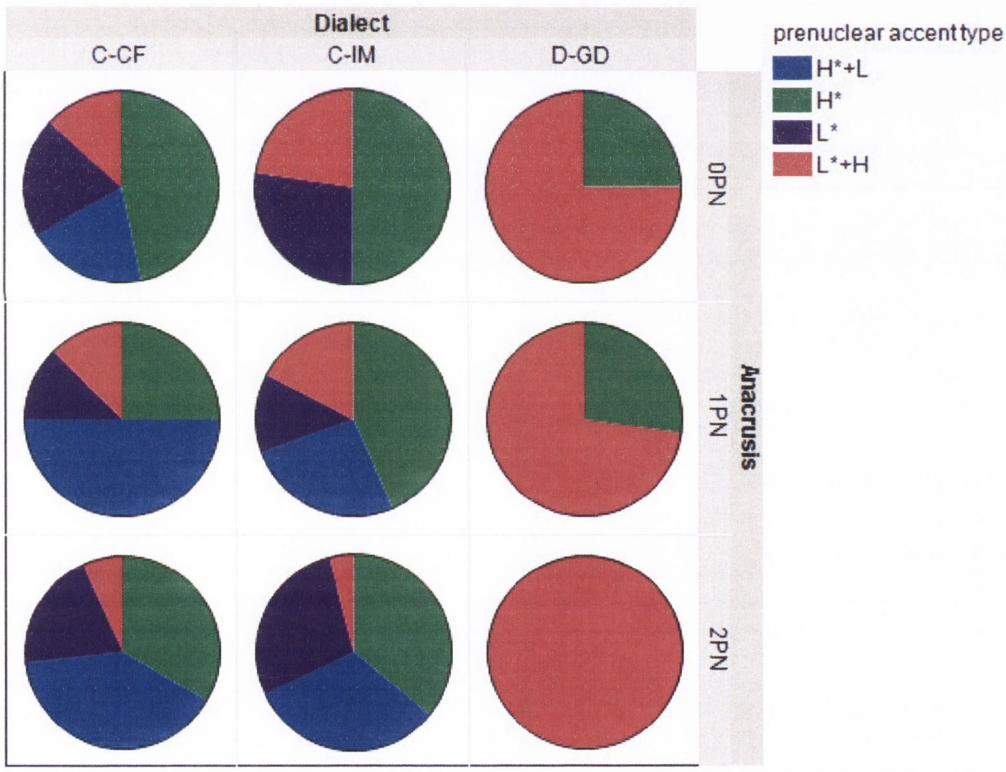

Figure 5.4 Distribution of prenuclear accent types in the prenuclear data. Rhythmic context: 0PN = absence of anacrusis, 1PN = one anacrusis syllable, 2PN = two anacrusis syllables.

In the Connemara prenuclear data, the H*+L accent occurs with a low frequency (Figure 5.4). In Cois Fharraige it is produced only 20%-50% of the time across the three anacrusis conditions, and fares even worse in Inis Mór with 26% in 1PN, 32% in 2PN and virtually no samples in 0PN. The second accent of interest, H*, occurs slightly more frequently (Cois Fharraige 25%-47%; Inis Mór 36%-50%). The excluded accents, L* and L*+H, amount to 25%-50% of the 0PN-2PN data in each variety.[35] As a consequence, the discussion of alignment and scaling in prenuclear H* and H*+L in Connemara is very limited due to data scarcity.

As will be seen in the normalised f0 contours (upcoming Section 5.4), the realisation of the prenuclear accent is not thought to be regressively influenced by the nuclear accent. Nevertheless, to maintain a parallel with the nuclear dataset, the prenuclear accent type is shown in the full IP context in Figure 5.5.

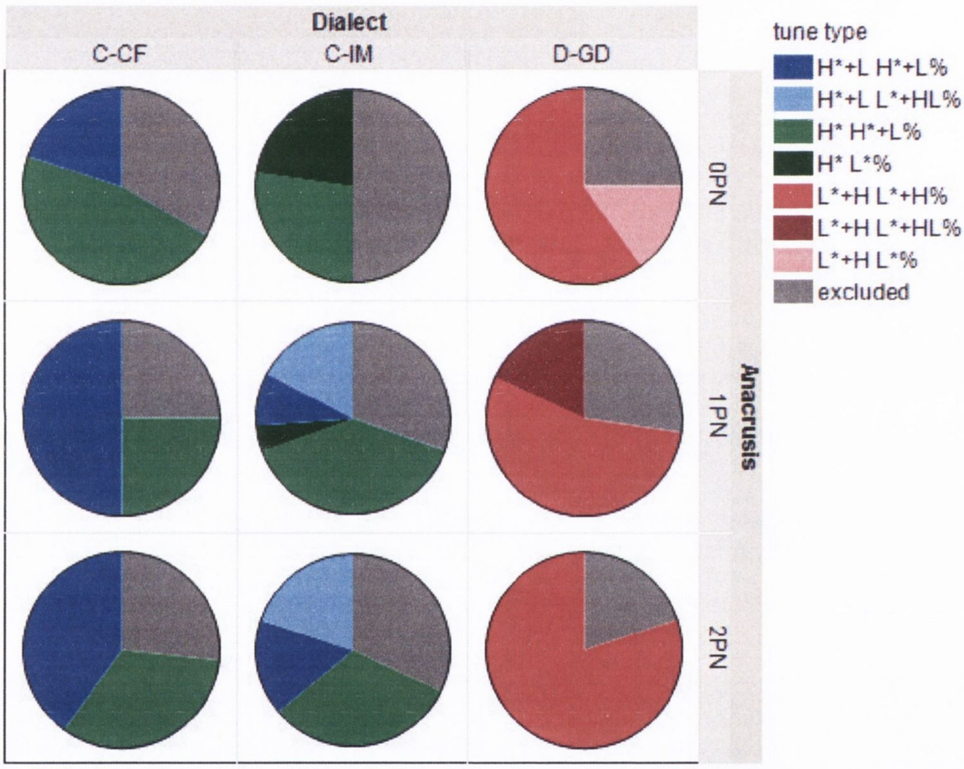

Figure 5.5 Distribution of tune types in the prenuclear data. Rhythmic context: 0PN = absence of anacrusis, 1PN = one anacrusis syllable, 2PN = two anacrusis syllables.

The inspection of tonal patterns in the prenuclear data suggests that the core tunes occur here just as in the nuclear dataset, albeit with different frequencies. Cois Fharraige combines the prenuclear H* and H*+L with H*+L%. Inis Mór follows the prenuclear H*+L with either H*+L% or L*+HL% (the latter used solely by speaker IM3), and prenuclear H* with H*+L% or L*% (the latter attributable mostly to speakers IM1 and

[35] The prenuclear L* and L*+H accents, which are subsumed under excluded tunes in Figure 5.5, are all followed by H*+L%.

IM2). Gaoth Dobhair compounds the prenuclear L*+H mostly with L*+H%. The small number of the L*+HL% and L*% nuclei is, again, due to speaker GD4.

5.4 General overview of alignment results - time-normalised f0 contours

Section 5.4 provides an overview of the nuclear and prenuclear alignment results through time-normalised f0 contours of selected data (explained in Section 5.3) in the three varieties. These contours were produced with the freely available ProsodyPro script written by Yi Xu (Xu, 2005). To depict the realisation of the selected pitch accents in the phrase, plots for the nuclear contours are displayed in Figure 5.6, and for the prenuclear contours in Figure 5.7. The contour-derived f0 metrics: f0 elbow, duration of the f0 movement and the f0 excursion size, each presented along with its Fujisaki model counterpart, are covered separately in more detail in Sections 5.5 to 5.7, respectively. For an explanation of terms 'tail' and 'anacrusis', the speech materials, as well as the measurement methods of the alignment data, the reader is referred to Chapter 3.

5.4.1 Contours in nuclear data

Figure 5.6 introduces mean time-normalised f0 contours for selected nuclear data in Cois Fharraige, Inis Mór and Gaoth Dobhair. The contours are colour-coded according to tail condition: the absence of tail (N0) is shown in red, while the presence of tail syllables (N1 and N2) is indicated by two shades of blue. The grey boxes indicate the target syllable.

Observation of the f0 curve in the horizontal (timing) dimension clearly indicates that the rhythmic context and the tune type influence the elbow timing in the nuclear accent, but a difference can be observed between the two dialects. The two Connemara varieties exhibit early nuclear falls in linked contours (H* H*+L%; also L*+H H*+L% in Inis Mór), and medial falls in the two-peaked pattern (H*+L% H*+L%). Moreover, the onset of the falling movement (i.e. H elbow) is not affected by tail length in linked contours. However, in the two-peaked contour the H elbow appears to shift to an earlier position in N0 (note the lack of data for this condition for Inis Mór). On the other hand, Gaoth

Dobhair displays a relatively earlier rise onset (i.e. L elbow) under time-pressure in N0 in both tonal contexts (H* L*+H% and L*+H L*+H%).

With respect to the vertical (scaling) dimension, the nuclear accent is not generally influenced by tail length. The only case of truncation related to the limited segmental material in N0 is found in the Cois Fharraige two-peaked pattern (note the lack of data for this condition for Inis Mór). The remaining nuclear accents are relatively unaffected by the absence of tail (all Connemara falls in linked contours, and Gaoth Dobhair rises in both tonal contexts). The expanded f0 excursion in Inis Mór falls preceded by L*+H is presumably due to high scaling of the trailing H of the rise.

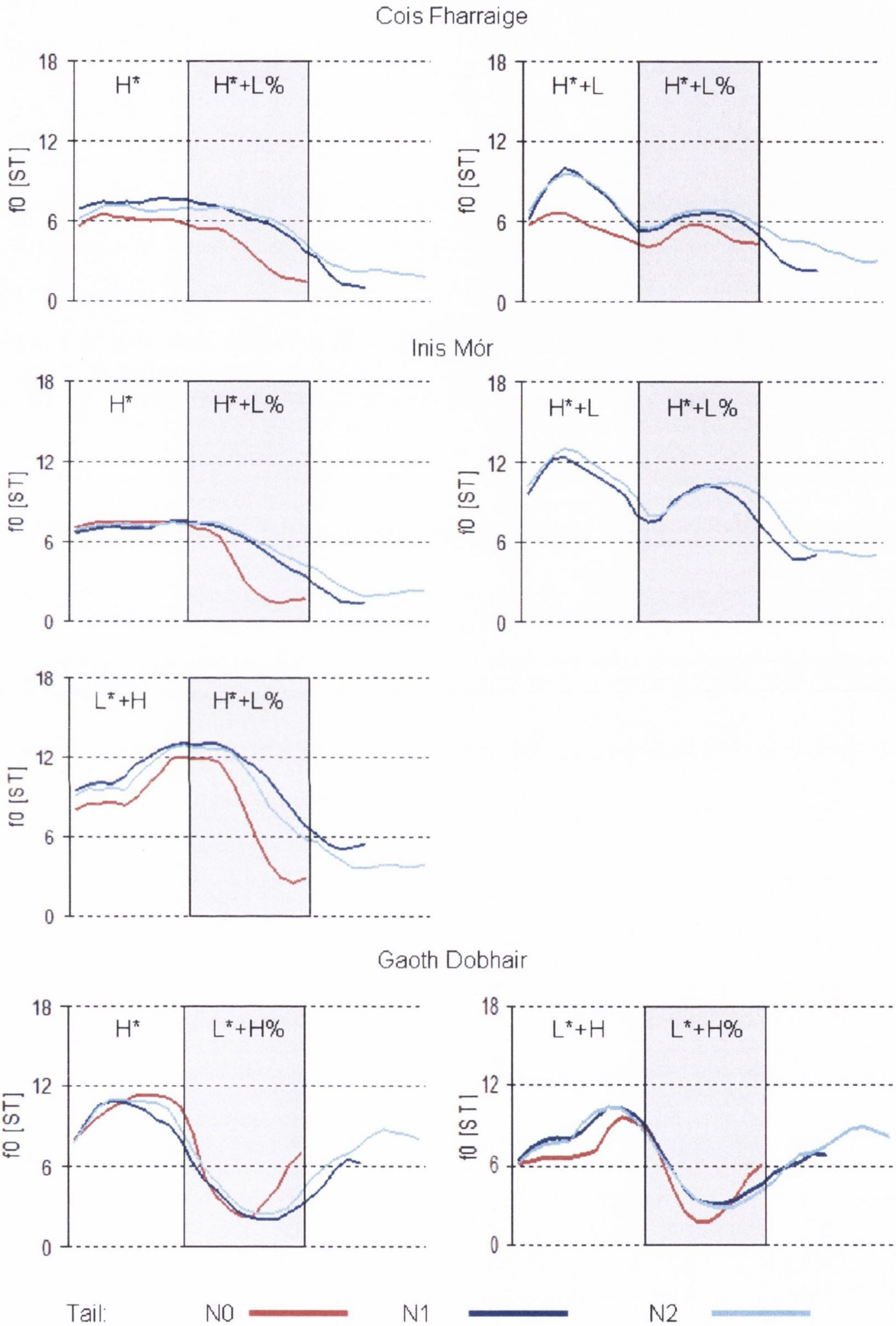

Figure 5.6 Time-normalised f0 contours in the nuclear data. The nuclear accented syllable is highlighted in grey. Rhythmic context: N0 = absence of tail, N1 = one tail syllable, N2 = two tail syllables.

5.4.2 Contours in prenuclear data

Figure 5.7 shows mean time-normalised f0 contours for selected prenuclear data in Cois Fharraige, Inis Mór and Gaoth Dobhair. The Connemara contours contain a prenuclear H* or H*+L accent, while the Gaoth Dobhair contours feature a prenuclear L*+H. The f0 curves are colour-coded according to anacrusis condition: the absence of anacrusis (0PN) is shown in red, while the presence of either one (1PN) or two (2PN) anacrusis syllables is coded by two different shades of blue. The prenuclear syllable is indicated by the grey box.

Observation of elbow timing of the prenuclear accent indicates a cross-dialect difference. The absence of anacrusis has no effect on either H* or H*+L accents in the two Connemara varieties, while a mild influence is found in L*+H of Gaoth Dobhair.

The prenuclear H*+L accents in the two-peaked (H*+L H*+L%) pattern appear to differ in terms of H timing between the two Connemara varieties. In Cois Fharraige they exhibit a syllable-medial peak also observed in the nuclear H*+L (Section 5.4.1). In Inis Mór the peak is only achieved late in the syllable, thus later than in the nuclear H*+L, but these contours are based on just a handful of samples from two speakers, IM3 and IM5 (1PN: N = 5, 2PN: N = 8).

Let us now look at the Connemara prenuclear H* accents for potential peak delay in the absence of anacrusis. This accent type is produced as a flat f0 stretch in both varieties, i.e. it features no or a weak f0 onglide and no discernible peak.[36] In Cois Fharraige H*, the modest ascent towards the H inflection in 0PN and 2PN amounts to 0.8-1.9 ST on average; this result is based mostly on the data of just two speakers (CF3 and CF4). The Inis Mór H* accents do not even feature a noticeable onglide (an average 'rise' of 0.4-0.7 ST in all three anacrusis conditions); also, the vast majority of the H* data was produced by two speakers, IM1 and IM4. As a consequence, all prenuclear H* accents of

[36] This does not preclude the possibility of the existence of a late-peak variant of H* in Cois Fharraige or Inis Mór in other prosodic contexts, or in spontaneous speech. However, this variant was not found in the present data for Cois Fharraige and Inis Mór, either in the alignment or the remaining two (sentence mode and focus) datasets.

Connemara are given only a brief mention in the alignment section, and are excluded from further discussion of f0 movement duration and the f0 excursion size.

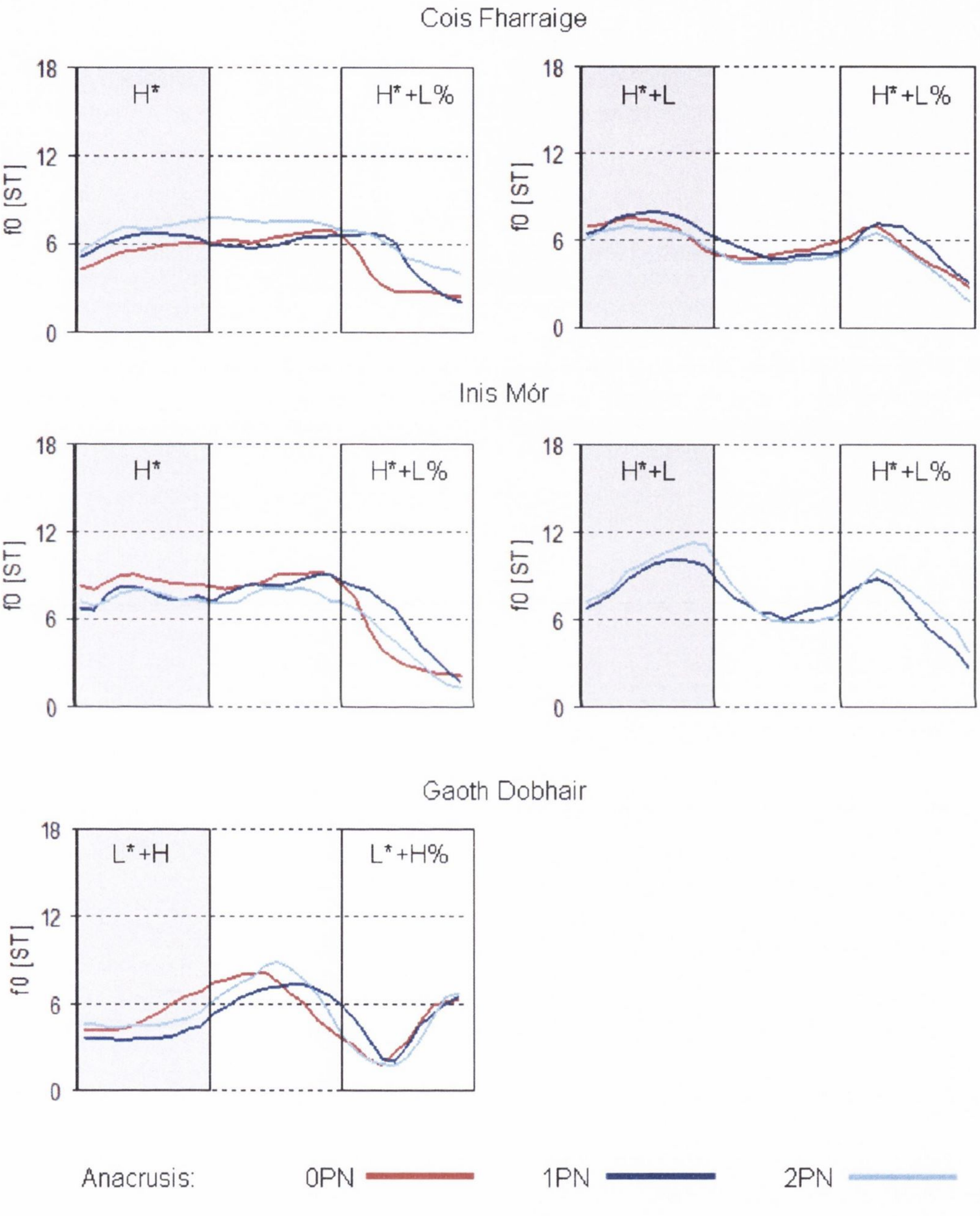

Figure 5.7 Time-normalised f0 contours in the prenuclear data. The prenuclear accented syllable is highlighted in grey. Rhythmic context: 0PN = absence of anacrusis, 1PN = one anacrusis syllable, 2PN = two anacrusis syllables.

The prenuclear L*+H accents in the Gaoth Dobhair data seem to display a relatively earlier rise onset in 0PN compared to the two anacrusis conditions. The location of the L elbow is perhaps not as easy to detect as in the nuclear data, and hence deserves closer scrutiny in the relevant section on elbow timing (Section 5.5).

With regard to the frequency domain, a careful inspection of the prenuclear accents leads one to conclude that neither the H*+L nor L*+H accents are affected in terms of scaling of the f0 movement due to anacrusis length. This observation will be explored in more detail in Section 5.7 on the f0 excursion size of pitch accents of Connemara and Donegal.

5.5 Timing of pitch accent elbow

Alignment of target tones in Connemara and Donegal Irish has been measured as the f0 elbow (i.e. inflection) pertaining to the fall onset in H*+L and the rise onset in L*+H accents. As explained earlier, the elbow was chosen over the absolute peak/valley to make the contour-derived metric directly comparable to the accent command timing parameter of the Fujisaki model. For the methods of measuring timing of the f0 inflection from the f0 contour and with the accent command T1 and T2 time-points, the reader is referred to Chapter 3. All alignment results presented in Section 5.5 are expressed in relative terms (segmental boundaries: syllable onset = 0%, C_1V: = 20%, V:C_2 = 80%, syllable offset = 100%) and discussed mainly in terms of mean values per variety; other descriptive measures are only provided when found crucial to illustrate a particular issue in more detail.

5.5.1 Contour-measured elbow in nuclear accents

Figure 5.8 shows box plots of the contour-measured elbow timing (t-N) in nuclear accents in the three varieties. The results confirm the occurrence of two alignment patterns in Connemara and only one in Donegal. In the case of Connemara nuclear H*+L accents which are subject to linking of two immediately neighbouring H tones, a consistent early fall onset is observed across all tail lengths (C-CF: after H* = 20-26%; C-IM: after H* = 16-20%, after L*+H = 17-21%). The 20% landmark corresponds to the H elbow being located near the onset of the accented vowel. Nuclear H*+L accents exhibit a syllable-medial fall onset when preceded by H*+L; a timing difference is found between zero-tail and the two tail conditions (C-CF: N0 = 44%, N1 = 66%, N2 = 72%; C-IM: N0 – no data, N1 = 64%, N2 = 68%). These landmarks correspond to the H elbow at mid-vowel in N0, and towards the final portion of the vowel in N1 and N2. Gaoth Dobhair nuclear rises are timed identically regardless of the preceding accent type. The timing difference is conditioned by the absence vs. presence of tail in both tonal contexts (after H*: N0 = 47%, N1 = 72%, N2 = 76%; after L*+H: N0 = 50%, N1 = 76%, N2 = 78%). These time-points correspond to the elbow located at the vowel centre in N0 vs. the right edge of the vowel in N1 and N2.

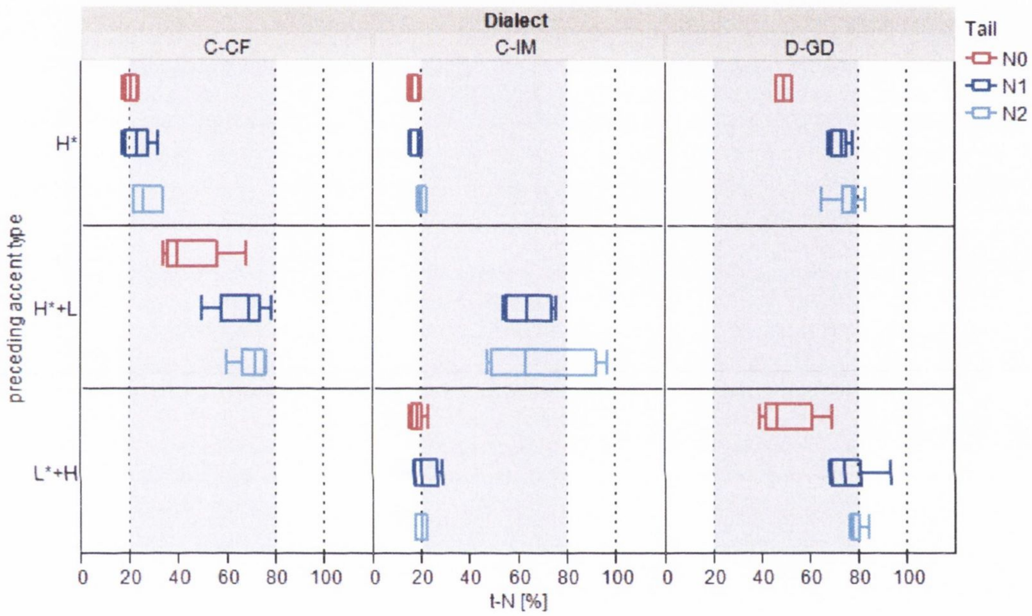

Figure 5.8 Box plots of the contour-measured relative elbow location (t-N) in nuclear Connemara H*+L and Donegal L*+H accents across three tail conditions (N0-N2). Nuclear accents are grouped according to the type of preceding accent (H*, H*+L or L*+H, on the y axis). Relative segmental boundaries are indicated on the x axis: syllable onset = 0%, /C_1V:/ = 20%, /V:C_2/ = 80%, syllable offset = 100%. Grey boxes indicate the relative duration of the accented vowel.

In order to assess the effect of tail as well as tune type on nuclear elbow alignment, a full ANOVA would need to include three factors (Dialect, Tail and Preceding Accent Type). However, the nuclear dataset in its present form is not sufficient for this complex design. Consequently, the data for each speaker has been averaged across all tonal contexts per tail condition to broadly test the influence of Dialect and Tail.

The results of the two-way ANOVA resolve two specific questions related to elbow alignment in nuclear accents. The first question involves a possible timing difference between Cois Fharraige and Inis Mór (if the latter was to follow a pattern similar to Inis

Oírr). The post-hoc Tukey HSD test of the significant effect of Dialect ($F(2, 10) = 4.64$, $p = 0.037$) does not support this hypothesis. Out of the three pairwise comparisons only the elbow timing difference between Inis Mór and Gaoth Dobhair is significant (LS means difference = 29%, $p < .05$).

The second question addressed through ANOVA explores the influence of tail length on elbow timing in nuclear accents. Apart from Dialect (explained above), Tail was also found to be significant ($F(2, 20) = 13.41$, $p < .001$). The results of the post-hoc Tukey HSD confirm that in the absence of tail the elbow is timed earlier than when tail syllables are present (N0 < N1 by 20% and N0 < N2 by 24% at $p < .05$). The non-significance of the interaction ($F(4, 20) = 0.35$, n.s.) suggests that all three varieties respond uniformly to tail length.

5.5.2 Fujisaki model elbow in nuclear accents

Figure 5.9 presents box plots of elbow timing measured with the accent command time-points (T-N) in nuclear accents. It can be observed that the Fujisaki model results generally reflect the contour-measured elbow results (cf. Figure 5.8). In the Gaoth Dobhair data, the L elbow is captured with high precision except for rises preceded by H* in N1 and N2, where L is supposedly located 10-15% earlier (N1 = 62%, N2 = 63%) than in the t-N measurement. The model also gives an accurate elbow match for the Connemara falls preceded by H*+L across all tail lengths.

The more noticeable inadequacy in capturing the f0 elbow is found in Connemara falls which occur in linked contours (i.e. H* H*+L% and L*+H H*+L%) in the presence of tail syllables. Figure 5.9 suggests that the fall onset in this tonal context is subject to a lag (C-CF after H*: N1 = 30%, N2 = 32%; C-IM after H*: N1= 32%, N2 = 31%, after L*+H: N1 = 41%). The most plausible explanation for the T-N delay involves an extensive duration of the fall in the linked contours in N1 and N2. As the H-to-L movement duration can often exceed the 194 ms limit imposed by β, the elbow accuracy is sacrificed in favour of the fall *shape,* which is achieved by delaying T2 of the accent command. This proposition is tested in more detail in Section 5.6 on f0 movement duration.

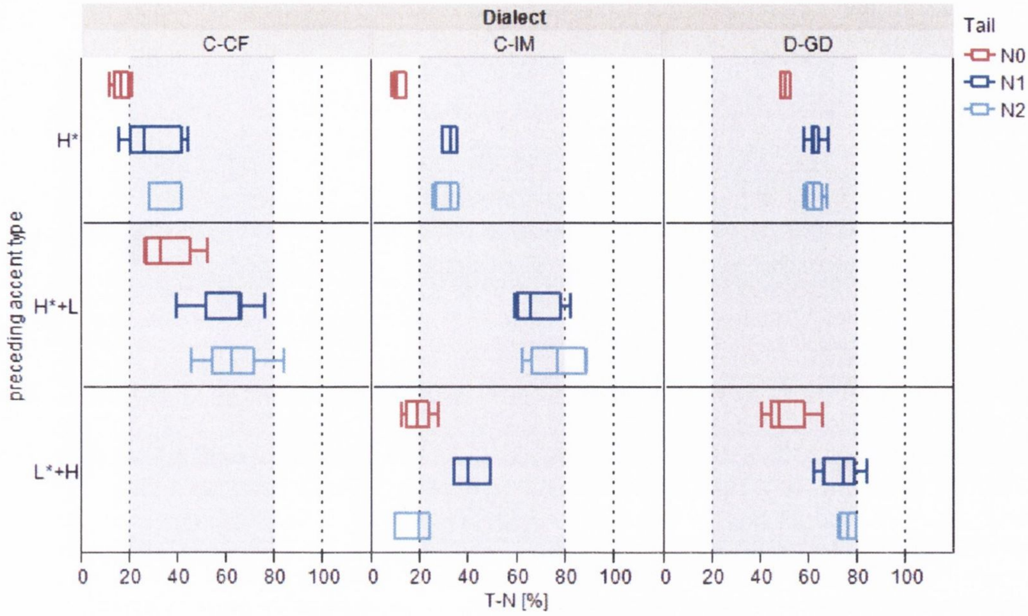

Figure 5.9 Box plots of the Fujisaki model-derived relative elbow location (T-N) in nuclear Connemara H*+L and Donegal L*+H accents across three tail conditions (N0-N2). Nuclear accents are grouped according to the type of preceding accent (H*, H*+L or L*+H, on the y axis). Relative segmental boundaries are indicated on the x axis: syllable onset = 0%, /C_1V:/ = 20%, /V:C_2/ = 80%, syllable offset = 100%. Grey boxes indicate the relative duration of the accented vowel.

5.5.3 Contour-measured elbow in prenuclear accents

Figure 5.10 presents box plots of the contour-measured elbow timing in prenuclear accents (H* and H*+L for Connemara, and L*+H for Donegal). The results are presented in the same fashion as those for nuclear accents (Section 5.5.1) with two minor differences: (1) anacrusis is the rhythmic context; (2) there is no preceding tonal context to consider. Because of the scarcity of the Connemara data, the main attention is devoted to discussing the Gaoth Dobhair results (red box in Figure 5.10).

Observation of the Gaoth Dobhair results in Figure 5.10 indicates that the L elbow in prenuclear accents is affected by anacrusis. An earlier rise onset is observed in zero anacrusis compared to the other two conditions (0PN = 47% vs. 1PN = 71% and 2PN = 75%). This difference is confirmed by the one-way ANOVA with Anacrusis as factor ($F(2, 6) = 6.89$, $p = .027$). The post-hoc Tukey HSD results show that the L elbow is approximately 25% earlier when the anacrusis syllables are absent (0PN < 1PN by 23% and 0PN < 2PN by 26% at $p < .05$). Additionally, the examination of speaker means shows that the early pattern in 0PN is produced by three out of four speakers. Speaker GD1 is the exception in that the L elbows in his data occur mid-syllable (52-55%) in the zero anacrusis condition.

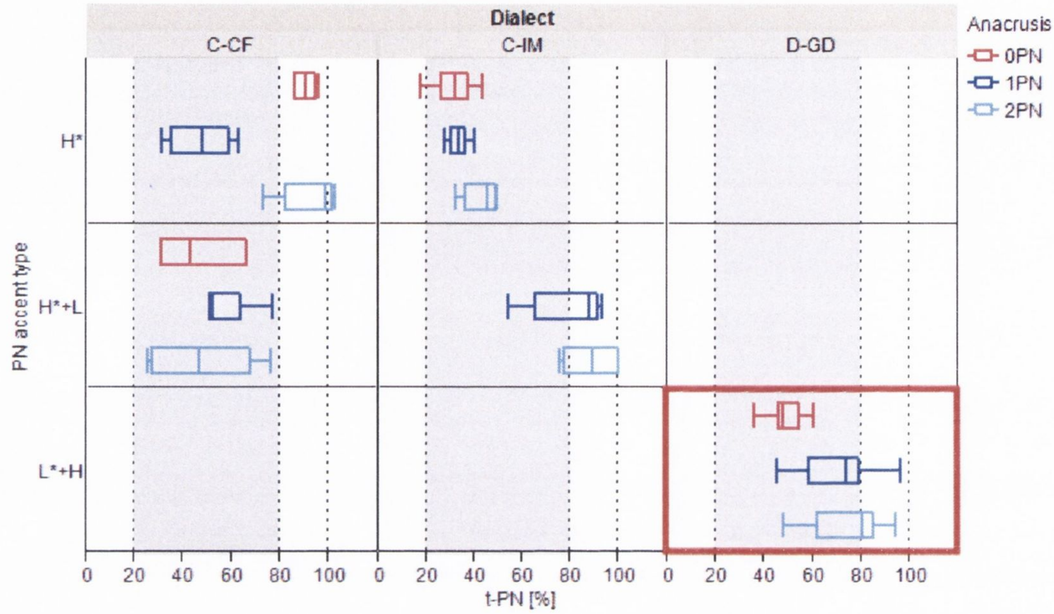

Figure 5.10 Box plots of the contour-measured relative elbow location (t-PN) in prenuclear accents across three anacrusis conditions (0PN-2PN). Prenuclear accents are grouped according to their type (H*, H*+L and L*+H, y axis). Relative segmental boundaries are indicated on the x axis: syllable onset = 0%, /C_1V:/ = 20%, /V:C_2/ = 80%, syllable offset = 100%. Grey boxes indicate the relative duration of the accented vowel. The Gaoth Dobhair data is of main interest (red box).

Let us now briefly turn to the Connemara prenuclear results. Looking separately at the H*+L and H* groups, it appears that neither of them is affected by anacrusis in either of the two varieties. The H elbow in the H*+L accents in Cois Fharraige is located near the vowel centre (46-54%), while in Inis Mór it is towards the end of the syllable (82-90%). The considerably late timing in Inis Mór may be due to speaker (the H*+L data coming only from IM5 and IM3, who generally is a late 'aligner').[37] In prenuclear H* accents the elbow occurs more early in Inis Mór (32-48%) than in Cois Fharraige 0PN and 2PN (83-93%). This seeming alignment difference is actually related to the latter being realised with a small, but perceptible onglide (covered in Section 5.4.2 on time-normalised contours in the prenuclear data).

[37] IM3 is also the only one among all Connemara speakers to use L*+HL% outside of the focus data.

5.5.4 Fujisaki model elbow in prenuclear accents

Figure 5.11 illustrates the elbow location in prenuclear accents (H* and H*+L for Connemara, and L*+H for Donegal) measured with the time-points of the Fujisaki model accent command. The results are presented in the same way as in the nuclear dataset (Section 5.5.2). The two minor differences include: (1) anacrusis instead of tail; (2) the absence of the preceding tonal context. Gaoth Dobhair is of main interest as having a sufficient amount of prenuclear data (red box in Figure 5.11).

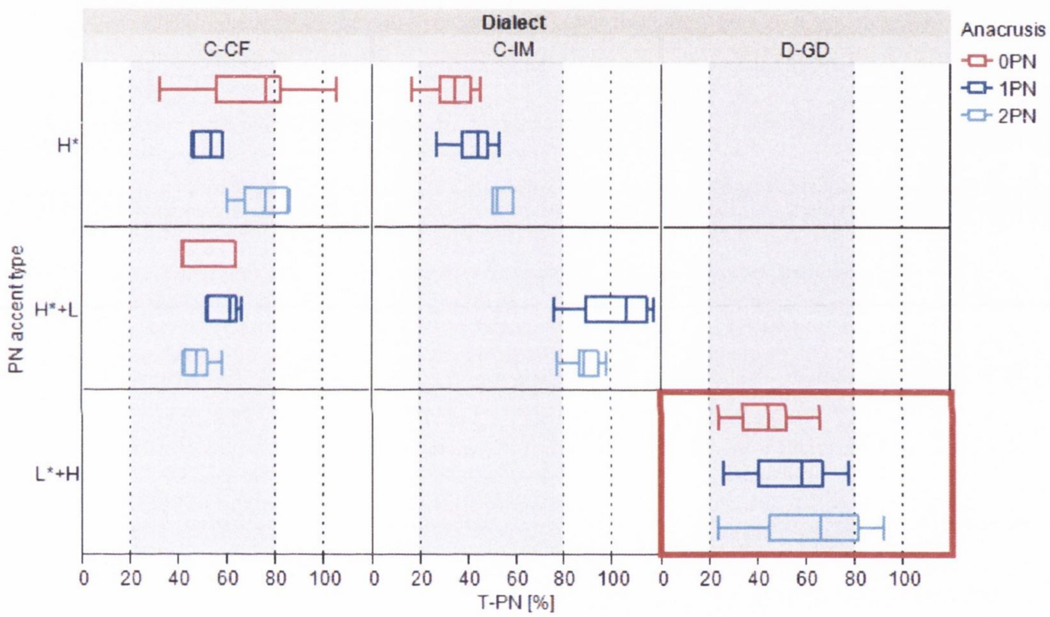

Figure 5.11 Box plots of the Fujisaki model-derived relative elbow location (T-PN) in prenuclear accents across three anacrusis conditions (0PN-2PN). Prenuclear accents are grouped according to their type (H*, H*+L and L*+H, y axis). Relative segmental boundaries are indicated on the x axis: syllable onset = 0%, /C_1V:/ = 20%, /V:C_2/ = 80%, syllable offset = 100%. Grey boxes indicate the relative duration of the accented vowel. The Gaoth Dobhair data is of main interest (red box).

The overall impression is that the accent component of the Fujisaki model reflects the contour-measured elbow measurements for Connemara, but not for Donegal.[38] Let us inspect the results for the northern variety in more detail. The mean L elbow values obtained with T1 of the accent command are earlier (43-63%) than those measured from the f0 contour, and the spread of values is larger. Possibly, the decreased precision of T1

[38] Note that timing of the H elbow in H* accents in the Connemara data was estimated from T1 (the T1+194 ms calculation described in Section 3.5.2 of Chapter 3).

in modelling the elbow in prenuclear L*+H is caused by the less well-defined L inflections compared to the nuclear rises (cf. time-normalised contours in Section 5.4). Another reason for the larger spread of the T-PN values in D-GD could be considerably short rise durations (i.e. less than 194 ms) in the prenuclear L*+H, for which T1 would need to be retracted so that the accent command will reach the H inflection in time. This statement is tested in Section 5.6.2 on the duration of the f0 movements in prenuclear accents.

5.6 F0 movement duration in bitonal accents

The remaining discussion of the timing properties of pitch accents in Connemara and Donegal Irish is devoted solely to the H*+L and L*+H categories. Section 5.6 covers duration of the f0 movement understood as the time interval between the H and L elbows in the two pitch accent types. This measure is provided to (1) illustrate how the bitonal pitch accents in Irish are realised with respect to the timing of the H and L turning points, and (2) test how suitable the accent component is for reflecting these realisations. For a more elaborate explanation of these two points the reader is referred to Chapter 3.

Figure 5.12 illustrates the initial prediction for the f0 movement duration in H*+L and L*+H accents under the expansion of the right-hand segmental material. When more post-accentual syllables are available, the trailing tone may dislocate rightwards, thus increasing the duration of the f0 movement. The durations are here conventionally grouped into short, medium and long; this division will be referred to in Sections 5.6.1 and 5.6.2. If the rightward elbow dislocation prediction is correct, then f0 movements exceeding 200 ms in duration will be modelled by the accent component with decreasing accuracy.

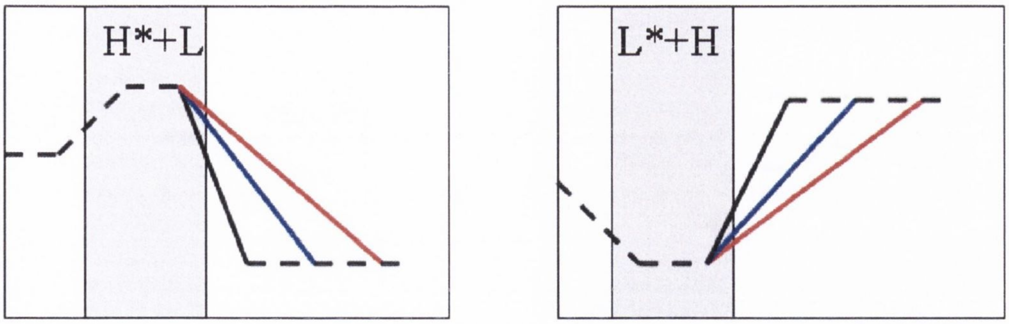

Figure 5.12 Schematic representation of the f0 movement duration in H*+L and L*+H accents under the expansion of the right-hand segmental material. The progressive rightward shift of the trailing tone results in increasingly longer durations of the f0 movement (short = black, medium = blue, long = red). The position of the accented syllable in relation to the f0 contour is indicated by the grey box.

5.6.1 Movement duration in nuclear H*+L and L*+H accents

Figure 5.13 presents the results for the f0 movement duration in nuclear H*+L and L*+H accents in the three varieties of Irish. Evidently, the f0 movement duration under tail expansion changes less in Gaoth Dobhair than in Connemara. The Gaoth Dobhair rises in N0 and N1 are mostly short; even those in N2 do not exceed 200 ms by much (means: after H* = 252 ms; after L*+H = 255 ms). Also the Connemara H*+L nuclei generally exhibit fall durations close to 200 ms when preceded by H*+L (except Inis Mór N2 where larger variation is observed).

Medium and long f0 movements in Connemara falls are found in linked contours in the presence of tail, particularly N2. In the H* H*+L% contour the duration of the nuclear fall frequently exceeds 300 ms (C-CF: N2 = 380 ms; C-IM: N1 = 325 ms, N2 = 436 ms); the same trend is observed in Inis Mór falls in the L*+H H*+L% tune (N1 = 300 ms, N2 = 333 ms). The longer duration of the falls in the linked contours is most likely due to early timing of the H elbow (at the vowel onset) and a progressive rightward drift of L with an increase in tail length. The comparatively higher values for Inis Mór in Figure 5.13 may be evidence of a stronger preference for the L delay, but can also be related to a slower speaking rate among the Inis Mór informants (the Cois Fharraige speakers were the fastest in all three experimental tasks – for comparison see the IP duration results for the sentence mode data in Table 4.2, Section 4.11.1 of Chapter 4).

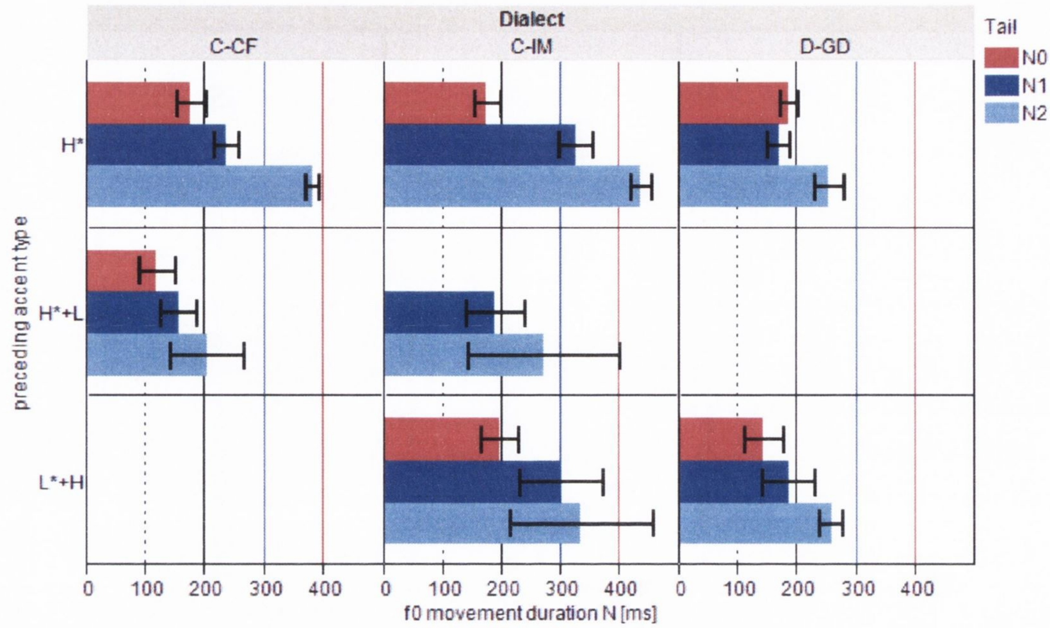

Figure 5.13 Means and standard deviations for f0 movement duration in nuclear H*+L and L*+H accents across three tail conditions (N0-N2). Nuclear accents are grouped according to the type of preceding accent (H*, H*+L or L*+H, y axis). The coloured vertical lines on the x axis correspond to the upper limit for conventionalised f0 movement durations (short = black, medium = blue, long = red).

Figure 5.14 presents a histogram of the f0 movement duration in nuclear accents in the three varieties. The duration scale is divided into 100 ms units with arbitrary upper limits indicating three degrees of the accent command match: up to 200 ms (accurate), up to 300 ms (acceptable) and up to 400 ms (deteriorated). The last group also includes some extremely long f0 movements (exceeding 400 ms).

Visibly, Gaoth Dobhair (N = 49) is the least problematic variety for the Fujisaki model with 98% accurate or acceptable data, and nearly no deterioration (2%, panel D-GD in Figure 5.14). Cois Fharraige (N = 41) is the second most model-friendly variety with 90% of the nuclear falls being accurate or acceptable, and only 10% deteriorated (panel C-CF in Figure 5.14). Loss of accuracy is more frequent in Inis Mór (N = 43), where 65% of the nuclear data are acceptable, while deterioration affects the remaining 35% (panel C-IM in Figure 5.14). The two alternative solutions to modelling slow falls under a constant beta setting involve capturing accent shape while sacrificing the elbow, or vice versa.

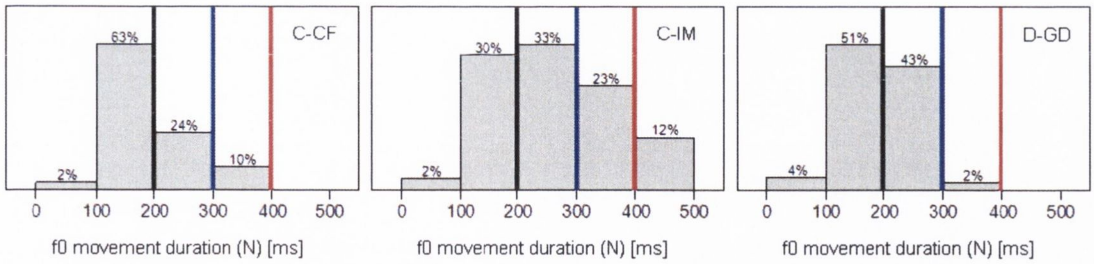

Figure 5.14 Histogram of f0 movement duration in nuclear H*+L (C-CF and C-IM) and L*+H (D-GD) accents. The coloured vertical lines on the x axis correspond to the arbitrary landmarks reflecting the accent command match (accurate = black, acceptable = blue, deteriorated = red).

5.6.2 Movement duration in prenuclear H*+L and L*+H accents

Figure 5.15 presents the f0 movement duration in prenuclear accents. In Gaoth Dobhair the overwhelming majority of prenuclear L*+H does not exceed 200 ms in duration. Unlike the nuclear data, the f0 movement duration in the IP-initial rises is not affected by anacrusis length. In fact, the rises exhibit longer durations in the absence of anacrusis (0PN = 194 ms vs. 1PN = 152 ms and 2PN = 147 ms). Recalling the findings on elbow alignment in prenuclear L*+H (Section 5.5.3) one may infer that the increased duration of the rise in 0PN results from a slight retraction of L and stable timing of H in the first post-accentual syllable.

In both Connemara varieties prenuclear H*+L accents exhibit either short or medium f0 movement durations (Cois Fharraige: 0PN = 177 ms, 1PN = 182 ms, 2PN = 251 ms; Inis Mór: 1PN = 237 ms, 2PN = 287 ms). The duration of the fall is not affected by anacrusis length (the slight increase seen in 2PN is actually caused by an expansion of the accent group length (three unstressed syllables in 2PN vs. two in 0PN and 1PN). The comparatively longer durations in Inis Mór may be caused by a slower speaking rate among the informants.

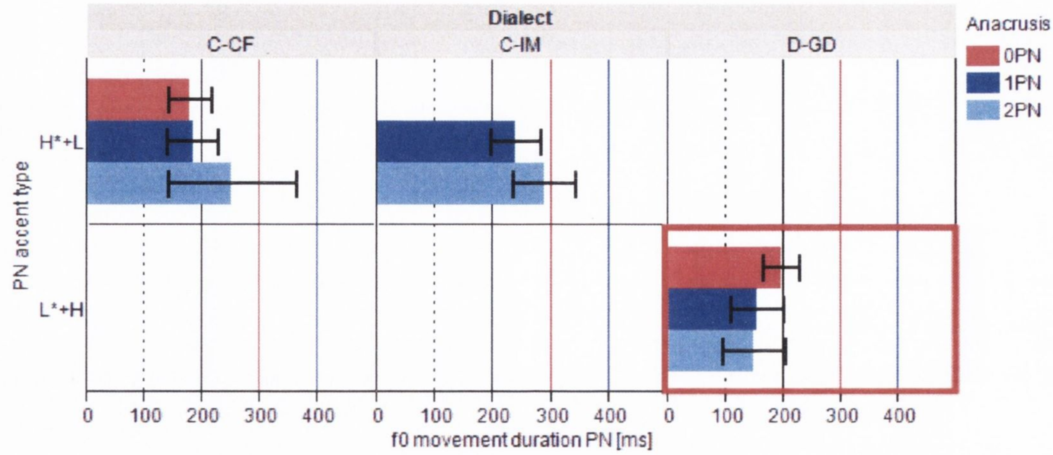

Figure 5.15 Means and standard deviations for f0 movement duration in prenuclear H*+L and L*+H accents across three anacrusis conditions (0PN-2PN). The coloured vertical lines on the x axis correspond to the upper limit for conventionalised f0 movement durations (short = black, medium = blue, long = red). The Gaoth Dobhair data is of main interest (red box).

Figure 5.16 demonstrates a histogram of the f0 movement duration in prenuclear accents. Clearly, the Gaoth Dobhair data (N = 46) again poses no serious challenge to the Fujisaki model with 100% data in the accurate or acceptable group. Cois Fharraige (N = 17) is the second most model-friendly variety with only 18% deteriorations. Inis Mór (N = 13) yet again contains the highest percentage of data where loss of accuracy is noticeable (38%).

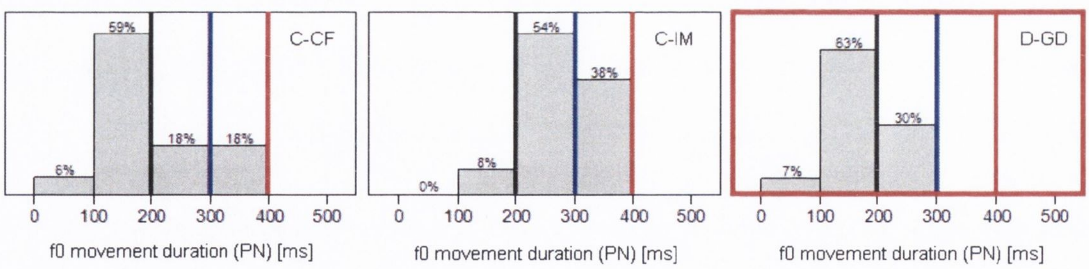

Figure 5.16 Histogram of f0 movement duration in prenuclear H*+L (C-CF and C-IM) and L*+H (D-GD) accents. The coloured vertical lines for the x axis correspond to the arbitrary landmarks reflecting the accent command match (accurate = black, acceptable = blue, deteriorated = red). The Gaoth Dobhair data is of main interest (red box).

5.7 F0 excursion size in bitonal accents

Section 5.7 covers the f0 excursion size in H*+L and L*+H accents in Connemara and Donegal Irish (the initial overview of f0 excursion was provided in Section 5.4 on time-normalised contours). Excursion size was chosen over absolute peak scaling to examine how well the accent command amplitude of the Fujisaki model (Aa) corresponds to the contour-measured counterpart. Also, the potential influence of the right-hand rhythmic context on accent scaling was of interest (i.e. truncation in the absence of tail; anacrusis not expected to affect the size of an f0 movement). For the methods of measuring the f0 excursion size from the contour and with the accent command amplitude see Chapter 3.

5.7.1 F0 excursion in nuclear H*+L and L*+H accents

Figure 5.17 juxtaposes the f0 excursion size of nuclear H*+L and L*+H accents measured from the contour (upper panel) and with the Fujisaki model accent command amplitude (lower panel). Observation of the results indicates that the f0 size of the accent is generally not affected by tail. An exception is seen in Cois Fharraige falls in N0 preceded by H*+L, where a curtailed f0 course (i.e. truncation) of the fall is observed compared to the two tail conditions (f0 excursion-N: N0 = 2.2 ST vs. N1 = 4.9 ST and N2 = 4.4 ST). No data for this tonal context in N0 is available in Inis Mór.

The Fujisaki model Aa generally reflects the contour-measured f0 excursion size rather well. However, it misses the important one, i.e. the truncated Cois Fharraige falls in N0 preceded by H*+L. Here the accent command amplitude is not reduced like what was observed in the f0 excursion measurement (Aa-N: N0 = 0.15, N1 = 0.19, N2 = 0.20). The reason for Aa-N's inability to convey truncation is related to the Fb setting. As the base frequency is set to the global f0 minimum, which in this contour is found in the trailing L of the preceding H*+L, the amplitude of the nuclear fall is consequently overestimated.

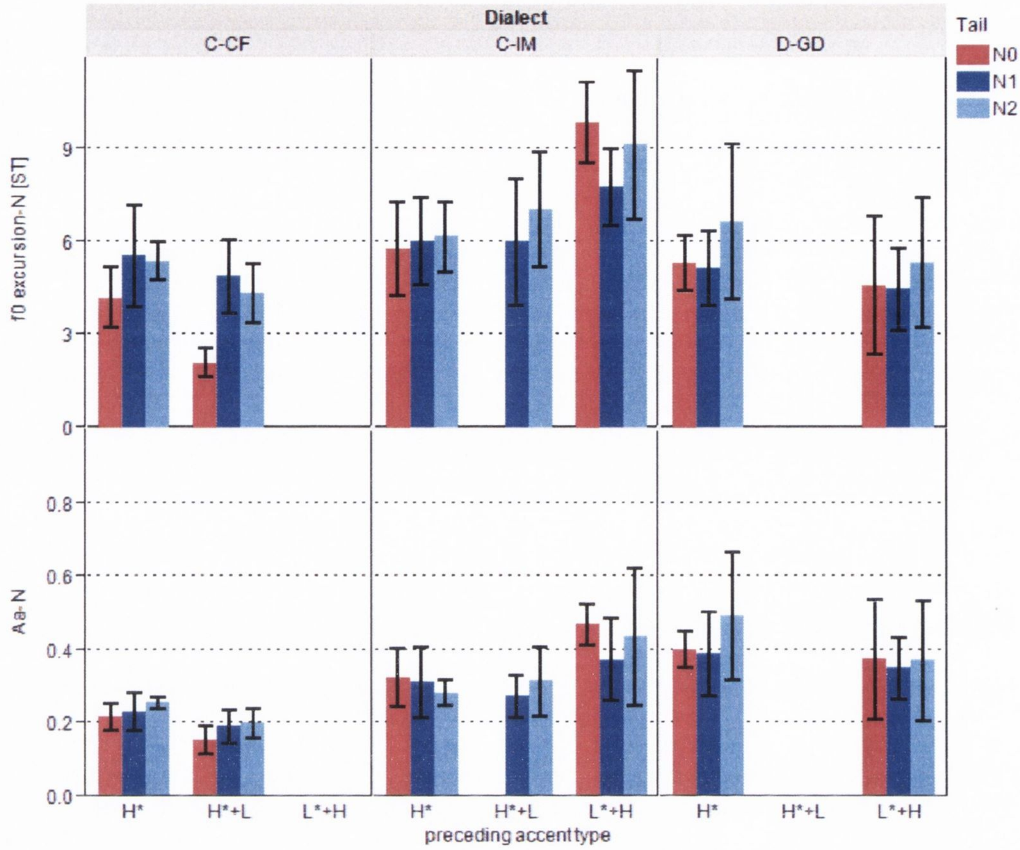

Figure 5.17 Means and standard deviations for the f0 excursion size of nuclear H*+L and L*+H accents in three tail conditions (N0-N2) depending on preceding accent type (x axis). The excursions are grouped according to the method of measurement: from the f0 contour (upper panel) and with the Fujisaki model accent command amplitude (lower panel).

5.7.2 F0 excursion in prenuclear H*+L and L*+H accents

Figure 5.18 presents the contour-measured f0 excursion size (upper panel) opposite the Fujisaki model Aa (lower panel) in prenuclear H*+L and L*+H accents. Observation of the contour-measured f0 excursion confirms the expectation that the left-hand rhythmic context has no influence on the f0 size of the prenuclear accent in any of the three varieties. The slight excursion increase in Inis Mór falls in 2PN (5.2 ST vs. 4.1 ST in 1PN) is likely related to late timing of L in the final unstressed syllable in the accent group (cf. Section 5.6.2). The amplitude of the Fujisaki model accent command captures the f0 excursion size accurately. This result suggests little or no interaction between the amplitudes of the phrase command and the IP-initial accent command in the prenuclear data.

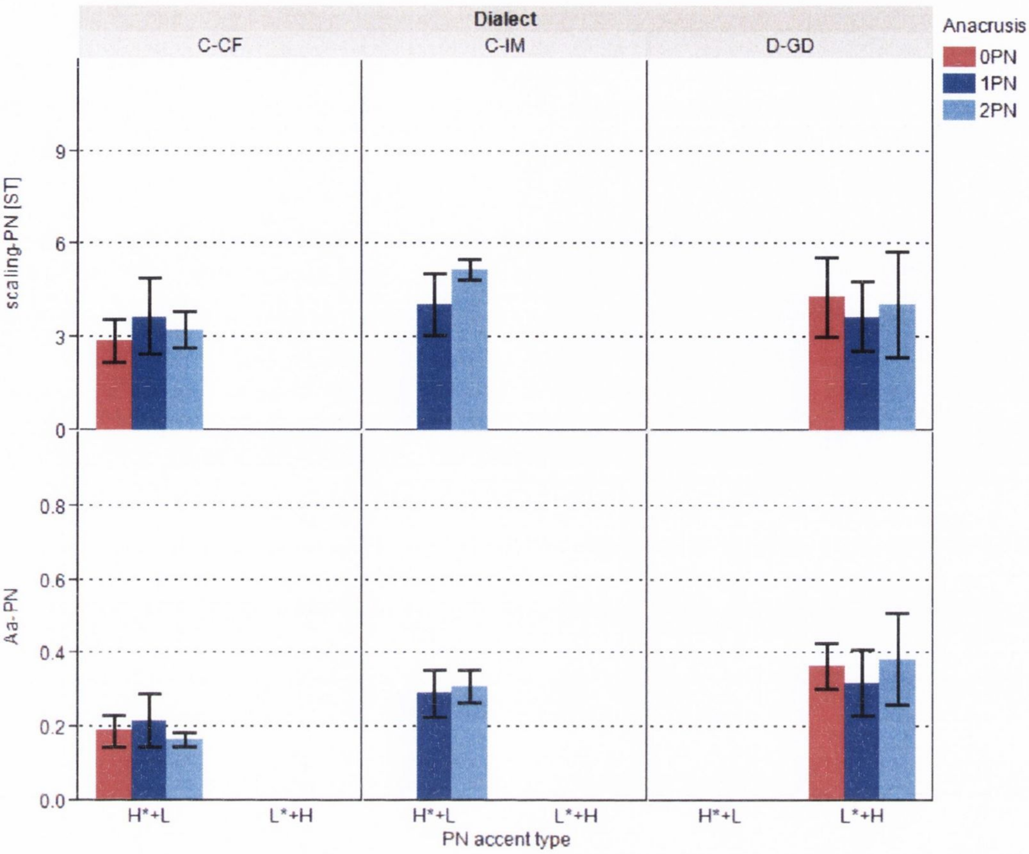

Figure 5.18 Means and standard deviations for the f0 excursion size of prenuclear H*+L and L*+H accents (x axis) in three anacrusis conditions (0PN-2PN). The excursions are grouped according to the method of measurement: from the f0 contour (upper panel) and with the Fujisaki model accent command amplitude (lower panel).

5.8 Discussion

Section 5.8 summarises the findings on alignment and scaling of pitch accents in the phrase-initial and phrase-final position. The subsequent parts cover a comparison of the present findings with the existing findings for Irish as well as for other languages, and suitability of the accent component of the Fujisaki model to approximate the H*+L and L*+H accents of Connemara and Donegal Irish.

5.8.1 Summary of present timing and scaling results for Irish

The alignment and scaling results for Connemara and Donegal Irish are summarised in Table 5.2. Apparently, Cois Fharraige and Inis Mór largely share a similar timing strategy influenced by the rhythmic and tonal contexts, while Gaoth Dobhair responds to the rhythmic context only. The majority of effects are found in nuclear accents, implying that the three varieties are affected nearly exclusively by the right-hand rhythmic context. The effect of anacrusis is found only for one metric in Gaoth Dobhair.

Table 5.2 Summary of the alignment and scaling results for Connemara and Donegal Irish. Coding: N0 = absence of tail syllables, 0PN = absence of anacrusis syllables. Symbols: (←) elbow retraction, (↓) truncation, (>) longer than, (x) no effect found, (?) effect could not be tested.

	f0 metric	Cois Fharraige H*+L	Inis Mór H*+L	Gaoth Dobhair L*+H
Nuclear accents	Elbow timing	Tail and tune Two-peaked: ←N0 Linked: x	Tail and tune Two-peaked: ? Linked: x	Tail: ←N0
	F0 movement duration	Tail: ←N0 Tune: linked > two-peaked	Tail: ←N0 Tune: linked > two-peaked	Tail: ←N0
	F0 excursion	Tail and tune Two-peaked: ↓N0	x	x
Prenuclear accents	Elbow timing	x	x	Anacrusis: ←0PN
	F0 movement duration	x	x	x
	F0 excursion	x	x	x

In terms of alignment, Gaoth Dobhair responds to tail and anacrusis, while showing resistance to the type of preceding accent in the nuclear position. If Gaoth Dobhair was to respond to the tonal context like Connemara, then rises preceded by H* would have an early L elbow, since the anticipatory f0 drop from H* is already in place. Cois Fharraige and Inis Mór, on the other hand, are sensitive to tail and the tonal context; the latter is the more pervasive determiner of timing of the nuclear fall (early in the linked contours vs. medial in the two-peaked contours). Neither Cois Fharraige nor Inis Mór is affected by anacrusis, and the late-peak variant of H* was not found in either of the two varieties. Finally, both Connemara varieties are nearly identical in terms of alignment.

With respect to f0 movement duration, none of the three varieties responds to anacrusis. This is not surprising, since pitch accents in Connemara and Donegal Irish operate within left-headed stress groups. In the nuclear position, the duration of an f0 movement in

Gaoth Dobhair is affected by tail, while in Cois Fharraige and Inis Mór it is influenced by tail as well as by the tonal context.

The results for the f0 excursion size suggest that under optimal voicing conditions Connemara and Donegal are fairly resistant to using truncation (disregarding the prenuclear data, where no effects are observed), whereby the early elbow location allows for a full f0 course of the pitch accent. Indubitably, both dialects opt for compression as the preferred accommodation strategy. Interestingly, Connemara limits and Inis Mór completely evades the tonal context for truncation in N0 (only a few of H*+L H*+L% samples in C-CF and none in C-IM).

5.8.2 Comparison with existing findings for Irish

This section offers a brief comparison of the present results with those of Dalton and Ní Chasaide (2005, 2006). The findings are summarised in Figure 5.19. The prenuclear results for Cois Fharraige and Inis Mór are not included due to the modest amount of data compared to Gaoth Dobhair. An attempt is made to explain the possible reason for the differences between the previous and present findings.

The one basic difference between the two studies involves the specification of the tonal context. The works of Dalton & Ní Chasaide state that the accents under scrutiny are prenuclear H* and nuclear H*+L in Connemara, and L*+H accents in Donegal. However, the immediately preceding or following accent types are not explicitly stated. The most plausible explanation for not doing so is that Dalton & Ní Chasaide's data would have been homogenous with just one tune type per variety. This consistency in tune would be relatively easy to achieve with a sentence list as the elicitation method. The data used in this work was recorded in mini-dialogues, which gave very natural-sounding samples, but at the expense of fewer data samples per condition due to appreciable variation in tune. The advantage of this unexpected variation is that a wider array of alignment patterns, particularly for Connemara, has been unveiled.

Let us now note a number of differences in the results reported in the two studies. Dalton & Ní Chasaide showed that Cois Fharraige has early nuclear peaks near the syllable onset across the three tail conditions, while this study uncovered the occurrence of early peaks in the linked contour along with medial peaks in the two-peaked contour (Figure 5.19). The analysis of the new data suggests that the early pattern noted by Dalton & Ní Chasaide may have come from the linked contour, either H* (H*) H*+L%, or the downstepped H* (!H*) !H*+L% variant, where stable early H alignment is typically observed. The Gaoth Dobhair findings presented by Dalton & Ní Chasaide are largely replicated in the current study. The small difference in 0PN could be due to a difference in the segmental composition of the target syllable ('gob' vs. 'lán' differing in vowel length and voicing). It is also possible that the L retraction in the absence of anacrusis in Gaoth Dobhair may be a speaker-dependent strategy.

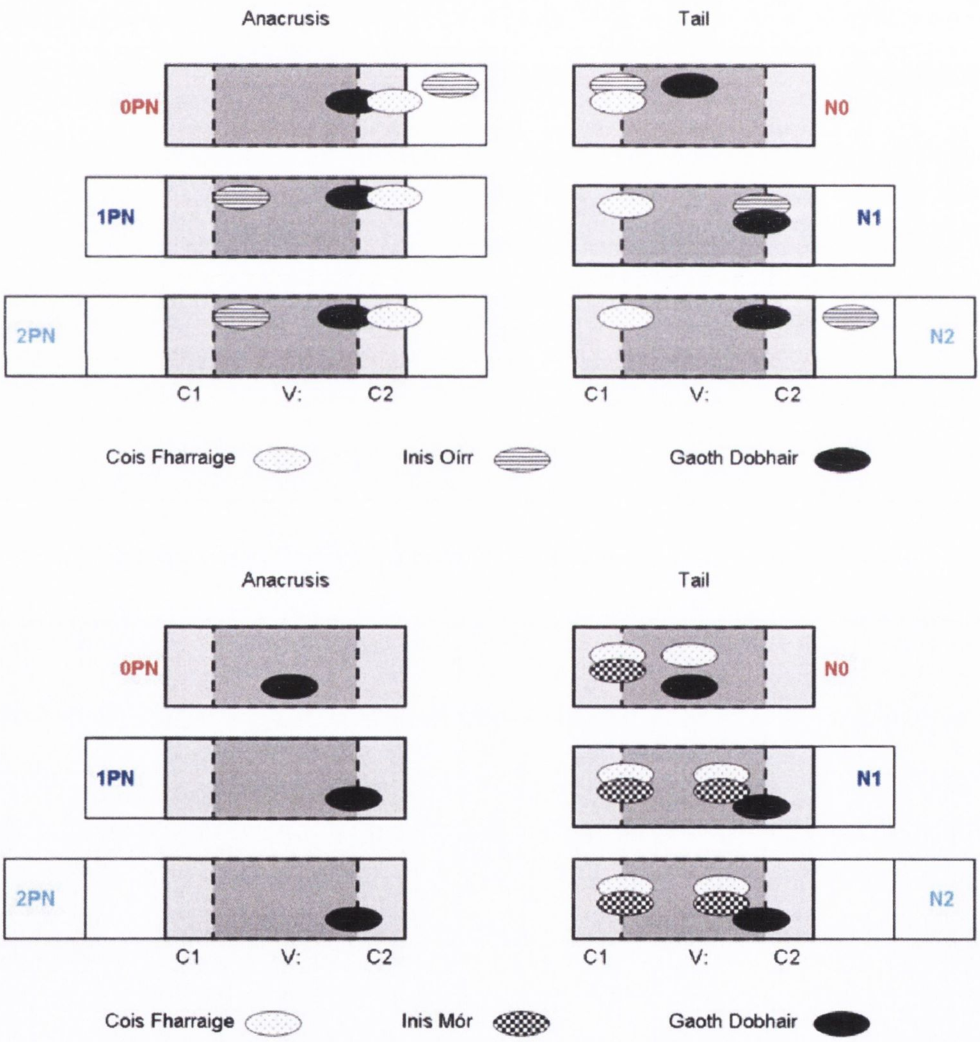

Figure 5.19 Schematic representation of the findings of Dalton and Ní Chasaide (2005, 2006) (upper panel) and the findings in the present study (lower panel). Segments of the target syllable are indicated by grey boxes: the initial (C1) and final (C2) consonants = light grey, the vowel (V) = dark grey.

A direct comparison of the Inis Oírr and Inis Mór results is not possible. Nevertheless, it seems quite striking that two Aran Islands would have such different alignment patterns. The present results clearly show that Inis Mór shares the peak timing strategy with Cois Fharraige, and not with Inis Oírr. The only hint at some similarity with the late H timing previously shown for Inis Oírr was found in the data of only one Inis Mór speaker. IM3, the only male speaker in this group, frequently produced H*+L accents with the peak near the syllable offset regardless of the accent position in the phrase, as well as some late-peak L*+HL% nuclei; most of these, however, were found in his sentence mode and focus data. This possibly gender-specific pattern definitely merits further work in relation to Inis Mór as well as other varieties of Irish. Also, a cross-island study of the prosody of Aran appears a promising avenue for research.

5.8.3 Comparison with findings for other languages

Here a brief comparison of the present findings with those in Section 5.2.3 is provided. Let us look at timing of nuclear accents first. A leftward shift of the target under pressure from an upcoming boundary shown for the four selected languages (Swedish, English, German and Chickasaw) was also found in Connemara Irish falls in the two-peaked (H*+L H*+L%) tune and Donegal rises in both the all-rising and the high-plus-rising (L*+H L*+H% and H* L*+H%) tunes. In this sense Irish joins the list of languages which may use target retraction in the absence of tail as the preferred accommodation strategy. The early H anchoring in the 'flat hat' (H* H*+L%) pattern regardless of tail length, which was found by Kügler et al. (2003) for German and also in this study for Connemara, could potentially be seen as an extreme case of peak retraction conditioned by the immediate tonal context.

The prenuclear alignment results for the L elbow in Donegal Irish are the opposite of 'peak lag' observed by Nolan and Farrar (1999) for varieties of English. Perhaps identical timing behaviour cannot be expected for phonologically opposite tones. Still, it is surprising to see the same effect under a change of the right-hand context in the nuclear and the left-hand context in the prenuclear rises. On the other hand, resistance to anacrusis in the modestly represented prenuclear H*+L data in Connemara resembles the findings for Swedish (Alstermark & Erikson, 1971), where the nuclear accents did not respond to the left-hand rhythmic context. The predicted sensitivity of the Connemara varieties to the right-hand context such as shown for Swedish, as well as for English (e.g. Silverman & Pierrehumbert, 1990) and Spanish (e.g. Prieto, van Santen, & Hirschberg, 1995) clearly needs to be studied for prenuclear H*+L accents.

5.8.4 Suitability of Fujisaki model for characterising alignment data

Overall, the accent component of the Fujisaki model performed rather well in modelling the pitch accents of Irish. Or, in other words, a substantial proportion of pitch accents in Irish do not pose a challenge to the accent component.

Accent command timing was largely accurate except for two cases. The first one was found in Connemara falls in linked contours in the presence of tail syllables. In this context the match was less accurate due to duration of the f0 movement largely exceeding the beta-imposed 200 ms limit. The second instance of decreased timing accuracy involved Donegal prenuclear rises in 0PN and 1PN whose duration was shorter (only 150 ms on average). In brief, the accent component performs best when the actual f0 movement duration does not deviate seriously from the default duration determined by the beta setting.

The accent command amplitude reflected the f0 excursion size of H*+L and L*+H accents in most cases. Goodness of the Aa fit was interpreted as indicative of the accent commands having little interaction with the phrase command in the alignment dataset. The only notable mismatch was found in the handful of the Cois Fharraige H*+L accents in the absence of tail, where truncation of the f0 excursion was missed.

5.9 Summary

Chapter 5 demonstrated the alignment and scaling characteristics of the IP-initial and nuclear accents in Connemara (H*+L, also prenuclear H*) and Donegal (L*+H) Irish. The timing results showed that Cois Fharraige and Inis Mór exhibit early or medial nuclear falls depending on the tune type (linked vs. two-peaked), and are sensitive to tail but not to anacrusis. Both varieties were found to be very similar with respect to H alignment. Donegal, on the other hand, was found to respond to tail as well as anacrusis, but not to the tune type (in the nuclear data). F0 movement duration and the f0 excursion size were scrutinised to assess the performance of the Fujisaki model accent component on the pitch accents in the alignment dataset. The timing and amplitude parameters were found to accurately model a substantial proportion of the H*+L and L*+H accents. The following final experimental chapter will investigate the role of alignment and scaling in the expression of focus along with four other simple fundamental frequency and duration metrics.

Chapter 6

Intonation of focus in Connemara and Donegal Irish

6.1 Introduction

Chapter 6 investigates the prosodic encoding of focus in Connemara and Donegal Irish. Contrastive focus in three accent positions in the phrase (initial, medial and final) is compared to broad (neutral) focus. The aim of this chapter is to determine whether f0 and duration are actively involved in conveying contrastive focus in the three varieties, and if so, whether differences are found depending on the position of focused element in the phrase. This experiment tests the effect of focus in the absence of morphological marking, but it is worthwhile noting that Irish has morphological and syntactic means available for the expression of focus (e.g. McCloskey, 1999; Sulger, 2009).

The chapter first introduces the background on the intonation of focus (Section 6.2). The results are presented in Sections 6.3 to 6.10. Following the presentation of the tune inventory (Section 6.3) and the stylised f0 contours (Section 6.4) in the focus data, a more detailed coverage of the selected phonetic correlates of focus is provided. Scaling and timing of the focal H, register span and level, as well as duration of the accented syllable and accent group are examined in Sections 6.5 to 6.10. Finally, the discussion (Section 6.11) incorporates a summary of the focus results, comparison of these results with the findings in the selected studies, and assessment of the suitability of the Fujisaki model for capturing f0 contours of focus data in Irish.

6.2 Background on intonation of focus

Section 6.2 first introduces focus marking by means of intonation as well as duration (Section 6.2.1). Then the existing works on the intonation of focus in Donegal Irish are introduced (Section 6.2.2). The section concludes with a summary of findings in selected studies of focus, which either use some or all of the f0 metrics chosen for this study (Section 6.2.3).

6.2.1 General characteristics of focus

From a functional perspective, focus can be defined as a method of "(...) fixing the attention of a listener on some portion of an utterance" (Cruttenden, 1997: 80). In the elementary classification two types of focus can be distinguished on the basis of the scope of the highlighted information.[39] In narrow focus, one specific element in the phrase is made more prominent, whereas in broad focus a larger constituent, usually the whole phrase, is made important (Ladd, 2008). Contrastive focus, which is of interest in this work, is a special kind of narrow focus in which a particular constituent is being 'corrected' or 'contrasted' (Gussenhoven, 2007).

Highlighting of the important information in narrow focus can be done by a variety of means including lexical, grammatical and intonational strategies (Cruttenden, 1997). Textual means can be used on their own or in conjunction with prosodic means, but intonation only can also be used to convey emphasis (Hirst & Di Cristo, 1998).

Among the intonational means a number of strategies are available for marking focus. A special type of pitch accent (Hirst & Di Cristo, 1998; Ladd, 2008) can be used to mark the focal element. The focal peak may be aligned later (Frota, 2000), or earlier (Face, 2001).[40] The change in the alignment pattern can be specifically acknowledged in the notation (H+L* vs. H*+L in Frota, 2000).[41] The surrounding accents can be reduced or deleted (Hirst & Di Cristo, 1998; Ladd, 2008). Deaccentuation of rightward (i.e. post-focal) elements is obligatory in some languages such as e.g. English (Gussenhoven, 2007), while in others the occurrence of post-focal accents is reported (D'Imperio, 2001). A perhaps more unusual strategy involves stress shift to a normally unstressed syllable along with accentuation (Adamou & Arvaniti, 2010).

Other devices for marking focus include raising of the focal peak (D'Imperio, 2001; Face, 2001; Féry & Kügler, 2008; Meyer & Mleinek, 2006) or expanding the local f0 range on

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[39] For a detailed classification of types of focus see e.g. Gussenhoven (2007).

[40] No change in alignment is also possible (Hellmuth, 2006 for Egyptian Arabic).

[41] The change in (usually peak) alignment under focus can, or may not, be explicitly equated with the use of a different accent type depending on the particular work.

the focused element (Xu, 1999).[42] The pitch of the pre-focal region usually remains unaffected, while the post-focal region is suppressed (Y. Chen, 2010; Cooper, Eady, & Mueller, 1985; Face, 2001; Xu & Xu, 2005). Duration changes may also occur. An increase in duration can affect just the accented syllable (Baumann, Becker, Grice, & Mücke, 2007; Y. Chen & Gussenhoven, 2008; Face, 2001) or a larger domain such as the focused word (Baumann et al., 2007; Cooper et al., 1985; Jun & Kim, 2007). Finally, languages/dialects can differ in whether, how often and in what way they use these devices (S. W. Chen, Wang, & Xu, 2009; O'Rourke, 2012).

6.2.2 Existing findings for Irish

Only one study has been conducted so far on the role of f0 in the encoding of focus in Irish (O'Reilly, Dorn, & Ní Chasaide, 2010). The study provides the characteristics of how intonation-only focus is produced by bilingual speakers of Irish from Gaoth Dobhair and speakers of English from Rann na Feirste and Gaoth Dobhair in Donegal. Because the Gaoth Dobhair Irish data is fully included here, the findings of the study are summarised only briefly. Focus was produced nearly identically in both languages, but notable differences were found depending on the position of the focal element in the phrase. In IP-initial and IP-medial focus, both varieties used an expanded f0 excursion on the focal accent, frequent reduction of the pre-focal accents and post-focal deaccentuation. IP-final focus, however, was largely similar to broad focus.

6.2.3 Findings in selected studies for other languages

Six studies have been chosen for an overview of the effects of focus on the f0 contour. The findings for the selected languages are summarised in Table 6.1. All studies examine the f0 and duration metrics in contrastive focus (cf) compared to broad focus (bf) in a number of positions in the phrase. The effects of contrastive focus are observed either in a specific position in the phrase (IP-initial = cf1, IP-medial = cf2, IP-final = cf3), or apply

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[42] The scaling measurements of focus can involve just the peak height, the f0 excursion of the accent, or both.

to all contrastive focus (cf). These findings will be compared with the present results for Irish in the discussion (Section 6.11).

The studies in Table 6.1 cover a number of parameters affected by focus. The first four describe the intonation contour (scaling and timing of the focal peak, as well as the f0 of the pre-focal and post-focal regions). Two duration measures and other features are also presented. The directionality of each metric under focus is indicated by the projection of the arrow. Horizontal arrows are used to reflect shifts in peak timing: left (←) for retraction and right (→) for delay. Vertical arrows are used to code the frequency domain or duration: down (↓) for reduction and up (↑) for boosting/lengthening. Crosses (x) denote that the f0 metric did not play a role in the production of contrast.

Table 6.1 Summary of the focus results in six selected studies. Symbols: (←) peak retraction, (→) peak delay, (↓) f0 reduction, (↑) f0 boost, or segmental lengthening, (x) no effect found, empty field = the parameter was not reported on.

	Madrid Spanish (Face, 2001)	American English (Xu & Xu, 2005)	German (Baumann etal., 2007)	Standard Chinese (Chen & Gussenhoven , 2008)	Dutch (Hanssen etal., 2008)	Romanian (Manolescu etal., 2009)
Position of focal item in IP	cf1 cf2	cf1 cf2 cf3	cf3	cf2	cf3	cf1 cf2 cf3
Focal H timing	←cf1	x	→cf3		←cf3	←cf1 ←cf2
Focal H scaling / f0 excursion	↑cf2	↑cf	↑cf3	↑cf2	x or ↓cf3	↑cf1 ↑cf2 ↑cf3
F0 of pre-focal region		x or ↓cf				↓cf
F0 of post-focal region	x	↓cf			↓cf3	↓cf
Accented syllable duration	↑cf1 ↑cf2	↑cf	↑cf3	↑cf2	onset: ↑cf3 nucleus: x	vowel: ↑cf
Accent group duration			↑cf3			
Other			bf: downstep cf: upstep	focal L ↓cf (if present)		

Inspection of Table 6.1 suggests that two particular metrics, focal H scaling and duration of the accented syllable (which also happen to be examined in all six studies) are heavily used for encoding focus. The focal H undergoes boosting in nearly all six languages, but not equally across all positions in the IP. Madrid Spanish, for instance, makes use of the H boost when the focal accent occurs IP-medially, but relies on peak retraction in the IP-initial position. Dutch is exceptional in that the focal H in the IP-final accent may not only remain unchanged but even become reduced in f0. With respect to the accented syllable duration, either the entire syllable undergoes lengthening (Madrid Spanish, American English, German and Standard Chinese), or at least a particular segment (Dutch and Romanian) is lengthened. The pre-focal and post-focal regions may remain similar to broad focus or may undergo suppression. Timing of the focal peak can undergo retraction (Madrid Spanish, Dutch and Romanian), delay (German) or remain unchanged (American English). Other features are only sporadically reported on.[43]

6.3 Nuclear accent and tune inventory in focus data

Figure 6.1 demonstrates the distribution of nuclear (i.e. focal) accent types in the focus data of Connemara and Donegal Irish.[44] The transcription includes the accent and boundary tone combinations occurring in the three varieties in this dataset. The classification is based on the H*+L vs. L*+H distinction. The nuclear accents are grouped according to focus type (broad = bf, contrastive = cf) and, in the case of contrastive focus, the position of the item in the phrase (IP-initial = cf1, IP-medial = cf2, IP-final = cf3).

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[43] Studies of focus can use the f0 excursion size of the focal accent along with, or instead of, peak scaling. The decision to omit the f0 excursion metric from the present study was motivated by a general absence of a rising onglide in the H*+L accents of Connemara under broad focus. Rise size in the context of Gaoth Dobhair, however, would be a most suitable measure along with rise slope (used by e.g. Y. Chen & Gussenhoven, 2008; Hanssen, Peters, & Gussenhoven, 2008).

[44] The term 'nuclear accent' denotes the most prominent pitch accent in the phrase (Cruttenden, 1997). In languages where post-focal deaccentuation takes place the focal accent becomes the 'early nucleus' (for nucleus placement see e.g. Gussenhoven, 2004; Ladd, 2008).

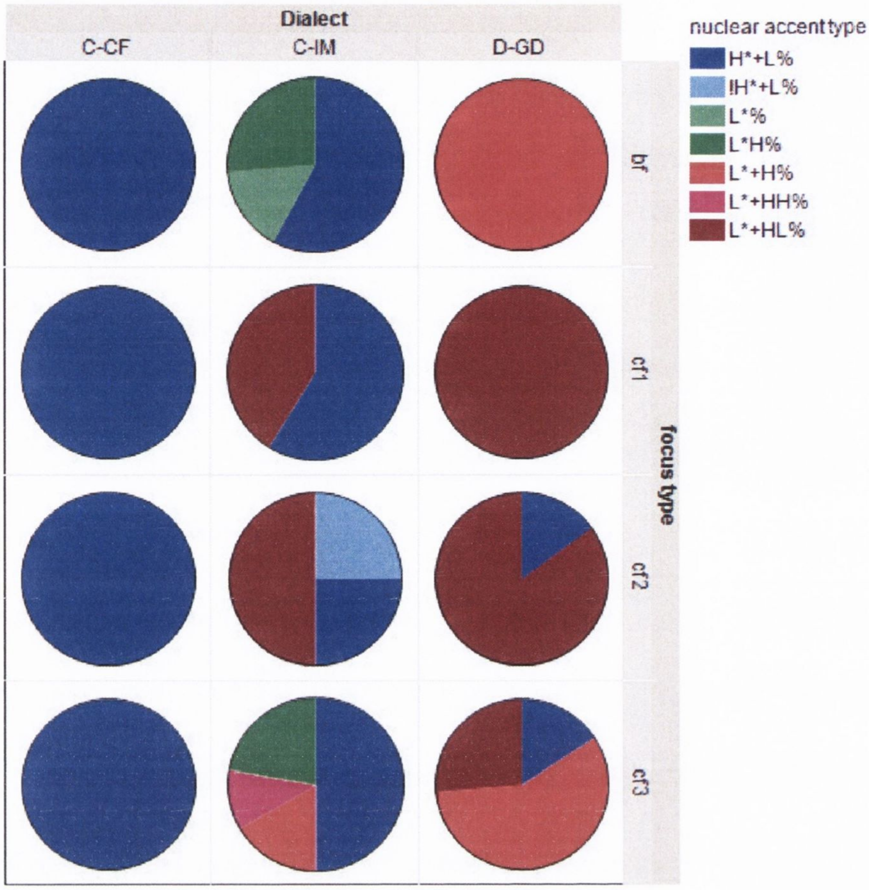

Figure 6.1 Distribution of nuclear accent types in the focus data.

Notably, Cois Fharraige and Gaoth Dobhair exhibit one (or two) typical nuclear tunes in each focal condition, while Inis Mór shows considerable variation (Figure 6.1). Cois Fharraige uses only H*+L% nuclei in broad and contrastive focus (100%).[45] Gaoth Dobhair uses L*+H% exclusively in broad focus (100%) and frequently in IP-final contrastive focus (58%), whereas in IP-initial and IP-medial contrastive focus it produces mainly L*+HL% (100% and 85%, respectively). Some atypical H*+L% nuclei are also found in cf2 and cf3 (15% and 16%). On the other hand, in Inis Mór only between 50% and 60% of data in bf, cf1 and cf3 involves the H*+L% nucleus. Frequent use of the rise-fall tune (L*+HL%) is observed in IP-initial and IP-medial contrastive focus (cf1 = 41%, cf2 = 50%). In order to enable comparison of the f0 metrics only data containing the dialect-typical nuclei (H*+L% in Connemara and L*+H(L)% in Donegal) can be selected for further analysis.

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[45] Data for IP-medial contrastive focus (cf2) in Cois Fharraige comes from just three speakers (speaker CF1 did not produce contrast in the IP-medial position).

Figure 6.2 presents the frequency of the selected nuclear accent types (H*+L%, L*+H% or L*+HL%) in conjunction with the IP-initial accent. The medial accent is omitted from the figure in broad and IP-final contrastive focus, as it either repeats the pattern of the IP-initial accent (usually), or is left unaccented. The discussion of the simplified tunes is limited to broad focus along with cf2 and cf3, because cf1 has only one (i.e. nuclear) accent, and has been effectively covered in Figure 6.1.

At the tune level Cois Fharraige exhibits appreciable transparency across all focus conditions. In broad focus, the all-falling (H*+L H*+L%) pattern (53%) and the flat hat (H* H*+L%) pattern (20%) are most frequently used. In IP-final contrastive focus, on the other hand, the prenuclear H*+L pattern (40%) is often replaced with a sequence of L* accents (47%). The L* H*+L% and H*+L H*+L% tunes are also used in cf2 (67% and 33%, respectively). The small number of exclusions in the Cois Fharraige data (bf = 27% and cf = 13%) involves tunes with prenuclear L*+H accents.

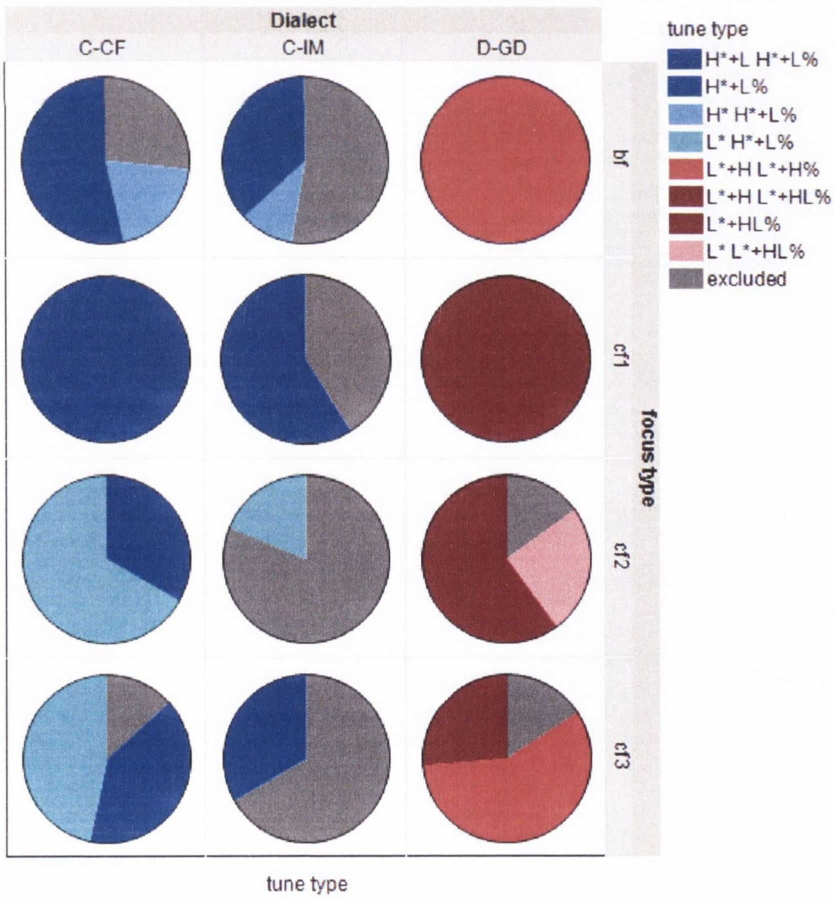

Figure 6.2 Distribution of tune types in the focus data.

The tune distribution in the Gaoth Dobhair data largely mirrors the nuclear accent type distribution in Figure 6.1. In other words, the nucleus (either L*+H% or L*+HL%) is preceded by L*+H accents in bf and cf3. Reduction of the prenuclear accents to L* is found only in IP-medial contrastive focus (cf2 = 25%). The small number of exclusions in cf2 (15%) and cf3 (16%) feature the odd H*+L% nuclei already shown in Figure 6.1.

The high degree of tune variability in the Inis Mór focus data precludes its suitability for phonetic measurements. The speakers use a wide variety of prenuclear-plus-nuclear accent combinations. To begin with, only 48% of the broad focus data exhibits the most frequent H*(+L) H*+L% Connemara pattern. In cf3, this pattern amounts to only 33%. The excluded tunes (Figure 6.2) which involve any deviations from the underlying H*+L H*+L% pattern, amount to 41%-81% depending on the focus condition. Clearly, with the rejection rate often exceeding the amount of useable data, Inis Mór needs to be excluded from the parametric analysis. In order to substantiate this decision, the variability in Inis Mór focus tunes will be illustrated through stylised contours in Section 6.4.

Before proceeding with the discussion of the quantitative results for the focus data, a note on the link between phrase-medial deaccentuation in broad focus and its impact on the measurements is due. It has been mentioned here, as well as in previous chapter on sentence mode, that the medial element can be left unaccented in the three-accent phrases. In the sentence mode data, the absence of the IP-medial accent did not preclude the comparison of f0 contours, as only the first and final pitch accents were analysed. In the focus data, however, accentuation of the IP-medial element is of major importance, because the accentual H in contrastive focus is compared to its broad focus counterpart in terms of timing and scaling. In the broad focus data, only two out of four Cois Fharraige speakers (CF1 and CF4) and two out of five Gaoth Dobhair speakers (GD1 and GD4) produced an accent on the IP-medial element. Due to the small amount of broad focus data with accentuation in A2 the subsequent coverage of timing and scaling of the focal H in Sections 6.5 and 6.6 will refer chiefly to the IP-initial and IP-final accents. Also, the ANOVA tests of the f0 metrics in focus data will not include the IP-medial context.

6.4 General overview of focus results - stylised contours

Section 6.4 is devoted mainly to the discussion of stylised f0 contours in selected focus data in Cois Fharraige and Gaoth Dobhair. The Inis Mór contours are covered separately, and only insofar as to justify the exclusion of the entire focus dataset for this variety. The stylised contours enable direct comparison of the broad and contrastive focus renditions in three positions in the IP. The contour-derived f0 metrics: timing and scaling of the focal peak, as well as register level and span, each presented along with its Fujisaki model counterpart, are covered separately in Sections 6.5 to 6.8. For details on how the contour-derived and the Fujisaki model measurements were taken see Chapter 3.

Figure 6.3 illustrates mean stylised f0 contours for selected focus data in Cois Fharraige and Gaoth Dobhair. It transpires that both varieties mark focus by means of intonation, but they do it differently depending on the position of the focal element in the IP. The most prominent highlighting is found in IP-medial focus (cf2), followed by IP-initial focus (cf1), while only mild differentiation is observed in IP-final focus (cf3).

We start with the focus strategies employed by Cois Fharraige and Gaoth Dobhair speakers in the IP-initial position. In cf1 both varieties use their own default accent type (H*+L or L*+H) on the focal element and slightly raise the focal peak. Deaccentuation of the post-focal material can be observed in the falling f0 trajectory up to the final boundary.[46] Additionally, Cois Fharraige shows a drop in f0 level in the IP-final region.

IP-medial focus in Cois Fharraige and Gaoth Dobhair is produced with the use of two similar strategies. The first one (red solid line) involves retaining the default broad focus accent choice (H*+L or L*+H) pre-focally and boosting the focal peak. Gaoth Dobhair additionally reduces the f0 excursion size of the pre-focal L*+H. In the second contour (red dashed line) the pre-focal accent is suppressed to L*, and the focal H is raised. The simultaneous relative boost of the focal H and retention of a similar register level to that of broad focus should result in the expansion of register span.

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[46] The auditory analysis of the focus data in the three varieties suggests that in spite of deaccentuation the stress prominence is still retained. The gradual dropping of f0 over the somewhat weaker rhythmic beats gives the impression of subtle downstep on the deaccented syllables.

IP-final contrastive focus is accomplished with two strategies in Cois Fharraige and one in Gaoth Dobhair. The shared strategy (red solid lines in cf3) involves the same tonal pattern and similar scaling of the turning points as in broad focus. The small difference in cf3 involves curtailment of the nuclear fall by raising L in Cois Fharraige, and an upward shift of the rise in the local register in Gaoth Dobhair. The alternative L* (L*) H*+L% variant in Cois Fharraige is characterised by a reduction of the pre-focal accents and a boosting of the focal accent gesture by concomitant raising of H and lowering of the trailing L tone.

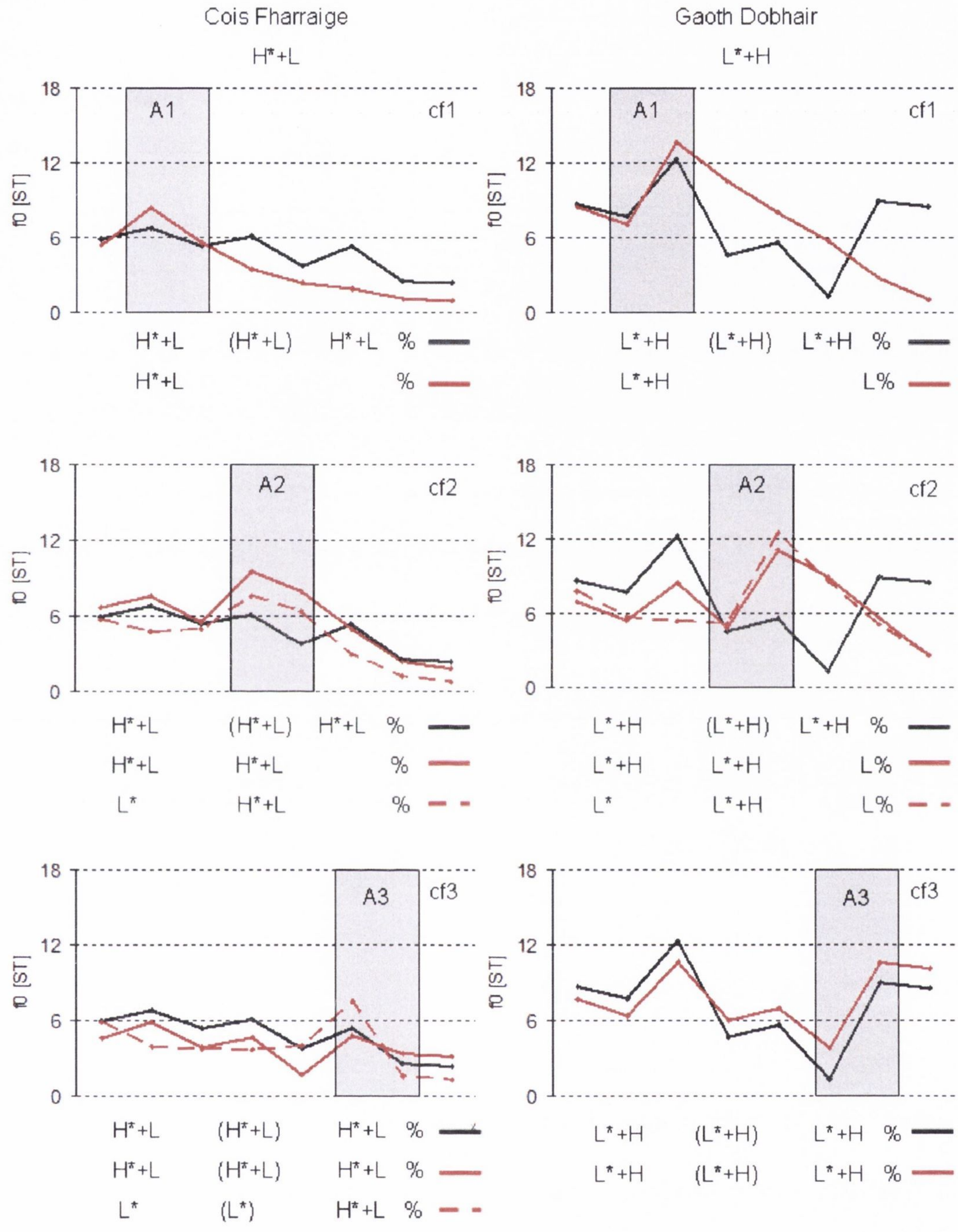

Figure 6.3 Stylised contours in the focus data of Cois Fharraige (left column) and Gaoth Dobhair (right column). Each contrastive focus (cf1, cf2, cf3) contour (red line) is plotted separately against broad focus (black line). The stylised contours represent eight turning points: a pair of high (H) and low (L) f0 points in each accent group, and the f0 at the IP-initial and IP-final boundaries. Grey boxes indicate the local pitch accent under focus (A1, A2 and A3).

The stylised contours in the excluded Inis Mór focus data are presented in Figure 6.4. The plots illustrate mean f0 contours based on the speaker's most frequent tune in each condition. It transpires that in the Inis Mór data up to four different contour types are found in each condition. Clearly, there are no systematic f0 trends in focus marking in the Inis Mór data. Further work is required on the extent to which speakers of Inis Mór and other varieties of Irish rely solely on f0 for focus marking.

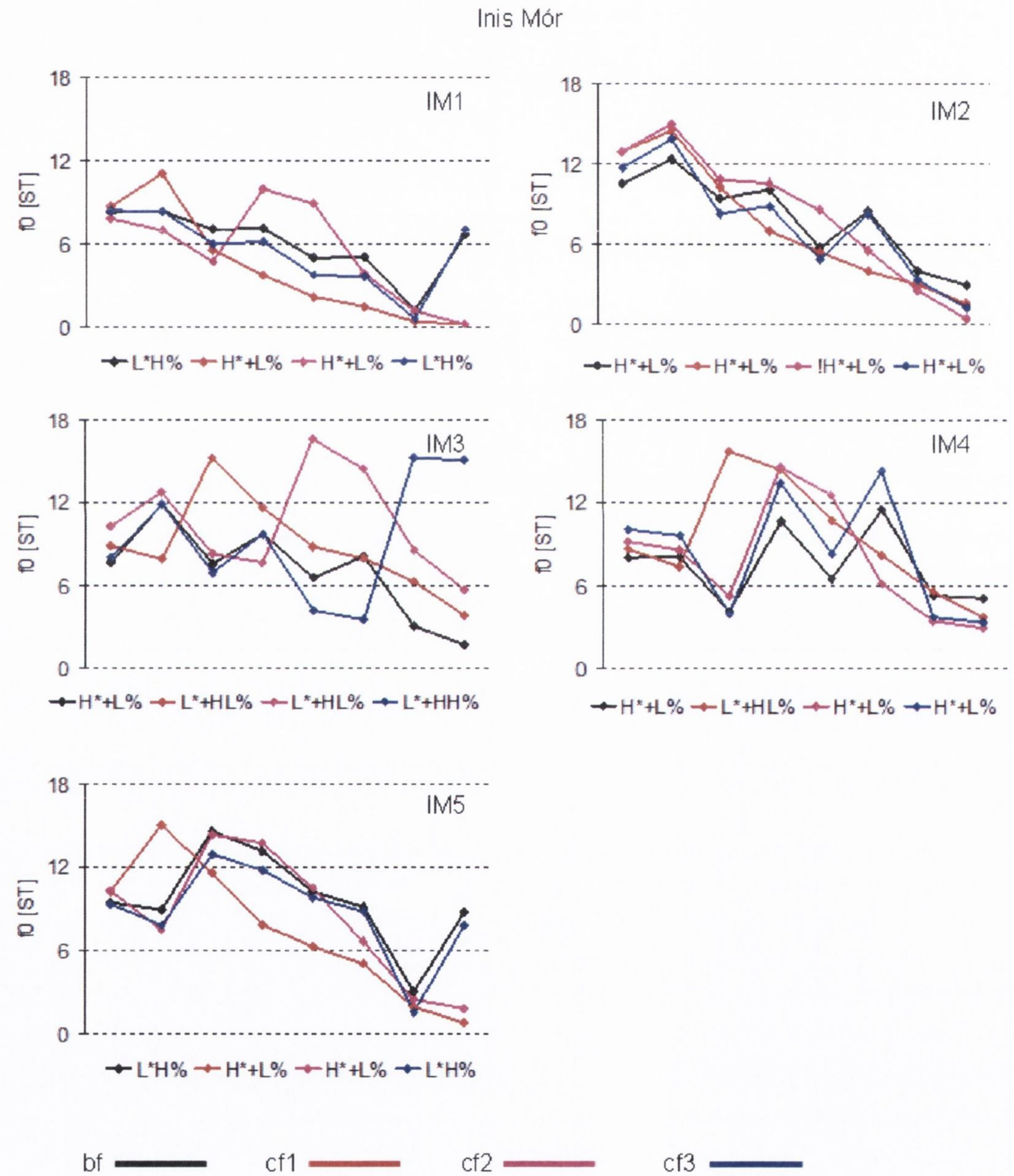

Figure 6.4 Stylised contours for Inis Mór speakers (IM1-IM5) in the focus data. Each panel contains the three contrastive focus contours (cf1, cf2, cf3) against broad focus (bf). The plots are based on the single most frequent tune used by each speaker in each condition.

6.5 Timing of focal peak

Section 6.5 presents the results on timing of the focal peak measured directly from the contour and with the Fujisaki model. The possibility of peak timing differences between the contrastive focus accent and its broad focus counterpart is considered. For details on how peak timing was measured in the focus data, as well as how it differs from elbow timing investigated in the previous chapter, see Section 3.5.3 of Chapter 3.

6.5.1 Contour-measured timing of focal peak

Figure 6.5 demonstrates timing of the contour-measured peak (t-H) in contrastive focus (cf) against broad focus (bf) in the Cois Fharraige and Gaoth Dobhair data. Peaks are grouped according to their position in the phrase (A1 to A3). Timing of the peak is expressed in relative terms, i.e. as a percentage of the accented syllable duration.

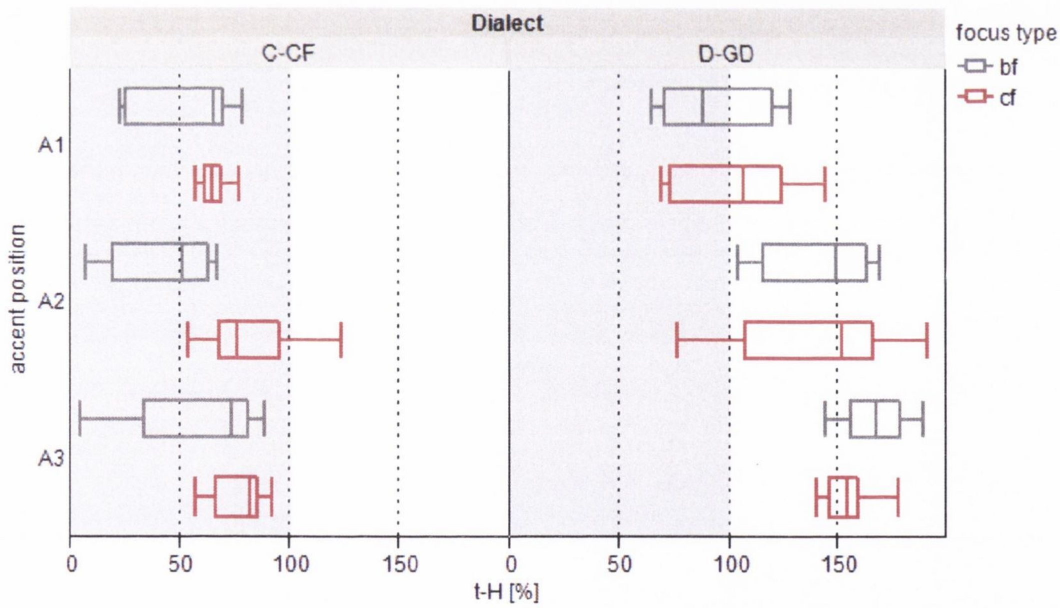

Figure 6.5 Box plots of contour-measured peak timing (t-H) in broad focus (bf = grey) and contrastive focus (cf = red) according to accent position in the IP (A1, A2, A3). Grey boxes indicate the relative duration of the accented syllable (0%-100%).

In Cois Fharraige, timing of the focal peak appears fairly consistent in contrastive focus, but substantial variation is observed in broad focus. Comparison of the median values alone would suggest that H timing in broad and contrastive focus is similar (median values for bf and cf: A1: 65% vs. 64%, A2: 50% vs. 76%, A3: 73% vs. 81%, respectively). The distribution of the focal peak timing results clearly shows that the values in contrastive focus are clustered closely (25% to 75%-percentile intervals in cf: A1 = 61%-68%, A2 = 67%-93%, A3 = 66%-85%). Broad focus peaks, however, exhibit a binomial distribution: early focal peaks are found at around 20% (i.e. close to the accented vowel onset) and medial peaks at around 75% (late in the vowel). This wide spread of data points is confirmed by the 25% to 75%-percentile intervals in the broad focus data (A1 = 25%-69%, A2 = 19%-63%, A3 = 30%-87%). The variability in peak timing in broad focus stems from diverse patterns in the Cois Fharraige group. Two speakers (CF2 and CF4) produce an early peak (on average at 20%-27%), one (CF1) uses the same pattern as in contrastive focus (70%-80%), and one (CF3) produces medial peaks in A1 (57%) but early peaks in A3 (24%).[47] Due to the irregular nature of the data, no definitive conclusions can be made about peak timing in focus in Cois Fharraige.

Observation of the Gaoth Dobhair t-H results in Figure 6.5 also suggests variability in peak timing in the A1 and A2 data. On the surface, t-H appears to be affected not by focus type but by the accent position in the phrase: the peak is timed earlier in the IP-initial position compared to the IP-medial and IP-final positions (median values: A1: bf = 88% vs. cf = 106%, A2: bf = 149% vs. cf = 152%, A3: bf = 167% vs. cf = 155%). Similarly to what was found for Cois Fharraige, t-H in the Gaoth Dobhair focus data shows a binomial distribution in A1 and A2. First, the IP-initial focus exhibits extremely early peaks, either at 60%-80% (i.e. the right edge of the accented vowel), or in the first post-accentual syllable (100%-140%). This trend is found both in broad and contrastive focus in A1. The peak values in A2 also show a wide distribution, with broad focus displaying two clusters at 100%-120% and 150%-170%, and contrastive focus at 60%-100% and 140%-160%. The picture emerging from the Gaoth Dobhair A1 and A2 data would suggest that the peak can be located anywhere in the accent group, which is at odds with the fairly stable H timing found in the IP-final accent (25% to 75%-percentile intervals in A3: bf = 155%-178%, cf = 145%-161%). Thus, the Gaoth Dobhair data does not lend itself to making substantial assumptions on peak timing in focus in this variety.

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[47] The early H in the broad focus data of speaker CF3 in A3 is caused by her producing the H* H*+L% pattern in this condition, whereas speakers CF1, CF2 and CF4 all produce the H*+L (H*+L) H*+L% sequence. Additionally, speakers CF1 and CF4 produce the IP-medial accent, while CF2 does not.

Summing up, neither the Cois Fharraige nor the Gaoth Dobhair results for peak timing in broad and contrastive focus lend themselves to statistical validation. All in all, it is left to future exploration to determine the timing strategies regularly employed by Cois Fharraige and Gaoth Dobhair speakers for marking focus structure.

6.5.2 Fujisaki model timing of focal peak

Figure 6.6 presents accent command-derived peak timing in the focus data. The model-based results are largely similar to the contour-derived t-H results in Figure 6.5. The only partial discrepancies are found in the Gaoth Dobhair data in contrastive focus in A2 and A3, where the H elbow is captured with less precision. Recall from Chapter 3 that timing of the *peak* in L*+H accents in the Gaoth Dobhair focus data is derived from T1, i.e. the location of the L elbow. This decision was motivated by the mostly regular occurrence of H in the first post-accentual syllable, which suggests its close timing relationship with the preceding L. Judging by the Fujisaki model T-H results it appears that T2 might have been just as good, or perhaps a better, reference time-point for measuring H timing in the Gaoth Dobhair focus data.

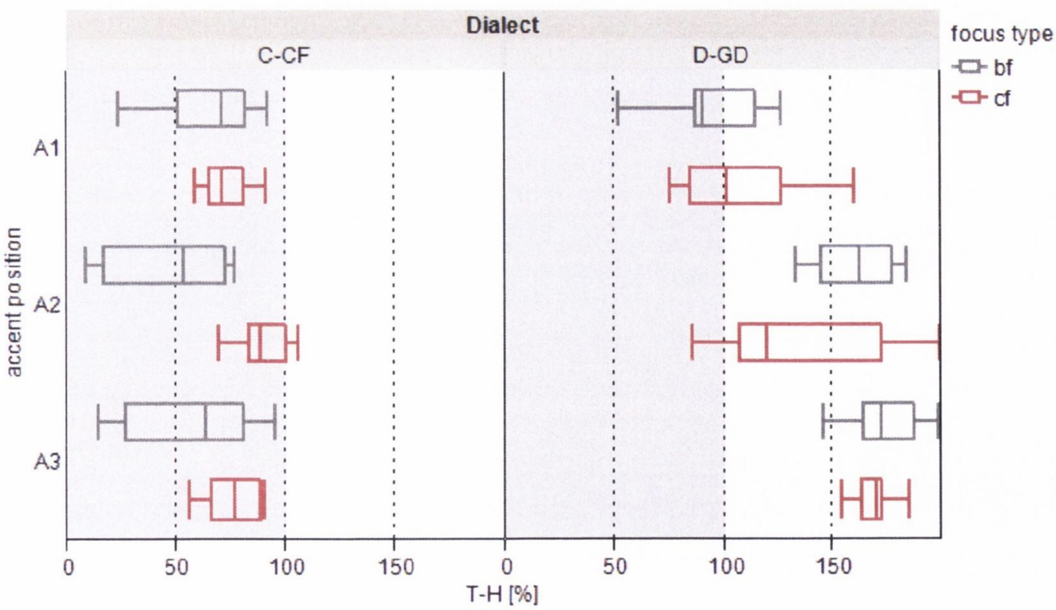

Figure 6.6 Box plots of Fujisaki model-derived peak timing (T-H) in broad focus (bf = grey) and contrastive focus (cf = red) according to accent position in the IP (A1, A2, A3). Grey boxes indicate the relative duration of the accented syllable (0%-100%).

6.6 Scaling of focal peak

Section 6.6 covers scaling of the focal peak measured directly from the f0 contour and with the Fujisaki model. The main interest lies in the f0 boost of the accentual peak in contrastive focus compared to the neutral counterpart. The pre-focal and post-focal elements are not included here, since they were already shown to be either unaltered or reduced in f0 pre-focally, and cancelled out (i.e. deaccented) post-focally (see Section 6.4 on stylised f0 contours in the focus data).

6.6.1 Contour-measured scaling of focal peak

Figure 6.7 illustrates contour-measured peak height (f0-H) in broad and contrastive focus. Peaks are grouped according to their position in the phrase (A1 to A3). Additionally, trend lines connecting the means are introduced to illustrate the relationship between consecutive peaks along the IP. These are only of interest in broad focus, as the sequence of A1, A2 and A3 occurs in one rendition, whereas in contrastive focus each of these accents was produced in a different IP.

Observation of Figure 6.7 suggests that the accentual peak is boosted in contrastive focus in the non-final IP positions compared to neutral focus. Peak raising is most notable IP-medially (median values for A2: C-CF: bf = 6.3 ST vs. cf = 8.9 ST; D-GD: bf = 7.3 ST vs. cf = 11.3 ST), and is relatively milder in the IP-initial position (median values for A1: C-CF: bf = 6.2 ST vs. cf = 8.2 ST; D-GD: bf = 11.3 ST vs. cf = 12.3 ST). No visible f0 boost is observed IP-finally (25% to 75%-percentile intervals for A3: C-CF: bf = 2.7-7.3 ST vs. cf = 2.6-7.3 ST; D-GD: bf = 7.3-10.3 ST vs. cf = 9.3-11.5 ST).

A two-way ANOVA with factors Dialect and Focus was carried out on peak scaling (f0-H) as the dependent variable. The tests were performed separately on the IP-initial (A1) and IP-final (A3) accents (recall that IP-medial focus is excluded from ANOVA). The results indicate the effect of Focus only in the IP-initial position ($F(1, 7) = 9.75$, $p = .017$). The post-hoc Tukey HSD test reveals that the focal peak in A1 in contrastive focus is significantly higher than in broad focus (+1.5 ST, $p < .05$). Peak height in the IP-final position (A3) is confirmed not to be affected by focus ($F(1, 7) = 2.22$, n.s.). The significant effect of Dialect is disregarded here, as this superficial difference stems from the Cois Fharraige speakers using a more limited f0 range in the focus dataset compared to the Gaoth Dobhair speakers (cf. stylised contours in the two varieties in Figure 6.3).

The trend lines connecting the mean values for broad focus peaks (grey lines in Figure 6.7) indicate that peaks usually drop in f0 with subsequent position in the phrase. In Cois Fharraige, the first peak is the highest (A1 = 6.2 ST), while peaks in A2 (4.6 ST) and A3 (4.8 ST) are lower in comparison to A1 by an almost equal amount.[48] Gaoth Dobhair exhibits a similar trend except for a small raising of the IP-final peak relative to the IP-medial peak (A1 = 11.3 ST, A2 = 7.3 ST, A3 = 9.1 ST). This relationship between consecutive peaks will be brought up in the context of the Fujisaki model in the next section (6.6.2).

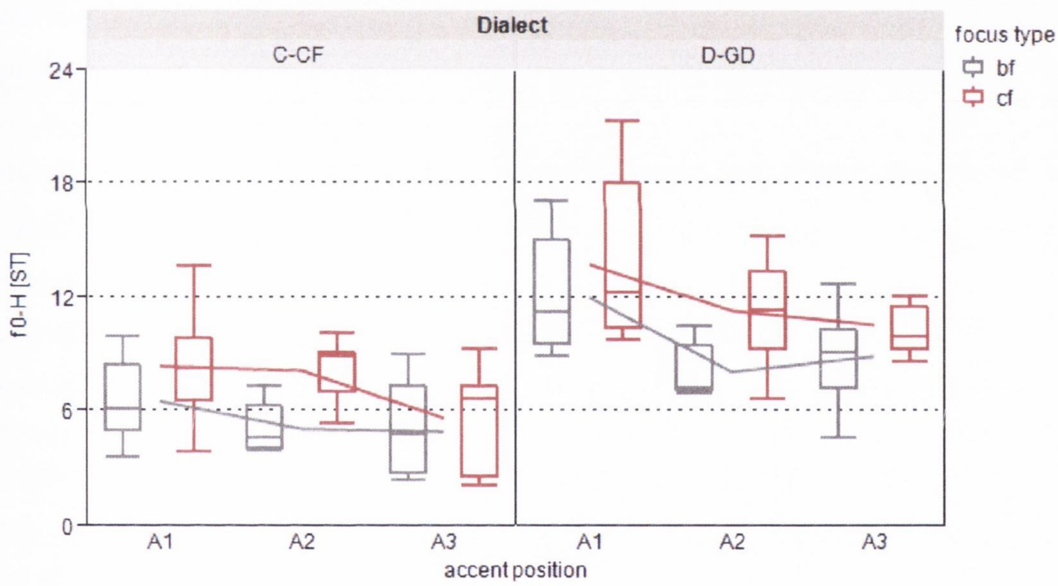

Figure 6.7 Box plots of contour-measured peak scaling (f0-H) in broad focus (bf = grey) and contrastive focus (cf = red) according to accent position in the IP (A1, A2, A3). Trend lines connect the mean peak scaling values in broad focus (grey line) and contrastive focus (red line). Only the broad focus trend lines are of interest.

[48] Progressive lowering of peak height (H1 > H2 > H3) was observed in the three-accent phrases in the Cois Fharraige sentence mode data.

6.6.2 Fujisaki model excursion of focal accent

Figure 6.8 illustrates the f0 excursion size of the accent in broad and contrastive focus measured with the Fujisaki model accent command amplitude (Aa). The excursion size is shown according to the accent position in the IP (from A1 to A3). The trend lines connecting the mean Aa values illustrate the relationship between subsequent accent commands in the phrase with respect to amplitude (looking only at broad focus).

The f0 excursion results in Figure 6.8 show similarity to those for peak scaling in Figure 6.7. The Aa values, however, show a more visible f0 boost of the focal accents than that which the f0-H values indicated. This is understandable, since the contour-measured H scaling will not necessarily overlap with the f0 excursion of the accent command. To test how well the two measures are related in each position in the IP, a series of correlations were run on f0-H and Aa in the three accent positions (collapsed over broad and contrastive focus). In the Cois Fharraige data, the f0-H vs. Aa relationship is markedly close (r values: A1 = 0.76, A2 = 0.91, A3 = 0.84). In the Gaoth Dobhair data, f0-H and Aa diverge in the IP final position (r values: A1 = 0.89, A2 = 0.91, A3 = 0.53). The relatively low correlation in A3 is most likely due to the divergence between independent H raising and the f0 excursion size in contrastive focus accents (compare Gaoth Dobhair stylised contours for A3 in Figure 6.3, Section 6.4). Interestingly, a similar difference between the two measures was observed in the sentence mode data in Gaoth Dobhair YNQ, where H of the IP-final L*+H was raised, but the f0 excursion remained similar due to concomitant raising of the nuclear L tone (Section 4.7).

The Aa trend lines in broad focus (grey lines in Figure 6.8) exhibit different tendencies depending on the dialect. In Cois Fharraige, the f0 excursion size in consecutive accents is nearly identical along the phrase (A1 = 0.19, A2 = 0.19, A3 = 0.20). In Gaoth Dobhair, however, the f0 excursion in A2 is less than in A1, but the excursion in A3 is notably expanded compared to both non-final accents (A1 = 0.43, A2 = 0.33, A3 = 0.54). To test how closely the f0 excursion size and peak height correspond to one another in general, i.e. regardless of position in the IP, correlations were run on f0-H and Aa for all broad focus accents (A1, A2 and A3 pooled together). The correlations were only moderate for both varieties (C-CF = 0.43, D-GD = 0.52). These results suggest that the two measures are incompatible to a certain degree. The f0 excursion size measured with Aa depends on the amplitude of the phrase command (as the two components are added), whereas peak scaling is measured autonomously.

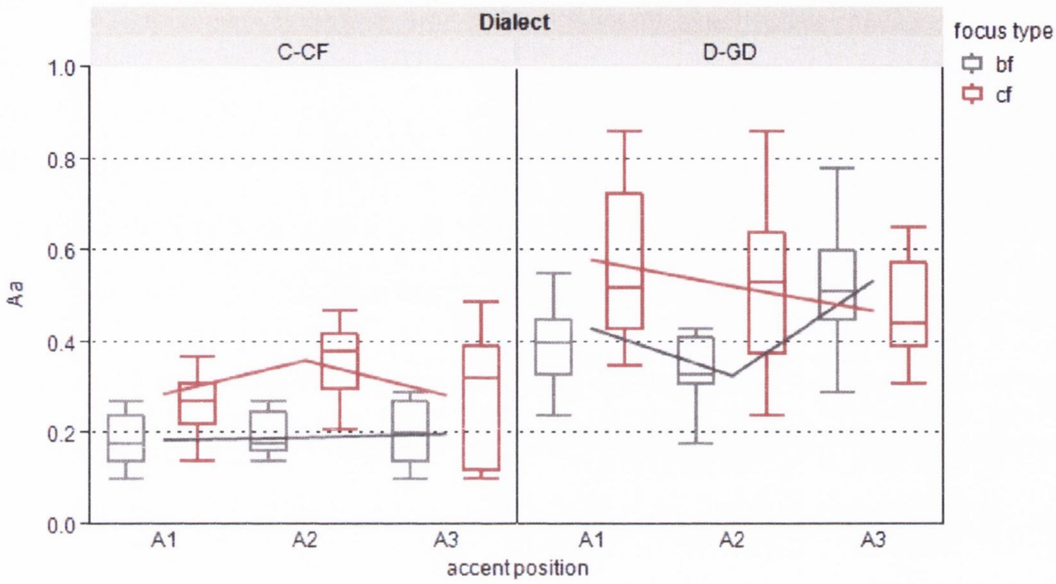

Figure 6.8 Box plots of the Fujisaki model-measured f0 excursion size (Aa) of pitch accents in broad focus (bf = grey) and contrastive focus (cf = red) according to accent position in the IP (A1, A2, A3). Trend lines connect the mean f0 excursion values in broad focus (grey line) and contrastive focus (red line). Only the broad focus trend lines are of interest.

6.7 Register level

Section 6.7 covers the register level results in the focus data for Cois Fharraige and Gaoth Dobhair. The data are scrutinised for the occurrence of a post-focal f0 drop in IP-initial and IP-medial contrastive focus (recall stylised contours in Figure 6.3).

6.7.1 Contour-measured register level

Figure 6.9 presents the contour-measured register level results in the three contrastive focus conditions compared to broad focus. In Cois Fharraige, the pitch floor is lowered in IP-initial and IP-medial contrastive focus (mean values: bf = 2.2 ST, cf1 = 0.9 ST, cf2 = 1.1 ST, cf3 = 1.9 ST). In Gaoth Dobhair, register level is raised in IP-final focus (mean values: bf = 1.3 ST, cf1 = 1.6 ST, cf2 = 2.4 ST, cf3 = 4.1 ST).

A two-way ANOVA of register level (excluding cf2) with factors Dialect and Focus indicates the effect of Focus ($F(2, 14) = 8.70$, $p = .003$) and Dialect*Focus Type ($F(2, 14) = 5.75$, $p = .015$). The post-hoc Tukey HSD test of the interaction reveals that the only significant difference is found in Gaoth Dobhair cf3, where register level is significantly raised compared to broad focus (+2.4 ST, $p < .05$). The examination of speaker means reveals that register level raising was used by all Gaoth Dobhair speakers except one (GD3), while in the Cois Fharraige group lowering occurred in the data of only two speakers (CF3 and CF4).

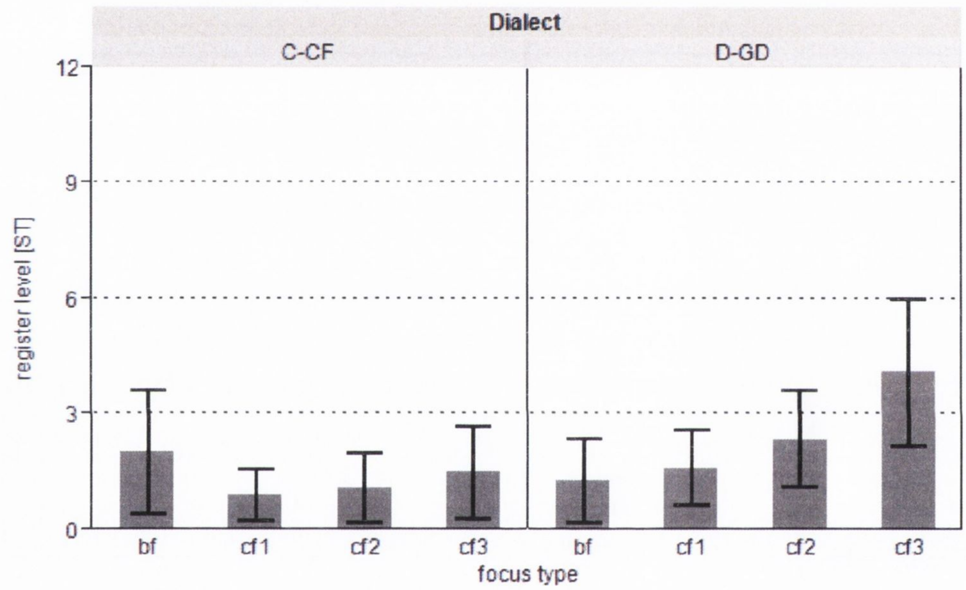

Figure 6.9 Means and standard deviations of contour-measured register level in broad focus (bf) and contrastive focus in three IP positions (cf1, cf2, cf3).

6.7.2 Fujisaki model register level

Figure 6.10 presents the register level results obtained with the base frequency (Fb) of the Fujisaki model for the three contrastive focus conditions compared to broad focus. Note that Fb has been converted to semitones (relative to the speaker baseline) to facilitate its comparison with the contour-measured register level (as described in the methodology, Section 3.5 of Chapter 3).

The base frequency results in Figure 6.10 closely resemble those for the contour-measured register level. This would be expected, since Fb does not depend on the phrase and accent components. The small difference between the base frequency and the contour metric in Cois Fharraige cf2 (Fb = 1.5 ST vs. register level = 1.1 ST) is most likely due to a less reliable f0 trace in the post-focal region due to lower intensity or creak.

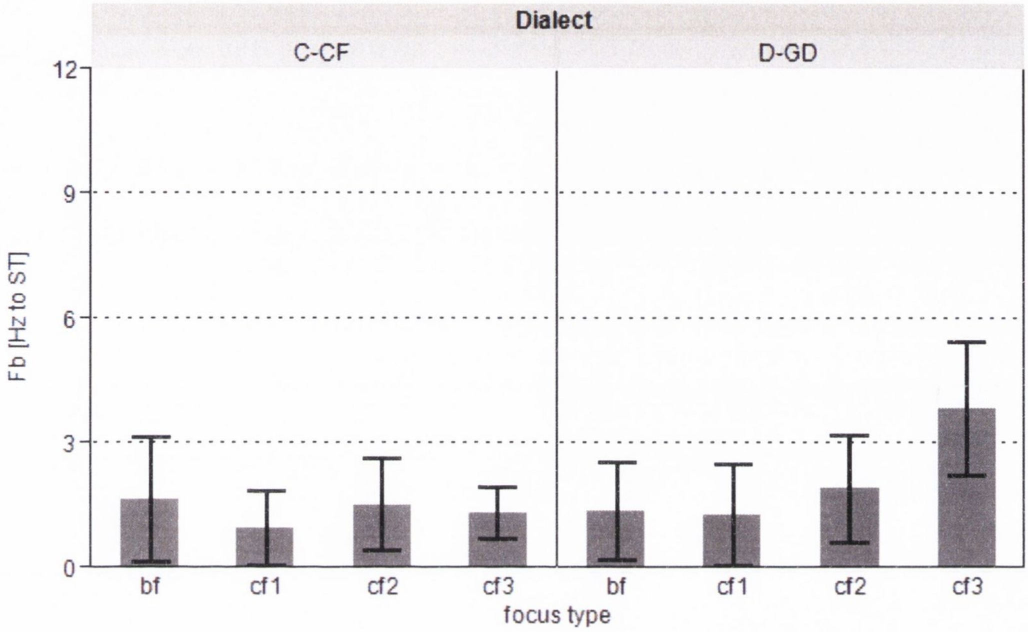

Figure 6.10 Means and standard deviations of the Fujisaki model base frequency (Fb) in broad focus (bf) and contrastive focus in three IP positions (cf1, cf2, cf3).

6.8 Register span

This section covers contour-measured register span in the focus data for Cois Fharraige and Gaoth Dobhair. The interest is in span expansion in non-final contrastive focus, which can be due to raising of the peak and concomitant lowering of register level if such is present (see stylised contours in Figure 6.3).

Figure 6.11 presents the register span results in contrastive focus compared to broad focus. In Cois Fharraige, span expansion is observed in non-final contrastive focus, cf1 and cf2 (mean values: bf = 4.3 ST, cf1 = 7.5 ST, cf2 = 7.1 ST, cf3 = 4.2 ST). In Gaoth Dobhair, however, span is somewhat increased only in IP-initial focus, while it is decreased in IP-medial and IP-final focus (mean values: bf = 10.9 ST, cf1 = 12.2 ST, cf2 = 9.1 ST, cf3 = 7.6 ST).

A two-way ANOVA of register span (excluding cf2) with Dialect and Focus Type as factors reveals the effect of Dialect ($F(1, 7) = 11.56$, $p = .011$) and Focus Type ($F(2, 14) = 14.13$, $p < .001$). The post-hoc Tukey HSD test of Focus Type shows that increased register span differs significantly from broad focus only in cf1 (+1.9 ST, $p < .05$). The effect of Dialect is disregarded here, as Cois Fharraige used a more limited register span compared to Gaoth Dobhair (cf. a similar superficial difference in contour-measured peak scaling in Section 6.6.1).

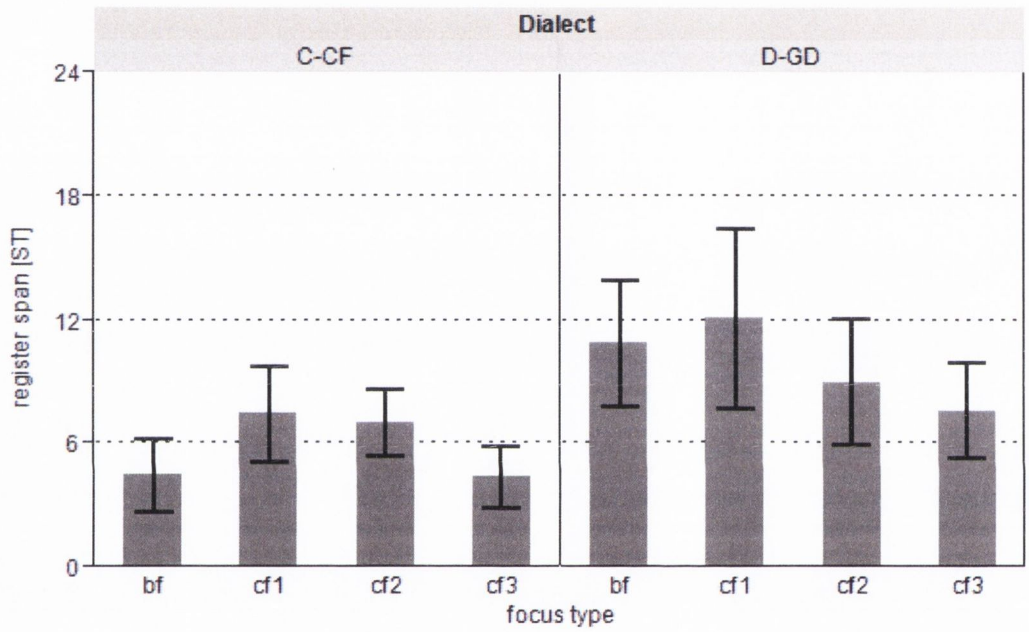

Figure 6.11 Means and standard deviations of contour-measured register span in broad focus (bf) and contrastive focus in three IP positions (cf1, cf2, cf3).

6.9 Accented syllable duration

This section covers the duration results for accented syllables in three IP positions in contrastive focus compared to broad focus. The main point of interest is in the effect of syllable lengthening under contrast.

The results shown in Figure 6.12 imply that the accented syllable undergoes lengthening in non-final contrastive focus in both varieties. The relative expansion of the accented syllable in the Cois Fharraige data amounts to 28 ms in A1 and 30 ms in A2 (means: A1: bf = 256 ms vs. cf = 284 ms; A2: bf = 182 ms vs. cf = 212 ms), and to 19 ms and 23 ms in the Gaoth Dobhair data (means: A1: bf = 286 ms vs. cf = 305 ms; A2: bf = 180 ms vs. cf = 203 ms). In IP-final focus, the difference between broad and contrastive focus is negligible (mean difference in A3: C-CF = 8 ms, D-GD = 4 ms).

A two-way ANOVA with factors Dialect and Focus was carried out on the accented syllable duration as the dependent variable. The tests were conducted separately for the IP-initial (A1) and IP-final (A3) accents. Lengthening of the accented syllable was significant for Focus in A1 ($F(1, 7) = 6.38$, $p = .039$) but not in A3 ($F(1, 7) = 2.70$, n.s.). The post-hoc Tukey HSD test of the significant difference in A1 indicates that the mean relative increase in the accented syllable duration in contrastive focus amounts to +27 ms ($p < .05$).

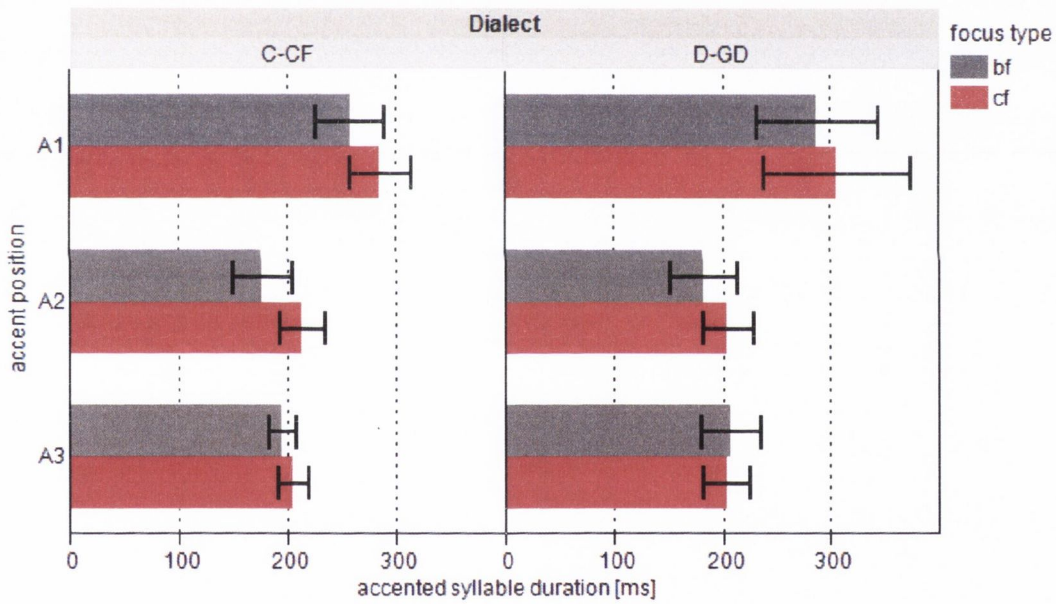

Figure 6.12 Means and standard deviations of the accented syllable duration in broad focus (bf = grey) and contrastive focus (cf = red) according to accent position in the IP (A1, A2, A3).

6.10 Accent group duration

Section 6.10 provides a brief overview of the results for accent group duration in contrastive focus against broad focus in three IP positions.

The results shown in Figure 6.13 mirror those for the accented syllable duration in Figure 6.12. Lengthening in the accent group due to contrastive focus occurs only in non-final IP positions in both varieties. The relative increase in the Cois Fharraige data amounts to 23 ms in A1 and 26 ms in A2 (means: A1: bf = 361 ms vs. cf = 384 ms; A2: bf = 317 ms vs. cf = 343 ms), and to 19 ms in A1 and 34 ms in A2 in the Gaoth Dobhair data (A1: bf = 412 ms vs. cf = 431 ms; A2: bf = 324 ms vs. cf = 358 ms). No difference between broad and contrastive focus is found in the IP-final accent groups (mean difference in A3: C-CF = 1 ms, D-GD = 4 ms).

ANOVA tests of accent group duration with factors Dialect and Focus were carried out for A1 and A3. The results for A1 indicate that the small increase in accent group duration in contrastive focus is negligible, as neither Focus nor the interaction gave significant F statistics (Focus: $F(1, 7) = 3.29$, n.s.; Dialect*Focus: $F(1, 7) = 0.06$, n.s.). The lack of effects in A3 (Focus: $F(1, 7) = 0.55$, n.s.; Dialect*Focus: $F(1, 7) = 0.06$, n.s.) is understandable, as lengthening in the IP-final accent group is not observed (Figure 6.13). The non-significant result in A1 can be explained by the fact that the increase in accent group duration under focus is equal to the amount by which the accented syllable is lengthened (see Section 6.9). In other words, only the accented syllable undergoes elongation, while the following unstressed syllables in the accent group retain their default duration.

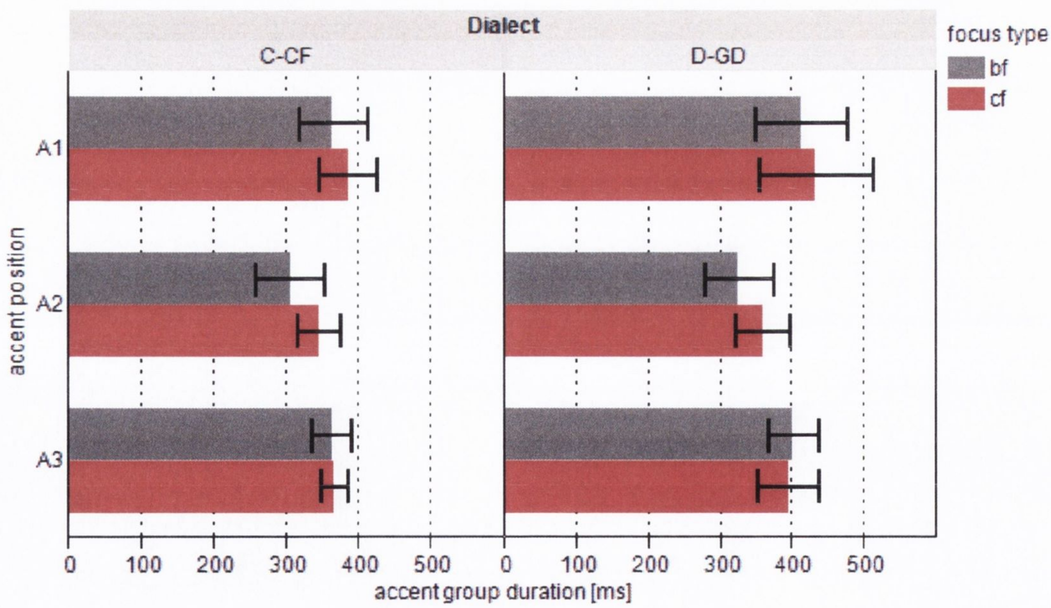

Figure 6.13 Means and standard deviations of the accent group duration in broad focus (bf = grey) and contrastive focus (cf = red) according to accent position in the IP (A1, A2, A3).

6.11 Discussion

Section 6.11 summarises the present findings on focus, compares these results with the findings for the six selected languages presented in Section 6.2.3, and comments on the suitability of the Fujisaki model to characterise broad focus and contrastive focus contours of Cois Fharraige and Gaoth Dobhair Irish.

6.11.1 Summary of present focus results for Irish

The results for focus in Cois Fharraige and Gaoth Dobhair are summarised in Table 6.2. The directionality of each metric is indicated by the projection of the arrow. Upward vertical arrows (↑) indicate an f0 boost or lengthening of a segmental unit. Crosses (x) denote that the f0 metric was not used for conveying contrastive focus, while question marks (?) signal the metrics for which a definitive trend could not be found.

Table 6.2 Summary of the focus results for Cois Fharraige and Gaoth Dobhair. Symbols: (↑) f0 boost, or lengthening, (x) no effect found, (?) effect could not be established based on the available data.

f0 metric	Cois Fharraige	Gaoth Dobhair
Timing of focal H	? ?	? ?
Scaling of focal H	↑cf1 ↑cf2	↑cf1 ↑cf2
Register level	x	↑cf3
Register span	↑cf1	↑cf1
Accented syllable duration	↑cf1 ↑cf2	↑cf1 ↑cf2
Accent group duration	x	x

Examination of Table 6.2 suggests large similarities between the focus strategies used by Cois Fharraige and Gaoth Dobhair speakers. Both varieties use analogous phonetic means to convey contrastive focus in the non IP-final positions (cf1 and cf2). IP-final contrastive focus (cf3), however, appears nearly identical to broad focus in both varieties with one exception (raised register level in Gaoth Dobhair). The seeming difference in peak timing between broad and contrastive focus noted earlier for both varieties (Section 6.5) was caused by the occurrence of two timing patterns in the Cois Fharraige broad focus data, and the Gaoth Dobhair A1 and A2 data in both focus types. As these trends were not regularly observed in sentence mode and alignment data, the findings for timing of the focal H presented here are for the moment treated with caution.

6.11.2 Comparison with findings for other languages

This section briefly compares the present findings on focus for Irish with those in the selected studies covered in Section 6.2.3. An exact metric-for-metric comparison is not possible in most cases, as only two of the six studies analysed focus in all three IP positions, and a different number of metrics was examined in each study. Nevertheless, an attempt is made to note at least some commonly shared features.

With respect to the timing of the focal peak, the two varieties of Irish seem to share the absence of H delay in the IP-final position with American English (Xu & Xu, 2005). The f0 boost of the focal peak in the phrase-initial and medial positions also features in most of the languages, while the absence of the boost IP-finally makes Irish resemble Dutch (Hanssen et al., 2008). Overall, the two varieties of Irish use similar devices to convey contrast in cf1 and cf2, but appear rather resilient to phonetic differentiation in cf3.

6.11.3 Suitability of Fujisaki model for capturing focus data

From the linguistically-motivated point of view, the accent component of the Fujisaki model performed only at an acceptable level in modelling focus data. The timing parameters of the accent component accurately reflected the alignment of the focal peak. Only a minor divergence between the two metrics was found in the A2 and A3 contrastive focus data of Gaoth Dobhair. As the peak in the Gaoth Dobhair focus data was calculated from T1 instead of T2 (based on the close relationship of the L and H tones), it remains to be tested whether T2 would yield an increased precision in capturing its location.

The results for accent scaling expressed as the f0 excursion size turned out to differ from the contour-measured peak scaling. The problem lies in the implied divergence between the two measures. The Fujisaki model is generally suited to capturing the f0 excursion size, but it provides no option for measuring tone scaling independently. In this respect the model is not as flexible as the contour measurements, from which both the accent excursion and peak height are easily available. The focus data again shows that while timing of f0 events is easily interpretable from the Fujisaki model commands, the scaling information is intertwined in the total sum of the phrase and accent components.

Finally, the interpretation of the relationship between consecutive accents in the IP in the Fujisaki model differs from the AM-based account of peak scaling (see Figure 6.14). In the latter approach, a sequence of descending peaks measured as independent scaling of the H tones will also show a descending trend in the f0 values (Figure 6.14b). However, the same sequence measured with the Fujisaki model will show the accent commands to be of the same amplitude (Figure 6.14a) because of the inherent presence of the declination component (for discussion of the representation of H in the AM vs. superpositional models see e.g. Ladd, 1984; Nolan, 1995). The exact accent command amplitude will depend on the absolute height of the peaks, as well as the scaling of the troughs which outline the course of Ap. The AM-modelled peaks and the Fujisaki model accent commands are identical only when Ap is equal to zero. The steeper Ap gets, the more the consecutive accent commands even out or grow in Aa along the phrase. Thus, one may conclude that because of its superpositional nature, the model makes it more difficult to interpret the f0 dynamics between consecutive accents in a phrase.

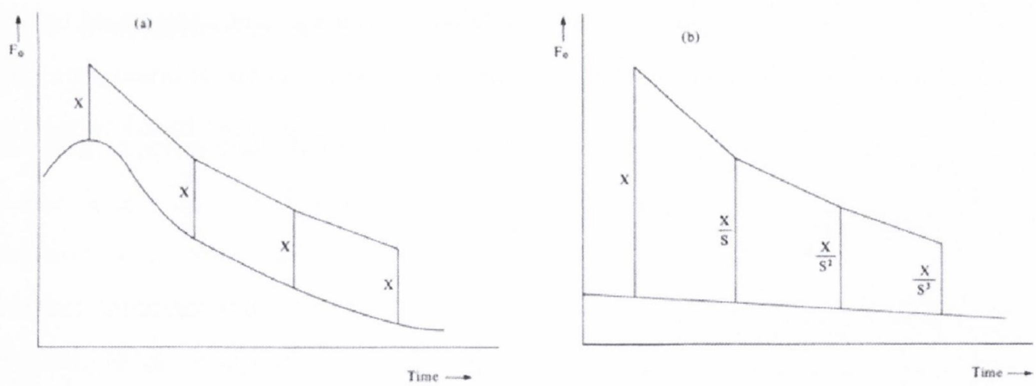

Figure 6.14 Decay of the f0 topline (H peaks) in the Fujisaki model (a) and in Pierrehumbert's model (b) (from Ladd, 1984).

6.12 Summary

Chapter 6 examined how focus is realised in Connemara and Donegal Irish. The tune level results showed that Cois Fharraige and Gaoth Dobhair typically use the default H*+L and L*+H accents in broad and contrastive focus; no special accent type for marking focus was encountered. Post-focal deaccentuation appeared to be the norm in all three varieties. Stylised f0 contours indicated that aside from the structural (H*+L vs. L*+H) difference, Cois Fharraige and Gaoth Dobhair actually use overwhelmingly similar means to convey contrastive focus. Inis Mór was excluded from further phonetic measurements, as no variety-specific trend could be found in broad or contrastive focus.

The timing results indicated the need for more work to establish whether early peaks in broad focus falls (Cois Fharraige) and IP-initial rises (Gaoth Dobhair) are generally used. Both varieties actively used peak raising and lengthening of the accented syllable in the IP-initial and IP-medial focus. Interestingly, Cois Fharraige and Gaoth Dobhair appeared resilient to the use of any marking of focus in the IP-final position.

The Fujisaki model was shown to work well for peak timing. The f0 excursion size of the accent command amplitude (Aa), however, was shown to differ from the contour-measured peak scaling due to the inherent dependence of the accent component on the phrase component. Also, the relationship between consecutive accents in broad focus IPs expressed through Aa was shown to differ from the conceptually AM-based sequential peak scaling.

Chapter 7

Summary and conclusions

This chapter summarises the findings on the intonation of Cois Fharraige, Inis Mór and Gaoth Dobhair with respect to three topics (sentence mode, tonal alignment and focus). The two chief research questions are revisited in the light of the results obtained in this work. Consideration is given to the possible limitations which may have prevented a clear-cut answer to those questions. Finally, directions for future research are outlined.

7.1 Main findings on the intonation of Connemara and Donegal Irish

The experimental part of this dissertation covered the two-level analysis of the melodic contours of two dialects of Irish: two varieties of Connemara (Cois Fharraige and Inis Mór) and one of Donegal (Gaoth Dobhair) Irish. The main findings obtained from the three experiments are summarised below.

7.1.1 Intonation of sentence mode

The first experimental chapter, Chapter 4, investigated the effect of sentence mode and phrase length on the f0 contours in Connemara and Donegal Irish. Wh- and yes-no questions were compared to structurally matched neutral declaratives in order to examine whether interrogativity affects the intonation of the two dialects at the tonal level, the phonetic level, or at both levels. The qualitative results showed that Cois Fharraige and Inis Mór chiefly used the declarative falling (H*+L H*+L%) tune in both question types. Gaoth Dobhair, on the other hand, modified the declarative rising (L*+H L*+H%) pattern in both question types, with wh- questions typically involving an IP-initial H* accent on the question word, and yes-no questions frequently featuring a high final boundary (L*+HH%). Changes at the local (peak height, IP onset) and global (register level and span, declination slopes) levels were observed in both Connemara and Donegal, but the latter made use of all the f0 metrics examined to mark one or both question types. Cois Fharraige and Inis Mór did not show such heavy reliance on the f0 metrics, whose use was mostly limited to the prenuclear region, and were found to behave similarly with regard to the encoding of sentence mode through intonation.

7.1.2 Elbow alignment and f0 excursion size of pitch accents

In Chapter 5 the phonetic realisation of the main accent categories under a varying rhythmic context (tail and anacrusis) in each dialect was scrutinised. The leading accent types (H*+L in Connemara and L*+H in Donegal) were looked at mainly with regard to the timing of the f0 inflection (i.e. the H and L elbows) in these two pitch accents. F0 excursion size was examined for the possible effect of truncation in monosyllabic IP-final accents (i.e. in the absence of tail). Additionally, f0 movement duration (the time distance between the H and L inflections) was looked at in the context of the Fujisaki model accent component.

With respect to elbow timing, some cross-dialect (Connemara vs. Donegal), but no within-dialect (Cois Fharraige vs. Inis Mór) differences were found. Cois Fharraige and Inis Mór exhibited two patterns in the nuclear position which depended on the preceding accent type: early falls were found in the linked (H* H*+L%) contour, and medial falls in the two-peaked (H*+L H*+L%) contour; only the latter were sensitive to tail length. Anacrusis did not affect the alignment of the H elbow in either of the two Connemara varieties. Gaoth Dobhair, on the other hand, responded to both rhythmic contexts (tail and anacrusis) with a leftward shift of the L elbow, but the preceding accent type had no effect. With respect to scaling, truncation of the nuclear accent was observed only in one context (Cois Fharraige falls in the two-peaked contour in the absence of tail syllables).

7.1.3 Intonation of syntactically unmarked contrastive focus

Chapter 6 examined the production of intonation-only contrastive focus (i.e. without syntactic or morphological marking) in declaratives in the three varieties of Irish. Contrastive focus was tested in three IP positions (initial, medial and final). Cois Fharraige and Gaoth Dobhair typically used the standard H*+L and L*+H accents in broad and contrastive focus, i.e. no special accent type was used for contrast. Post-focal deaccentuation occurred in all three varieties. Inis Mór was excluded from further discussion due to the high variability in tune type observed in the broad and contrastive focus data.

The quantitative results showed that aside from the tune level (H*+L vs. L*+H) difference, Cois Fharraige and Gaoth Dobhair employed similar devices in the production of contrastive focus. Raising of the focal peak and lengthening of the syllable under focus were found in the IP-initial and IP-medial position, while hardly any f0 or durational effects were observed in the IP-final position.

7.2 Addressing the two research questions

This work aimed at (1) describing the melodic features of the three varieties of Irish to find the cross-dialect and within-dialect differences, and (2) designing an IViE-constrained application of the Fujisaki model for Irish, as well as assessing the model for its usefulness as an analytical tool in quantifying the intonation contours of Connemara and Donegal. Each of these aims is addressed below.

7.2.1 Cross-dialect and cross-variety intonational variation

From the cross-dialect perspective, this work confirms the north vs. south intonational divide in Irish and shows that the differences are not limited to the phonological level. The tune results confirm that Connemara and Donegal contrast in terms of their tonal grammar, while the quantitative results indicate that these differences are further enhanced by concomitant phonetic effects in the melodic contour.

The possible micro-level intonational variation in Connemara Irish was investigated, but was not found. The results showed that under the same tonal specification the two varieties use similar phonetic devices. Firstly, Cois Fharraige and Inis Mór do not differ in terms of alignment. Secondly, they use largely the same strategy in the production of statements and questions. The one possible difference is related to the tonal level: the Inis Mór speakers generally used a wider variety of tunes than the Cois Fharraige speakers.

7.2.2 Use of the Fujisaki model in a linguistically-motivated description of Irish

The Fujisaki model was applied to the two dialects of Irish in a linguistically-motivated manner. The number of accent commands was matched to the actual number of pitch accents in the phrase, while phrase commands were used to model the course of baseline declination. Timing of the accent commands was set to the onsets of falling and rising f0 movements in a way that also captured the shape of the f0 movement as accurately as possible. Additional remedy settings were imposed on specified contour types to improve the match or the interpretability of the model parameters.

With respect to its practical use for synthesis purposes, the Fujisaki model is perfectly applicable to Irish. The model yielded satisfactory fits to the original f0 contours for a large proportion of the Connemara and Donegal data. Despite the initial difficulty caused by the avoidance of negative accent commands, once an IP-final negative command was allowed, Gaoth Dobhair was found to be the most model-friendly variety among the three. This is likely due to the northern variety having a more compact tonal grammar and a closer timing relationship between the L and H targets than Cois Fharraige and Inis Mór.

Unfortunately, the Fujisaki model did not prove to be an equally promising analytical tool for quantifying the intonation of Irish in a linguistically meaningful way. The timing parameters of the model are mostly accurate and easily translate into the peak/elbow location. The frequency measurements of tonal scaling and declination, however, are obscured in that one depends on the other, and are not easy to interpret. The model cannot measure independent peak height, only the f0 excursion of an accent. The phrase component broadly corresponds to baseline declination, which in itself may be a problematic point of reference, as the determining L tones can be scarce and variable in terms of scaling.

Summing up, the Fujisaki model would be best suited for synthesis, where it generally performs well. The model can only approximate what it was designed for: a broadly defined declination slope and the excursion size of pitch accents. For such a compact model, it does quite a lot. The question of whether the L tones are the best place to peg the declination line remains a separate theoretical and experimental matter.

7.3 Limitations of the study and future directions

A number of limitations of the present work indicate the potential avenues for future research. First of all, this study has shown that involving a small homogenous group of speakers does not guarantee that one 'default' tune will be produced, and data loss due to exclusions is problematic. Inis Mór showed notably more tune variation than Cois Fharraige and Gaoth Dobhair. Secondly, native speakers of Irish seem to favour certain contours which may not be used much by other speakers of the same variety. A more in-depth study with a substantial number of informants would be required to test this conjecture. Extending the research on the prosody of the Aran Islands to Inis Meáin appears a promising subject of study. Also, speech materials can be extended to semi-controlled and spontaneous data which native speakers of Irish are quite enthusiastic about.

In terms of the experiments, the results for sentence mode largely answered the postulated questions, but the alignment and focus studies require follow-up work. The next step for alignment would be to examine the effect of the right-hand context (the number of post-accentual syllables) on prenuclear accents. The focus experiment only scratched the surface of what is known about its prosodic expression in Irish. Clearly, work is required on the role of intonation in the presence of morphological/syntactic focus markers.

Finally, the Fujisaki model could be applied as a synthesis tool for the intonation of Irish. The application would require a more varied type of data on which the model can be trained and tested (e.g. Möbius, 1993; Mixdorff, 1998). Alternatively, another intonation model such as the PENTA (Parallel ENcoding and Target Approximation) model (Xu, 2005) could be successfully used.

Appendix

Recording materials

Corpus I Sentence mode

Connemara Irish: Sentence mode, subset A (‘margadh’)

- Céard as ar tháinig an bia ar fad?
Where did all the food come from?

- Bhí	**Cian**	**ag**	**an**	**margadh.**
Was	Cian	at	the	market.

Cian was at the market.

- Ó - tá’n oiread sin bia sa gcuisneoir.
Oh - there’s so much food in the fridge.

- ‘Raibh	**Cian**	**ag**	**an**	**margadh?**
Was	Cian	at	the	market?

Was Cian at the market?

- Ní raibh greim le n-ithe sa teach.
There wasn’t a bite to eat in the house.

- Is	**cé**	**‘bhí**	**ag**	**an**	**margadh?**
And	who	was	at	the	market?

And who was at the market?

- ‘Bhfuil na comharsana ar ais ón Spáinn go fóill?
Are the neighbours back from Spain yet?
- Tá.
Yes.
- Cén chaoi a bhfuil a fhios agat é sin?
How do you know that?

- Bhí	**Cian**	**ag caint**	**leo**	**sa**	**margadh.**
Was	Cian	talking	with them	in the	market.

Cian was talking to them in the market.

- Aon scéal ag Neansaí?
Does Neansaí have any news?
- Ní fhaca mé le fada í.
I haven’t seen her in a long time.

- ‘Raibh	**Cian**	**ag caint**	**léi**	**sa**	**margadh?**
Was	Cian	talking	with her	in the	market?

Was Cian talking to her in the market?

- Ghlaoigh na cailíní. Tá siad críochnaithe leis an siopadóireacht.
The girls called. They are finished with the shopping.

- Is	**cé**	**bheas**	**á**	**mbailiú**	**ón**	**margadh?**
And	who	will	them	collect	from the	market?

And who will collect them from the market?

Connemara Irish: Sentence mode, subset B ('Dónall')

- Céard a rinne tú inné?
  What did you do yesterday?

- Bhuail	**mé**	**le**	**Dónall.**
Met	I	with	Dónall.

I met Dónall.

- Cá raibh tú aréir?
  Where were you last night?
- Thíos, tigh Mháirtín.
  Down at Máirtín's house.

- Ach	**ar**	**bhuail**	**tú**	**le**	**Dónall?**
But	did	meet	you	with	Dónall?

But did you meet Dónall?

- Bhí Donncha ag an gcóisir le Caitlín.
  Donncha was at the party with Caitlín.

- Is	**cé**	**'bhí**	**le**	**Dónall?**
And	who	was	with	Dónall?

And who was with Dónall?

- Céard a rinne tú i ndiaidh an Aifrinn?
  What did you do after Mass?

- Bhuail	**mé**	**le**	**Gráinne**	**sa**	**mbialann.**
Met	I	with	Gráinne	in the	restaurant.

I met Gráinne in the restaurant.

- Bhí mé i gCill Rónáin ar maidin.
  I was in Cill Rónáin this morning.

- Ach	**ar**	**bhuail**	**tú**	**le**	**Gráinne**	**sa**	**mbialann?**
But	did	meet	you	with	Gráinne	in the	restaurant?

But did you meet Gráinne in the restaurant?

- Bhí muid ag an disco aréir. Bhí Ruairí in éineacht le Caitlín.
  We were at the disco last night. Ruairí was with Caitlín.

- Is	**cé**	**'bhí**	**ag damhsa**	**le**	**Nuala?**
And	who	was	dancing	with	Nuala?

And who was dancing with Nuala?

Donegal Irish: Sentence mode, subset A (‘margadh’)

- Cad as ar tháinig an bia uilig?
Where did all the food come from?

- Bhí	**Cian**	**ag**	**an**	**margadh.**
Was	Cian	at	the	market.

Cian was at the market.

- Ó - tá cuid mhór bia sa chuisneoir.
Oh - there is a lot of food in the fridge.

- ‘Raibh	**Cian**	**ag**	**an**	**margadh?**
Was	Cian	at	the	market?

Was Cian at the market?

- Ní raibh greim le h-ithe sa teach.
There wasn’t a bite to eat in the house.

- Is	**cé**	**‘bhí**	**ag**	**an**	**margadh?**
And	who	was	at	the	market?

And who was at the market?

- Ar fhill na comharsana ón Spáinn go fóill?
Did the neighbours return from Spain yet?
- D'fhill.
They did.
- Caidé mar atá a fhios agat fa sin?
How do you know that?

- Bhí	**Cian**	**ag caint**	**leo**	**sa**	**mhargadh.**
Was	Cian	talking	with them	in the	market.

Cian was talking to them in the market.

- Caidé mar atá Neansaí?
How is Neansaí?
- Ní fhaca mé le fada í.
I haven’t seen her in a long time.

- ‘Raibh	**Cian**	**ag caint**	**léi**	**sa**	**mhargadh?**
Was	Cian	talking	with her	in the	market?

Was Cian talking to her in the market?

- Cuir scairt ar na cailíní. Tá siad críochnaithe leis an siopadóireacht.
Call the girls. They are finished with the shopping.

- Is	**cé**	**bheas**	**á**	**mbailiú**	**ón**	**margadh?**
And	who	will	them	collect	from the	market?

And who will collect them from the market?

Donegal Irish: Sentence mode, subset B ('Dónall')

- Caidé a rinne tú inné?
  What did you do yesterday?

- Bhuail	**mé**	**le**	**Dónall.**
Met	I	with	Dónall.

I met Dónall.

- Cá raibh tú aréir?
  Where were you last night?
- Thíos, tigh Mháirtín.
  Down at Máirtín's house.

- Ach	**ar**	**bhuail**	**tú**	**le**	**Dónall?**
But	did	meet	you	with	Dónall?

But did you meet Dónall?

- Bhí Donncha ag an chóisir le Caitlín.
  Donncha was at the party with Caitlín.

- Is	**cé**	**'bhí**	**le**	**Dónall?**
And	who	was	with	Dónall?

And who was with Dónall?

- Caidé a rinne tú i ndiaidh an Aifrinn?
  What did you do after Mass?

- Bhuail	**mé**	**le**	**Gráinne**	**sa**	**bhialann.**
Met	I	with	Gráinne	in the	restaurant.

I met with Gráinne in the restaurant.

- Bhí mé i gCill Rónáin ar maidin.
  I was in Cill Rónáin this morning.

- Ach	**ar**	**bhuail**	**tú**	**le**	**Gráinne**	**sa**	**bhialann?**
But	did	meet	you	with	Gráinne	in the	restaurant?

But did you meet Gráinne in the restaurant?

- Bhí muid ag an disco aréir. Bhí Ruairí i gcuideachta Chaitlín.
  We were at the disco last night. Ruairí was in the company of Caitlín.

- Is	**cé**	**'bhí**	**ag damhsa**	**le**	**Nuala?**
And	who	was	dancing	with	Nuala?

And who was dancing with Nuala?

Corpus II Alignment

Connemara Irish: Nuclear alignment (Tail)

- Ar thug tú síob do Chian aréir?
Did you give Cian a lift last night?

- Níor thug.	**Bhí**	**an**	**carr**	**seo**	**lán.**	
	Was	the	car	this	full.	
No.	*This car was full.*					

- An bhfuil aon uisce sa mbaile?
Is there any water at home?

- Tá.	**Tá**	**an**	**citeal**	**lán**	**a'm.**
	Is	the	kettle	full	at me.
Yes.	*I have the kettle filled.*				

- An bhfuil aon uisce sa mbaile?
Is there any water at home?

- Tá.	**Tá**	**an**	**citeal**	**lán**	**aici.**
	Is	the	kettle	full	at her.
Yes.	*She has the kettle filled.*				

Connemara Irish: Prenuclear alignment (Anacrusis)

- Cén chaoi a raibh an dioscó?
How was the disco?

-	**Lán**	**go dtí**	**'n**	**doras.**
	Full	to	the	door.
	Full to the door.			

- Cé nár thaitin an cóisir leo?
Who didn't enjoy the party?

-	**A lán**	**de**	**na**	**seandaoine.**
	Many	of	the	old people.
	A lot of the older people.			

- An raibh fadhbanna leis na mic léinn aréir?
Were there problems with the students last night?

- Bhí	**a lán**	**acu**	**ar meisce.**
Was	many	of them	drunk.
Many of them were drunk.			

Donegal Irish: Nuclear alignment (Tail)

- D'tig leat an leabhar seo a thógáil?
  Could you carry this book?

- Tá brón orm.	**Tá**	**mo**	**mhála**	**lán.**	
	Is	my	bag	full.	
Sorry.	*My bag is full.*				

- An bhfuil uisce ar bith fágtha sa bhaile?
  Is there any water left at home?

- Tá.	**Tá**	**an**	**citeal**	**lán**	**de.**
	Is	the	kettle	full	of it.
Yes.	*The kettle is full of it.*				

- An bhfuil aon uisce sa bhaile?
  Is there any water at home?

- Tá.	**Tá**	**an**	**citeal**	**lán**	**aici.**
	Is	the	kettle	full	at her.
Yes.	*She has the kettle filled.*				

Donegal Irish: Prenuclear alignment (Anacrusis)

- Caidé mar a bhí an dioscó?
  How was the disco?

-	**Lán**	**go dtí**	**'n**	**doras.**
	Full	to	the	door.
	Full to the door.			

- Cé nár thaitin an cóisir leo?
  Who didn't enjoy the party?

-	**A lán**	**de**	**na**	**seandaoine.**
	Many	of	the	old people.
	A lot of the older people.			

- An raibh trioblóid leis na mic léinn aréir?
  Were there problems with the students last night?

- Bhí	**a lán**	**acu**	**ag ól.**
Was	many	of them	drinking.
Many of them were drinking.			

Corpus III Focus

Connemara Irish: Focus, subset A (Broad and contrastive/narrow focus)

Bhí gach rud ciúin sa teach. Bhí an clog ar an mballa ag déanamh 'tic-toc'.
Everything was quiet in the house. The clock on the wall was going 'tick-tock'.

Bhí	**Méabh**	**ina**	**luí**	**ar**	**an**	**leaba.**
Was	Méabh	in her	lying	on	the	bed.

Méabh was lying on the bed.
Bhí sí díreach ag titim ina codladh, nuair a tháinig cnag ar an doras.
She was just falling asleep, when there was a knock on the door.

- An raibh Bríd ina luí ar an leaba?
Was Bríd lying on the bed?

- Ní raibh.	**Bhí**	**Méabh**	**ina**	**luí**	**ar**	**an**	**leaba.**
	Was	Méabh	in her	lying	on	the	bed.
No.	*Méabh was lying on the bed.*						

- An raibh Méabh ina seasamh ar an leaba?
Was Méabh standing on the bed?

- Ní raibh.	**Bhí**	**Méabh**	**ina**	**luí**	**ar**	**an**	**leaba.**
	Was	Méabh	in her	lying	on	the	bed.
No.	*Méabh was lying on the bed.*						

- An raibh Méabh ina luí ar an urlár?
Was Méabh lying on the floor?

- Ní raibh.	**Bhí**	**Méabh**	**ina**	**luí**	**ar**	**an**	**leaba.**
	Was	Méabh	in her	lying	on	the	bed.
No.	*Méabh was lying on the bed.*						

- Cé a bhí ina luí ar an leaba?
Who was lying on the bed?

- Bhí	**Méabh**	**ina**	**luí**	**ar**	**an**	**leaba.**
Was	Méabh	in her	lying	on	the	bed.

Méabh was lying on the bed.

- Cá raibh Méabh ina luí?
Where was Méabh lying?

- Bhí	**Méabh**	**ina**	**luí**	**ar**	**an**	**leaba.**
Was	Méabh	in her	lying	on	the	bed.

Méabh was lying on the bed.

Connemara Irish: Focus, subset B (Neutral and emphatic focus)

- Bhí mise 'mo shuí sa chistin. Cá raibh tusa?
I was sitting in the kitchen. Where were you?

- Bhí	**mise**	**'mo**	**luí**	**ar**	**an**	**leaba.**
Was	I	in my	lying	on	the	bed.

I was lying on the bed.

- Bhí Eilín ina luí ar an leaba, ach ní raibh tusa!
Eilín was lying on the bed, but you weren't!

- Bhí	**mé**	**'mo**	**luí**	**ar**	**an**	**leaba!**
Was	I	in my	lying	on	the	bed!

I was so lying on the bed!

Oíche Dé Sathairn tá na deágoirí uilig ag dul amach. Tá Neasa ag dul ag a' damhsa. Seo comhrá idir Neasa (N) is a máthair (M).
Saturday night the teenagers are all going out. Neasa is going to the dance. This is a conversation between Neasa (N) and her mother (M).

M: - Tá mise 'dul ag a' mbingo. Cén fáth a bhfuil na sáltaí árda sin ort?
I'm going to the bingo. Why are you wearing those high heels?

N: -	**Tá**	**mé**	**'dul**	**ag**	**a'**	**damhsa.**
	Am	*I*	*going*	*to*	*the*	*dance.*

I'm going to the dance.

M: - Níl tú!
You are not!

N: -	**Tá**	**mé**	**'dul**	**ag**	**a'**	**damhsa!**
	Am	*I*	*going*	*at*	*the*	*dance!*

I am so going to the dance!

M: - Tá tú in ainm 's a bheith ag tabhairt aire do Mhamó.
You are supposed to be looking after Grandma.

N: - Tá tusa ag ramhailligh!
You are rambling!

Donegal Irish: Focus, subset A (Broad and contrastive/narrow focus)

Bhí gach rud ciúin sa teach. Bhí an clog ar an bhalla ag deanamh 'tic-toc'.
Everything was quiet in the house. The clock on the wall was going 'tick-tock'.

Bhí	**Méabh**	**ina**	**luí**	**ar**	**an**	**leabaidh.**
Was	Méabh	in her	lying	on	the	bed.

Méabh was lying on the bed.
Bhí sí díreach ag titim a chodladh nuair a tháinig cnag ar an doras.
She was just falling asleep, when there was a knock on the door.

- An raibh Bríd ina luí ar an leabaidh?
Was Bríd lying on the bed?

- Ní raibh.	**Bhí**	**Méabh**	**ina**	**luí**	**ar**	**an**	**leabaidh.**
	Was	Méabh	in her	lying	on	the	bed.
No.	*Méabh was lying on the bed.*						

- An raibh Méabh ina seasamh ar an leabaidh?
Was Méabh standing on the bed?

- Ní raibh.	**Bhí**	**Méabh**	**ina**	**luí**	**ar**	**an**	**leabaidh.**
	Was	Méabh	in her	lying	on	the	bed.
No.	*Méabh was lying on the bed.*						

- An raibh Méabh ina luí ar an urlár?
Was Méabh lying on the floor?

- Ní raibh.	**Bhí**	**Méabh**	**ina**	**luí**	**ar**	**an**	**leabaidh.**
	Was	Méabh	in her	lying	on	the	bed.
No.	*Méabh was lying on the bed.*						

- Cé a bhí ina luí ar an leabaidh?
Who was lying on the bed?

- Bhí	**Méabh**	**ina**	**luí**	**ar**	**an**	**leabaidh.**
Was	Méabh	in her	lying	on	the	bed.

Méabh was lying on the bed.

- Cá raibh Méabh ina luí?
Where was Méabh lying?

- Bhí	**Méabh**	**ina**	**luí**	**ar**	**an**	**leabaidh.**
Was	Méabh	in her	lying	on	the	bed.

Méabh was lying on the bed.

Donegal Irish: Focus, subset B (Neutral and emphatic focus)

- Bhí mise 'mo shuí sa chistin. Cá raibh tusa?
I was sitting in the kitchen. Where were you?

- Bhí	**mise**	**'mo**	**luí**	**ar**	**an**	**leabaidh.**
Was	I	in my	lying	on	the	bed.

I was lying on the bed.

- Bhí Eilín ina luí ar an leaba, ach ní raibh tusa!
Eilín was lying on the bed, but you weren't!

- Bhí	**mé**	**'mo**	**luí**	**ar**	**an**	**leabaidh!**
Was	I	in my	lying	on	the	bed!

I was so lying on the bed!

Oíche Dé Sathairn tá na deágoirí uilig ag dul amach. Tá Neasa ag dul ag a' damhsa. Seo comhrá idir Neasa (N) is a máthair (M).
Saturday night the teenagers are all going out. Neasa is going to the dance. This is a conversation between Neasa (N) and her mother (M).

M: - Tá mise a 'dul go dtí'n bingo. Cad chuige a bhfuil na sálaí árda sin ort?
I'm going to the bingo. Why are you wearing those high heels?

N: -	**Tá**	**mé a**	**'dul**	**ag**	**a'**	**damhsa.**
	Am	*I*	*going*	*to*	*the*	*dance.*

I'm going to the dance.

M: - Níl tú!
You're not!

N: -	**Tá**	**mé a**	**'dul**	**ag**	**a'**	**damhsa!**
	Am	*I*	*going*	*to*	*the*	*dance!*

I am so going to the dance!

M: - Tá tú in ainm 's a bheith ag tabhairt aire do do Mháthair Mór.
You are supposed to be looking after your Grandmother.

N: - Tá tú ag ramhailltigh!
You are rambling!

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