

# Variation Adds to Prosodic Typology

Esther Grabe

Phonetics Laboratory, University of Oxford

esther.grabe@phonetics.oxford.ac.uk

## Abstract

Variation has not been a major concern of prosodic typologists. Frequently, it is treated as noise in the data and held to conceal what is really important about the prosodic structure of the language. Consequently, most investigations are restricted to a single standard variety and cross-speaker variation is ignored or masked by statistical processing. The results are often assumed to be representative of the language as a whole. Recent research challenges this approach. Acoustic correlates of rhythm class, for instance, show that dialects of one language can differ as much in their rhythmic structures as two different languages. One dialect can be classified as ‘stress-timed’ and the other as ‘syllable-timed’. Furthermore, considerable cross-speaker variation occurs within dialects.

In this paper, I review a selection of data on prosodic variation across dialects and speakers. Then I present data on intonational variation. Examination of cross-speaker and cross-dialect variation in these data leads to new results on dialect-specific characteristics of intonation as well as to cross-dialect and cross-language generalisations.

## 1. Introduction

Research on prosodic typology has become increasingly popular. In this paper, I suggest that the empirical basis of prosodic typology should include data on cross-dialectal and cross-speaker variation. In a recent volume on urban dialects in the British Isles, Foulkes and Docherty summarise the motivation for a closer look at variation [1:21]:

‘The failure to address the fundamental fact of variability in speech may hinder progress in phonology. Phonological knowledge must enable listeners to cope with variability in the speech of others, and (arguably) plays a part in producing variable phonetic output on the part of the speaker. Understanding the nature and role of variability would therefore appear to be a highly productive route towards constructing an adequate model of phonological knowledge’.

Work on prosodic variation has been carried out, but not in a standard sociolinguistic framework, and most investigations have not systematically examined cross-dialectal and cross-speaker variation. Previous studies have concerned the effect on prosody of speaking style [2-6] and on speech rate [7,8]. The alignment of  $f_0$  peaks and troughs in different utterance positions has also received attention [9-13], as has the effect on  $f_0$  of segmental structure [14] and of segmental and prosodic structure in combination [15-19]. Only three of these studies, however, considered dialect [15,18,19]. None investigated cross-speaker variation in any detail.

Numerous studies [e.g. 20-32] have concerned the prosodic structure of selected dialects. Only a few studies, however, [18, 33-36, 40] have concerned several dialects, multiple speakers, or more than one speaking style. Recently, the transcription of intonation across dialects of one language has been considered [37-39]. Two studies have focused on

cross-speaker variation [36,41] and recently, cross-gender variation has received some attention [42-46].

In the following section, I will first briefly review the evidence for cross-dialect and cross-speaker variation in the rhythmic structure of speech. Then the core of this paper will show how data on cross-dialect and cross-speaker variation in different utterance types in English can advance intonational typology.

## 2. Variation and Rhythmic Typology

Empirical research on rhythmic typology has a long tradition [cf. 47,48]. Recently, this research has received a new impetus. Statistical methods for the rhythmic classification of languages have been developed. The results have provided some support for phoneticians’ classifications of languages as stress-timed or syllable-timed [47-57]. Unambiguous vindication of a categorical distinction between stress- and syllable-timed languages, however, has not emerged. Figure 1 illustrates this point. It shows a rhythmic classification of 18 languages using the Pairwise Variability Index (PVI) [47,56]. The PVI differs from the measures for rhythm proposed by Ramus, Mehler and Nespor [48] in that it is sequential; the PVI expresses the level of variability in successive vocalic and intervocalic intervals. It also incorporates a normalisation component for speaking rate. In Figure 1, variability in vocalic and intervocalic intervals are represented on the y-axis and the x-axis, respectively.

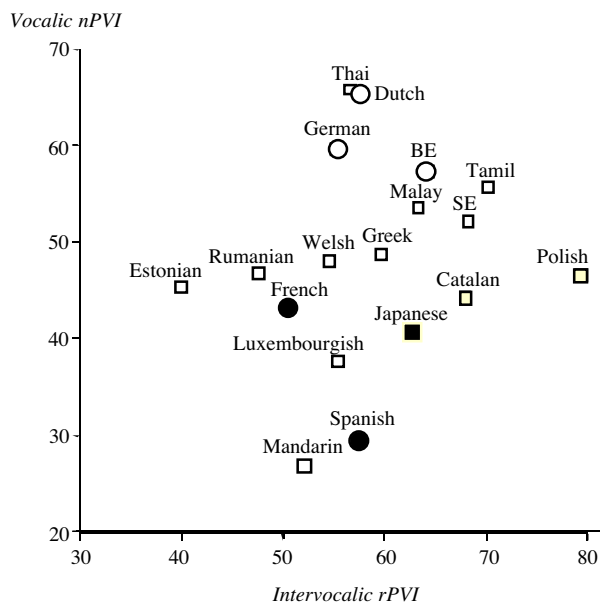


Figure 1. PVI rhythmic space for 18 languages. One speaker per language. 7 speakers from Spanish and French.. BE= British English, SE= Singapore English.

Figure 1 shows that the *PVI* discriminates between languages traditionally classified as stress-timed or syllable-timed. Dutch, German and British English (stress-timed) exhibit high vocalic variability and are well separated from French and Spanish (syllable-timed) where successive vowel durations are more similar. But the *PVI* does not separate the 18 languages into a stress-timed and a syllable-timed group. Instead, a continuum of more or less ‘stress-timed’ or ‘syllable-timed’ languages emerges.

One could argue that another acoustic measure of rhythm might provide a more convincing separation of the languages shown in Figure 1. However, all studies of ‘languages’ that are limited to a single standard variety ignore a potentially important confounding factor. Dialect differences in rhythmic classification have been reported e.g. for Italian, for Arabic and for English. Italian like French has been classified as syllable-timed, but southern varieties are said to tend towards stress-timing [38]. One classification method [48] revealed significant differences between dialects of Arabic [40]. British English is said to be stress-timed, but Singapore English is said to be syllable-timed [56], a claim supported by acoustic evidence. PVI values differ significantly between the two dialects [54,56].

An effect of speaker on rhythmic units based on duration was observed by [52]. The authors investigated a number of languages. Variation in PVI values from Castilian Spanish is illustrated in Figure 2. Anders Eriksson (Department of Linguistics, University of Stockholm) provided the data. In Figure 2, PVI values from seven speakers of Spanish have been added to the data in Figure 1. The new points were calculated from recordings directly comparable with those on which Figure 1 is based. The figure shows that the differences between individual Spanish speakers are at least as great as the differences between some languages.

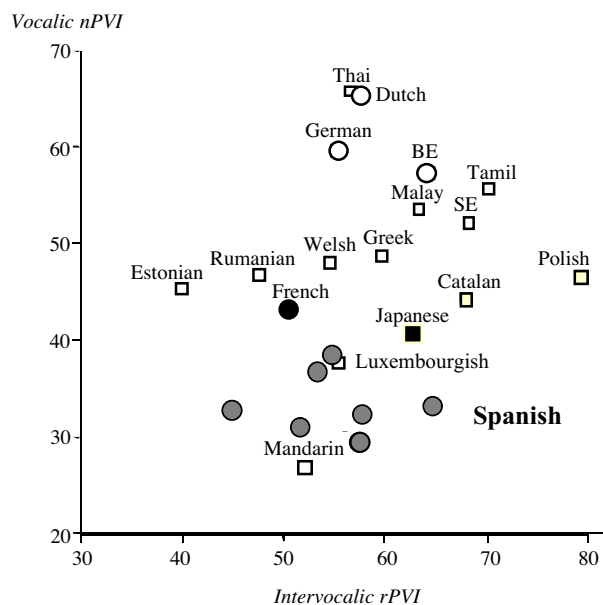


Figure 2. As Figure 1 with the addition of 7 speakers from Spanish (grey circles).

The data from different dialects of the same language and different speakers from one dialect show that it may be premature to establish firm rhythmic typologies until we can build them on comparable data from several speakers of

several dialects of each of a number of languages. Such data would allow us to describe acoustic correlates of rhythm in the speech of a particular speaker relative to that of other speakers from that dialect. Only then would we proceed to cross-dialectal and cross-language comparisons. The extent of overlap at each level would require careful attention.

This approach would increase the empirical power of our linguistic descriptions of rhythm. Moreover, it would be a clear step away from the relatively simplistic stress-timing/syllable-timing distinction. Finally, the data would show whether the variable ‘language’ has an effect beyond that of the constituent dialects.

## 2.1. Challenges from Variation for Intonational Typologies

I turn now to speaker and dialect variation in intonational typology. Research on the typology of intonation, pitch accent and tone has also become more popular [e.g. 58-61]. The autosegmental-metrical (AM) approach to the description of intonation [62] has had an effect on intonational typology comparable to that exerted by the recently developed acoustic measures for speech rhythm on rhythmic typology. Moreover, in intonational typology, at least within the AM approach, cross-dialect or cross-speaker variation has not been a central concern either. Comparisons of more than one variety per language are relatively rare. Exceptions concern tone in dialects of Mandarin Chinese [cf. 39], intonation in several dialects of British English [36], and rising accents in British, Australian and New Zealand English [23]. Intonation in several varieties of New Zealand English has also been examined [35]. A comparative study of three standard varieties of German is underway [30]. Pitch accent and intonation in Swedish dialects have been studied in detail [58], and dialect differences in Italian have also received attention [38].

Cross-speaker variation within dialects has been studied in research based on the IViE corpus [36,63], which holds recordings from multiple speakers from each of seven dialects of English. The data revealed cross-speaker variation within dialects in the production of nuclear accents in statements and yes/no questions. An individual combination of possible nuclear accents characterised each dialect. Sample data is shown in Table 2. The table gives the percentages of nuclear accent patterns produced in yes/no questions in Cambridge English and Bradford Punjabi English.

Table 2. Nuclear accent options in y/n questions in Cambridge and Bradford Punjabi English.

Transcriptions	Cambridge	Bradford Punjabi
H*L %	44.4	16.7
H*L H%	27.8	0
H* H%	0	0
H* %	0	11.2
L*H %	0	66.7
L*H H%	27.8	5.6

What role should such variation play in an account of the intonation of Cambridge or Bradford Punjabi English? One might discard the variation and draw up an account based on the options that speakers produce most frequently. In that case, the variation is treated as noise in the data. At best, any resultant typology will reflect just some of the intonational

characteristics of different dialects. Moreover, less frequent features of language may be systematic. In corpus-based linguistics, it is a common experience to encounter the property of speech that van Santen [64] called *lopsided sparsity*: the distribution of the features that characterise speech and language is extremely uneven. Some features occur very frequently but the vast majority are rare. But the type count of rare features is so large that the likelihood of encountering one in a small sample is near certainty. In the light of this, the structural variation in Table 2 is evidence of lopsided sparsity.

How then can we include the facts of variation while simultaneously capturing potential generalisations? I will argue that an investigation of variation can meet both needs. It can provide information about language- or dialect-specific aspects of intonation. That information in turn can lead to new and better generalisations.

### 3. Variation, Utterance Type and Linguistic Function

Haan [64] made a link between structural variation in intonation and potentially universal linguistic function. She showed that speakers' intonational choices can be constrained by a need to signal interrogativity. In an investigation of Dutch question intonation, she compared the acoustic features of declaratives with those of *wh*-, *yes/no* and declarative questions. The latter are questions without morphosyntactic question markers. Haan predicted a trade-off between syntactic and/or lexical markers of interrogativity and high(er) pitch in questions. High pitch would be maximally present in declarative questions which are not otherwise marked for interrogativity, less so in questions with inversions and even less so in questions with inversions and a *wh*-question word [65:56]. The incidence of final rises was specifically predicted to increase from declaratives to *wh*-questions to *yes/no* questions to declarative questions. Haan's data supported her prediction.

Haan's approach can be expanded to shed light on structural variation in the intonation of dialects of English. Her investigation of final rises was restricted to the presence or absence of rising *f0* in intonation phrase-final position. It was not based on an AM analysis of her data. The data in Table 3 are comparable to Haan's data, but include AM analyses of the observed nuclear accents.

The table shows data from declaratives, *yes/no* questions, *wh*-questions and declarative questions in the IViE corpus (N=714). Seven dialects and six speakers per dialect are represented. Each speaker read eight different declaratives and three examples each of *wh*-, *yes/no*-, and declarative questions. The utterances were read in random order and without context. Individual stimuli, rather than one single list, were presented to the subjects. The transcriptions were made in the IViE system for prosodic labelling [37,66,67]. The system is based on the ToBI concept [68] but includes modifications and additions.

Table 3 demonstrates cross-speaker and cross-dialect variation. It shows the percentage of nuclear accent patterns produced in each of the four utterance types in each of the seven dialects. Data are combined across speakers of a given dialect.

The speakers produced a range of nuclear accent patterns in the questions. In declaratives, Leeds and Bradford speakers produce only H\*L % (described as a 'nuclear fall' in the

British Tradition [69]), but in the other varieties, more than one pattern is possible even in declaratives.

Table 3. *Intonational variation in statements, wh-questions, yes/no questions and declarative questions in seven dialects of British English*

London	DEC	WH-Q	Y/N Q	DECQ
H*L %	95.8	55.6	27.8	5.6
H*L H%	4.2	33.3	16.7	16.7
H* H%	0	0	16.7	33.3
H* %	0	0	0.0	0
L*H %	0	0	0	0
L*H H%	0	0	0	38.9
L*H L%	0	0	0	0
L* H%	0	11.1	38.9	5.6
<b>Cambridge</b>				
H*L %	93.8	61.1	44.4	11.1
H*L H%	6.3	16.7	27.8	0
H* H%	0	0	0	0
H* %	0	0	0	0
L*H %	0	0	0	0
L*H H%	0	22.3	27.8	88.9
<b>Bradford</b>				
H*L %	100.0	83.3	16.7	22.2
H*L H%	0	5.6	0	5.6
H* H%	0	0.0	0.0	0
H* %	0	0	11.2	5.6
L*H %	0	0	66.7	66.7
L*H H%	0	0	5.6	0
<b>Leeds</b>				
H*L %	100.0	72.2	44.4	0
H*L H%	0	11.1	0	0
H* H%	0	0	0	5.6
H* %	0	0	0	0
L*H %	0	5.6	55.6	72.2
L*H H%	0	11.1	0	22.2
<b>Newcastle</b>				
H*L %	83.3	61.1	44.4	11.1
H*L H%	0	0	16.7	0
H* H%	0	5.6	0	0
H* %	0	0	0	5.6
L*H %	16.7	33.3	38.9	83.3
<b>Belfast</b>				
H*L %	4.2	5.6	0	0
H*L H%	0	0	0	0
H* H%	0	0	0	0
H* %	0	0	0	0
L*H %	83.3	94.4	94.4	83.3
L*H H%	0	0	5.6	16.7
L*H L%	12.5	0	0	0
<b>Dublin</b>				
H*L %	94	77.8	68.4	27.8
H*L H%	0	5.6	15.8	0
H* H%	0	0	0	0
H* %	0	0	0	0
L*H %	6	16.7	15.8	50.0
L*H H%	0	0	0	5.6
L*H L%	0	0	0	22.2

According to Haan's functional hypothesis, the structural variation in the four utterance types in Table 3 should reflect an increasing need for interrogativity signalled by intonation. In Haan's data, the incidence of final rises rose from declaratives to wh-questions to y/n questions to declarative questions. If Haan's observation generalises to English, then the incidence of final rises in Figure 3 should increase similarly.

To test this prediction, the IViE transcriptions were recoded. Both H\*L % and L\*H L% were recoded as HL. Here, the last pitch movement involved falling f0. All other patterns were recoded as LH (see Table 4.)

Table 4. Transcription and impressionistic description of patterns recoded as LH (rising).

Transcription	Impressionistic description	Recoding
H*L %	fall	HL
L*H L%	rise-plateau-fall	HL
H*L H%	fall-rise	LH
H* H%	high accent followed by a rise	LH
(L) H* %	high accent preceded by low target	LH
L*H %	rise-plateau	LH
L* H%	late rise	LH
L*H H%	double-rise	LH

Figure 3 shows how the incidence of final LH in the four utterance types increases as predicted.

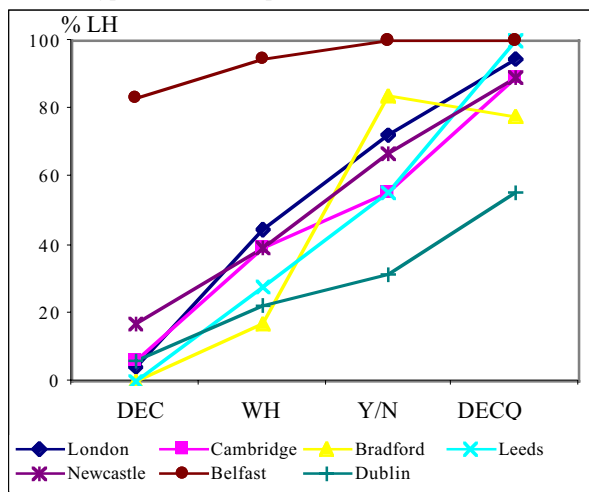


Figure 3. Distribution of LH patterns in nuclear position in declaratives, wh-questions, yes/no questions and declarative questions in seven varieties of English.

There are two exceptions. One is Belfast, where the incidence of LH in yes/no questions and declarative questions is 100%. This is not surprising; Belfast declaratives usually end in L\*H %. Table 3, however, shows that the incidence of L\*H H% patterns in Belfast increased from 6% in yes/no questions to 17% in declarative questions. Belfast speakers rise higher in declarative questions than in yes/no questions.

The other exception was Bradford, where the incidence of final rises increased from declaratives to yes/no questions, but not from yes/no questions to declarative questions. More data are required to investigate this anomaly.

After the transform arcsine (.01x) was applied to the data in Table 3, a two-way analysis of variance was conducted. The factors were utterance Type (4) and Dialect (7). The interaction was used as the error term. It was very small ( $MSq = 0.039$ ). As Figure 3 shows, all dialects but Bradford produced monotone increasing functions; Bradford deviated only in the percentage of LH patterns in declarative questions.

Type was highly significant [ $F(3,18) = 31.68, p < 0.001$ ] as was Dialect [ $F(6,18) = 10.98, p < 0.001$ ]. Post-hoc multiple comparisons revealed significant differences only between Belfast and each of the other six dialects.

The recoding of the data shows that the considerable intonational variation manifest in Table 3 is constrained by the number of morpho-syntactic cues to interrogativity in the text. Final rises become more likely when the number of morpho-syntactic cues to interrogativity decreases.

#### 4. Discussion

The data on intonational variation in English parallel Haan's findings for Dutch. Both sets of data reveal a functional trade-off between syntactic and/or lexical markers of interrogativity and high(er) question pitch. Furthermore, the fact that the English data come from a comprehensive AM analysis of the relevant dialects allows us to enlarge on Haan's study. As noted above, her investigation of final rises was restricted to the presence or absence of rising f0. Haan did not make AM transcriptions of the Dutch data. The data from English show that there is a one-to-many mapping between interrogativity and intonational form. In interrogatives, speakers have available a range of contours from which they can choose. They are not obliged to choose a rising contour when asking a question but the production of an LH pattern becomes more likely as less morpho-syntactic question information is available.

Haan suggested that her data show that phonological options are constrained by the universal Frequency Code [71-73]. High pitch is said to signal subordination, dependence, and lack of threat. In asking questions, the speaker depends on the listener's cooperation and the use of high pitch is frequent. Haan argued that the Frequency Code induces speakers to choose phonological units that involve final high/rising f0 if other cues to interrogativity are absent.

But why do languages and dialects offer their speakers the opportunity to produce high pitch with structurally different options? Taking the principles of the Frequency Code a step further, I suggest that speakers may have access to different structural options to express interrogativity in different degrees. For example, in a dialect which has L\*H % as well as L\*H H%, the latter may signal interrogativity more clearly than the former. Speakers' choices of particular nuclear accents then depend on the extent to which they intend to express interrogativity. Evidence for this suggestion comes from the Belfast data in Table 3. In Belfast English, L\*H H% is not observed when the need for intonational interrogativity is weaker, e.g. in wh-questions. In yes/no questions, the pattern appears. The incidence of the pattern increases further from 6% to 17% between yes/no and declarative questions. The rise-plateau-fall pattern L\*H L%, on the other hand, is observed only in declaratives.

My proposal does not claim that the different LH options for questions add nothing beyond degree of interrogativity to communicative impact. Whether they do or not is an empirical question.

In summary, I have shown that a pattern previously found in Dutch intonational data occurs in English too. Such cross-language similarity is a major concern of language typologists. The English data, however, reveal dialect-specific differences in structural options. Belfast speakers, for instance, use L\*H % and L\*H H% in yes/no questions whereas speakers from Leeds use L\*H % and H\*L %. Such differences are another concern of language typologists. In both cases, attention to variation reveals essential information.

## 5. Summary and Conclusion

In the development of objective paradigms for establishing prosodic typologies, we need to consider cross-speaker and cross-dialect variation. I have illustrated this point with a discussion of (a) variation in the acoustic correlates of rhythm class and (b) the production of intonation patterns by multiple speakers from several dialects of English.

The results show that the construction of valid linguistic typologies requires comparable data from several speakers of a dialect, several dialects of one language and a number of languages. Only such data can provide a sufficiently robust empirical basis for prosodic typology.

## 6. References

- [1] Foulkes, P.; Docherty, G., 1999. *Urban voices: accent studies in the British Isles*. Arnold.
- [2] Bruce, G., 1995. Modelling Swedish intonation for read and spontaneous speech. *Proceedings of ICPhS*, Stockholm, 2, 28-35.
- [3] Hirschberg, J., 2000. A corpus-based approach to the study of speaking style. In M.Horne (ed). *Prosody: Theory and Experiment. Studies presented to Gösta Bruce*. Kluwer, 335-350.
- [4] Hirst, D., Astésano, C. and Di Christo, A., 1998. Differential lengthening of syllabic constituents in French: the effect of accent type and speaking style. *Proceedings of ICSLP*, Sydney.
- [5] Swerts M., Strangert E., Heldner M., 1996. F0 declination in spontaneous and read-aloud speech. *Proceedings of ICSLP*, Philadelphia, 3, 1501-1504.
- [6] Terken, J., 2001. Variability and Speaking Styles in Speech Synthesis. In E. Keller, G. Bailly, A. Monaghan, J. Terken and M. Huckvale (eds.) *Improvements in Speech Synthesis*. Wiley & Sons.
- [7] Caspers, J., 1994. *Pitch movements under time pressure*. The Hague: Holland Academic Graphics
- [8] Monaghan, A.I.C., 2001. An Auditory Analysis of the Prosody of Fast and Slow Speech Styles in English, Dutch and German. In E. Keller, G. Bailly, A. Monaghan, J. Terken and M. Huckvale (eds.) *Improvements in Speech Synthesis*. Wiley & Sons.
- [9] Arvaniti, A., Ladd, D. R and Mennen, I., 2000. What is a starred tone? Evidence from Greek. In M. Broe and J. Pierrehumbert, *Papers in Laboratory Phonology V, Acquisition and the Lexicon*. CUP.
- [10] Santen, J. van; Hirschberg, J., 1994. Segmental effects on timing and height of pitch contours. *Proceedings of ICSLP*, Yokohama, 719-22.
- [11] Silverman, K.; Pierrehumbert, J. B., 1990. The timing of prenuclear high accents in English. In J. Kingston and M. E. Beckman, *Papers in Laboratory Phonology I*. CUP.
- [12] Steele, J., 1986. Nuclear accent F0 peak location: effect of rate, vowel, and number of syllables. *JASA* supplement 1, 80, s51.
- [13] Wichmann, A.; House, J.; Rietveld, T., 2000. Discourse effects on f0 peak alignment in English, in A. Botinis (ed.) *Intonation: Analysis, Modelling and Technology*. Kluwer Academic Publishers.
- [14] Lehiste, I.; Peterson, G.E., 1961. Some basic considerations in the analysis of intonation. *JASA*, 33, 428-435.
- [15] Bannert, R.; Bredvad, A., 1975. Temporal organisation of Swedish tonal accent: the effect of vowel duration. Working papers 10, Phonetics Laboratory, Department of General Linguistics, Lund University, Sweden.
- [16] Erikson, Y.; Alstermark, M., 1972. Fundamental Frequency correlates of the grave word accent in Swedish: the effect of vowel duration. Speech Transmission Laboratory. Quarterly Progress and Status Report 2-3, KTH, Sweden.
- [17] Grabe, E., 1998b. Pitch accent realisation in English and German. *Journal of Phonetics*, 26, 129-144.
- [18] Grabe, E., B. Post, F. Nolan and K. Farrar (2000). Pitch accent realisation in four varieties of British English. *Journal of Phonetics*, 28, 161-185.
- [19] Grønnum, N.; 1989. Stress group patterns, sentence accents and sentence intonation in Southern Jutland (Sønderborg and Tønder) - with a view to German. *ARIPUC*, 23, 1-85.
- [20] Cruttenden, A., 2001. Mancunian intonation and intonational representation. *Phonetica*, 58, 53-80.
- [21] Cruttenden, A., 1995. Rises in English. In: J. Windsor-Lewis (ed.), *Studies in General and English Phonetics*. Routledge, 155-173.
- [22] Fitzpatrick-Cole, J., 1999. The Alpine Intonation of Bern Swiss German. *Proceedings of ICPhS*, San Francisco, 2, 941-944.
- [23] Fletcher, J.; Grabe, E.; Warren, P., (to appear). Intonational variation in four dialects of English: the high rising tune. In [59].
- [24] Gussenhoven, C., 2000. The boundary tones are coming: on the nonperipheral realisation of boundary tones. In M. Broe and J. Pierrehumbert (eds) *Papers in Laboratory Phonology V. Acquisition and the Lexicon*, 132-151.
- [25] Jarman, E.; Cruttenden, A., 1976. Belfast intonation and the myth of the fall. *JIPA*, 6, 4-12.
- [26] Knowles, G.O., 1978. The nature of phonological variables in Scouse. In P. Trudgill ed. *Sociolinguistic patterns in British English*. Arnold.
- [27] Pellowe, J.; Jones, V., 1978. On intonational variability in Tyneside speech. In P. Trudgill ed. *Sociolinguistic patterns in British English*. Arnold.
- [28] Sebba, M., 1993. *London Jamaican: language systems in interaction*. Longman.
- [29] Tench, P., 1990. The pronunciation of English in Abercrave. In N. Coupland (ed) *English in Wales*. Multilingual Matters.
- [30] Ulbrich, C., 2002. A comparative study of intonation in three standard varieties of German. *Proceedings of Prosody 2002*, Aix-en-Provence.
- [31] Warren, P.; Britain, D., 2000. Prosody and intonation of New Zealand English. In A. Bell & K. Kuiper eds. *New Zealand English* Victoria University Press, 146-172.
- [32] Wells, J.C., 1982. *Accents of English: The British Isles* Vol. 2. CUP.

- [33] Auer, P.; Gilles, P.; Peters, J.; Selting, M., 2000. *Intonation regionaler Varietäten des Deutschen*. In D. Stellmacher ed., *Dialektologie zwischen Tradition und Neuansätzen*, Stuttgart: Steiner, 222-239.
- [34] Bruce, G.; Elert, C.; Engstrand, O.; Eriksson, A.; Wretling, P., 1999. Database tools for a prosodic analysis of the Swedish Dialects. *Proceedings Fonetik 99*, Göteborg: Göteborg University, Department of Linguistics, 37-40.
- [35] Warren, P.; Britain, D., 2000. Prosody and Intonation of New Zealand English. In A. Bell and K. Kuiper (eds) *New Zealand English*. Wellington: Victoria University Press. 146-172.
- [36] Grabe, E.; Post, B., 2002. Intonational Variation in English. *Proceedings of Prosody 2002*, Aix-en-Provence, France.
- [37] Grabe, E.; Post, B.; Nolan, F., 2001. Modelling intonational variation in English: the IViE system. *Proceedings of Prosody 2000*, Adam Mickiewicz University, Poznan, Poland.
- [38] Grice, M.; D'Imperio, M.; Savino, M.; Avesani, C., to appear. Strategies for intonation labelling across varieties of Italian. In [59].
- [39] Peng, M.; Chan, M.; Tseng, C.; Huang, T.; Lee, O.J.; Beckman, M., to appear. In [59].
- [40] Ghazali, S.; Hamdi, R.; and Barkat, M., 2002. Speech rhythm variation in Arabic dialects. *Proceedings of Prosody 2002*, Aix-en-Provence, France.
- [41] Peppé, S.; Maxim, J.; Wells, B., 2000. Prosodic Variation in Southern British English. *Language and Speech* 43 (3), 309-334.
- [42] Vermillion, P., 2001. The perception and production of intonational meaning by British men and Women. M.Phil dissertation, Queen Mary and Westfield College, University of London.
- [43] Hasegawa, Y.; Hata, K., 1994. Non-Physiological differences between male and female speech: evidence from the delayed fall phenomenon in Japanese. *Proceedings of ICSLP 94*, Yokohama, 1179-82.
- [44] Haan, J.; van Heuven, V.J., 1999. Male vs. Female pitch range in Dutch questions. *Proceedings of ICPHS*, San Francisco.
- [45] Daly, N.; Warren, P., 2000. Pitching it differently in New Zealand English: speaker sex and intonation patterns. *Journal of Sociolinguistics*, 5 (1), 85-96.
- [46] Warren, P.; Daly, N., 2000. Sex as a factor in rises in New Zealand English. In J. Holmes (ed) *Gendered Speech in Social Context: Perspectives from Gown and Town* pp. 99-115. Wellington: Victoria University Press.
- [47] Grabe, E.; Low, E., in press. Durational Variability in Speech and the Rhythm Class Hypothesis. In Gussenhoven, C and Warner, N. (eds) *Papers in Laboratory Phonology 7*. Cambridge: CUP.
- [48] Ramus, F.; Nespors, M.; Mehler, J., 1999. Correlates of linguistic rhythm in the speech signal, *Cognition*, 72, pp. 1-28.
- [49] Cummins, F.; Port, R. F., 1998. Rhythmic constraints on stress timing in English. *Journal of Phonetics*, 26 2 :145-171.
- [50] Barbosa, P., 2002. Explaining Cross-linguistic rhythmic variability via a coupled-oscillator model of rhythm production. *Proceedings of Prosody 2002*, Aix-en-Provence, France.
- [51] Frota, S.; Vigario, M.; Martins, F. 2002. Language discrimination and rhythm classes: Evidence from Portuguese. *Proceedings of Prosody 2002*.
- [52] Pellegrino, F.; Chaucat, J.; Rakotomalala, R.; Farinas, J., 2002. Can automatically extracted rhythmic units discriminate among languages? *Proceedings of Prosody 2002*, Aix-en-Provence, France.
- [53] Galves, A.; Garcia, J.; Duarte, D.; Galves, C., 2002. Sonority as a basis for rhythmic class discrimination. *Proceedings of Prosody 2002*, Aix-en-Provence, France.
- [54] Low, E.L. & Grabe, E. 1995 Prosodic patterns in Singapore English, *Proceedings of ICPHS*, 3, 636-639.
- [55] Grabe, E., Post, B. & Watson, I. 1999 The acquisition of rhythm in English and French, *Proceedings of ICPHS*, 2, pp. 1201-1204. San Francisco.
- [56] Low, E.; Grabe, E.; Nolan, F., 2001. Quantitative characterisations of speech rhythm: 'syllable-timing' in Singapore English. *Language and Speech*, 43 (4), 377-401.
- [57] Gibbon, D.; Gut, U., 2001. Measuring speech rhythm. *Proceedings of Eurospeech*, Aalborg, 91-94.
- [58] Bruce, G.; Garding, E., 1978. A prosodic typology for Swedish dialects. In E. Garding, G. Bruce and R. Bannert eds. *Nordic Prosody*. Lund University, Department of Linguistics, 219-228.
- [59] Hirst, D.; Di Christo, A., 1998. *Intonation Systems*. CUP.
- [60] Jun, S. (ed), to appear. *Prosodic Typology and Transcription: A Unified Approach*. OUP.
- [61] Vaissiere, J., 1995. Phonetic Explanations for Cross-linguistic Prosodic Similarities. *Phonetica*, 52, 123-130.
- [62] Ladd, D. R., 1996. *Intonational phonology*. CUP.
- [63] Grabe, E.; Post, B.; Nolan, F. 2001. The IViE Corpus on CD-ROM. Linguistics Department, University of Cambridge. Also available on-line and downloadable: <http://www.phon.ox.ac.uk/~esther/ivyweb>
- [64] Santen, J. van., 1994. Using statistics in text-to-speech system construction. *Proceedings of the ESCA/IEEE workshop on speech synthesis*, 240-243.
- [65] Haan, J., 2002. *Speaking of questions*. Published doctoral dissertation, LOT.
- [66] Grabe, E.; Nolan, F.; Farrar, K., 1998. IViE - A comparative transcription system for intonational variation in English. *Proceedings of the ICSLP*, Sydney.
- [67] Grabe, E., 2001. The IViE Labelling Guide. Phonetics Laboratory, University of Oxford. <http://www.phon.ox.ac.uk/~esther/ivyweb/guide.html>
- [68] Beckman, M.; Ayers, G., 1997. Guidelines for ToBI Labelling. [http://ling.ohio-state.edu/phonetics/E\\_ToBI](http://ling.ohio-state.edu/phonetics/E_ToBI)
- [69] Cruttenden, A., 1997. *Intonation*. Cambridge: CUP.
- [70] Ladd, D. R., 1996. *Intonational phonology*. Cambridge: CUP.
- [71] Bolinger, D., 1978b. Intonation across languages. J. Greenberd ed, *Universals of Human Language, Vol. II: Phonology*, 471-524. Palo Alto, Stanford University Press.
- [72] Gussenhoven, C., to appear. Why question intonations rise and why they sometimes fall. M. Hoey and N. Scott eds, *Questions: Multiple Perspectives on a Common Phenomenon*. University of Liverpool Press Language and Discourse Series.
- [73] Ohala, J., 1983. Cross-language Use of Pitch: An Ethological view. *Phonetica*, 40, 1-18.