Intonational variation in the British Isles

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Introduction and background

Intonation varies with dialect.

➡ in the British Isles, we find a number of different intonation systems.

The same utterance,
spoken with exactly the same intention,

can have different intonation patterns in different dialects.

Dialect intonation in the British Isles has been investigated extensively.

But in the past, limitations on recording facilities have made multiple comparisons of dialects difficult.

Studies have been mono-dialectal, data not comparable.

Studies rarely quantitative.

Intonational variation in the British Isles

ESRC funded research project
Cambridge and Oxford (Grabe, Nolan, Post)
1998 – 2003

Quantitative modelling of intonational variation in the British Isles

ESRC funded research project
Oxford (Grabe, Kochanski, Coleman)
2003 – 2006

Aims

- to collect a corpus of speech data from a number of English dialects,
- to collect directly comparable data,
- to carry out linguistic and quantitative analyses.

Outputs

- The IViE Corpus.
- An intonation transcription system.
- Descriptive publications.

The IViE corpus

- Speech database intended to give a flavour of intonational variation.
- Designed to illustrate some of the effects of dialect, style, speaker and gender.
- 36 hours of speech, available on the internet, free.

Seven urban dialects

London ('Jamaican')
Cambridge
Leeds
Bradford (Punjabi)
Newcastle
Belfast
Dublin

Five speaking styles

Sentences
Read text
Retold text
Map task
Free conversation

- Twelve speakers from each dialect, six male and six female.
- 16 years of age, attended same secondary school, parents born in area.

Four hours of speech transcribed:
words, prominent syllables, intonation.

Samples transcribed from each of the five styles.

~ 7200 intonation phrases.

~ 14400 accents.

Subsection on the internet.

Analysis of transcriptions

Main within-dialect finding

Considerable variation within and across speakers.

On identical texts and in identical contexts, speakers produce a **range** of contours.

Main between-dialect finding

Differences involve **usage** and **frequency** of contours rather than specific contour shapes.

Distributions **overlapped** across dialects and speakers.

Transcriptions

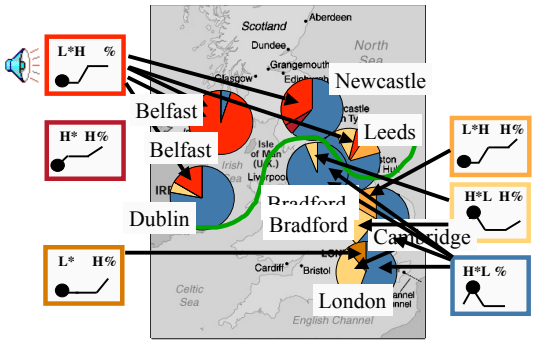
- Two-tone using H, L, *, %,
- H = pitch maximum,
- L = pitch minimum,
- * = stressed syllable,
- % means 'end of intonation phrase'.

Example

Graph showing distribution of nuclear accents in wh-questions

- produced on identical texts,
- in identical tasks,
- by speaker groups controlled for dialect, age and peer-group.

Nuclear Accent distribution in Wh-Questions



Next slide

Distribution of all nuclear accents in the IViE sentence data.

- Various sentence types,
- 714 sentences.

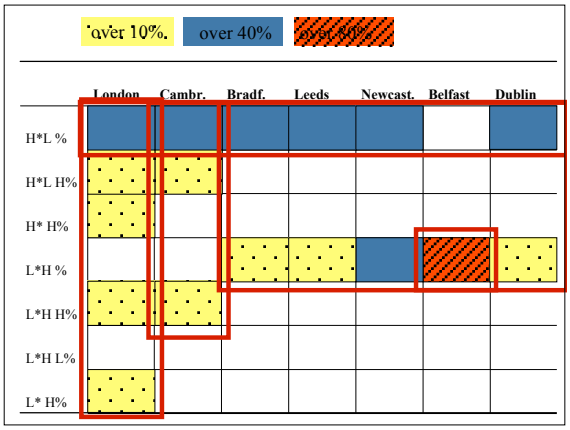
➡ Distributions of accent shapes within and between dialects overlap.

Data in following table simplified

over 10% accent accounts for more than 10% of total

over 40% accent accounts for more than 40% of total

over 80% accent accounts for more than 80% of total



Current project

Quantitative modelling of intonational variation in the British Isles

- Exploiting the transcriptions.
- Mapping between transcription and acoustics.

Remainder of the talk

Mapping between transcriptions and acoustics.

Computational-mathematical modelling of f_0 patterns associated with nuclear accents.

The question

The linguistic transcriptions allege that there are 7 different nuclear accents in the IViE data.

Is there quantitative support for this assertion?

Experimental investigation

Materials

- 714 read sentences; context-free.
- Four sentence types:
  declaratives, wh-questions,
  yes/no questions, declarative questions.
- Six male and six female speakers from each dialect.

Nuclear accent label	Stylisation	Description following the British tradition
1. H*L %		Fall
2. H*L H%		Fall-rise
3. H* H%		High rise
4. L*H %		Rise-plateau
5. L*H H%		Rise
6. L* H%		Late rise
7. L*H L%		Rise-plateau-fall

Distribution of nuclear accents in the sentences

Accents		Tokens
H*L %	fall	414
L*H %	rise-plateau	187
H*L H%	fall-rise	41
L*H H%	rise	32
H* H%	high rise	15
L* H%	late rise	12
L*H L%	rise-plateau-fall	9
NB: collapsed over dialects		710

The question

Can we find quantitative support for the existence of 7 different nuclear accents?

Method

Orthogonal-polynomial modelling of f_0 contours associated with nuclear accents.

Polynomial modelling

- Common mathematical approach to the description of curves.
- Models produce a hierarchy of descriptions of increasing complexity and accuracy.

- First step in the combination of polynomial equations and linguistic descriptions of prosody: Andruski and Costello (2004).
- Explored small differences in f_0 contours of three low falling tones in Green Mong.

(Language spoken in South-East Asia in the region surrounding the Southern Chinese border.)

- Green Mong has seven tones, three are quite similar in shape:

  low falling but differ in phonation type.
- Andruski and Costello asked: could *f*0 contour shape alone be used to identify the tones?

- Used polynomial equations to generate quantitative descriptions of the slope and the shape of the curvature of the three tones.
- Subsequent statistical analyses:

  the three tones can be discriminated above chance level on the basis of slope and shape.

Introduction to polynomial modelling

Orthogonal polynomials

Mathematical functions that describe curves of increasing complexity.

Polynomial

Mathematical expression involving a sum of powers in one or more variables multiplied by constants.

$a_2x^2 + a_1x + a_0$

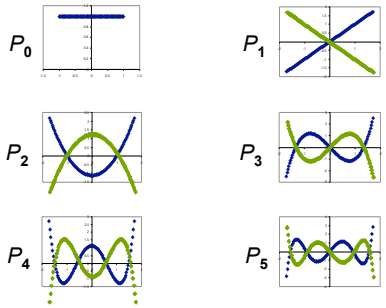
Orthogonal

Each term of the equation describes one aspect of the wiggliness of the curve.

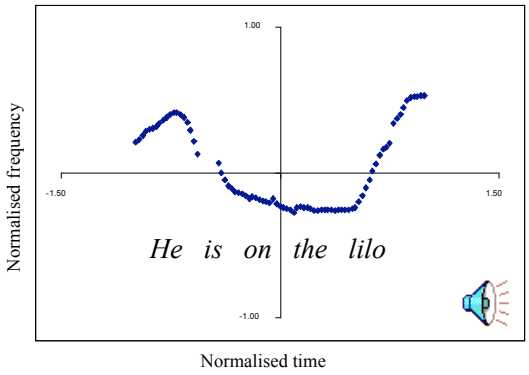
Legendre polynomials

Type of orthogonal function used, referred to by the letter *P*.

Every data point is treated equally.

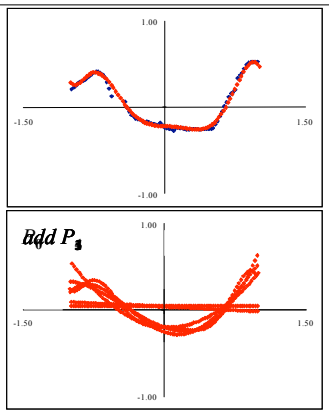


Added together, Legendre Polynomials can model contour shapes such as f_0 traces.



Original

Model



The model reduces the complexity of the f_0 contour to six coefficients.

Many contours require fewer coefficients.

Contours appear to be very complex but mathematically, they are relatively simple.

Our analysis

Analysis was carried out with a set of custom-written computer scripts.

Description of analysis and instructions for how to carry out modelling in MS Excel:

Grabe, Kochanski and Coleman (accepted, *Language and Speech*)

We used polynomial equations to describe

1. the average and
2. the slope of each f_0 contour,

and two kinds of curvature

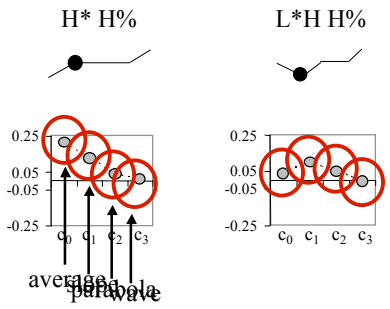
1. a parabola shape and
2. a wave shape.

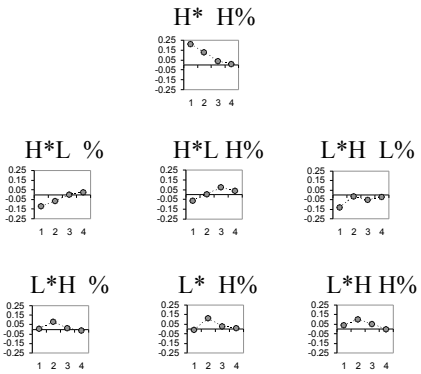
Each of the 710 nuclear accents was modelled separately.

Results shown are averages for each accent types.

Results

Example: results for two rising accents





Question

Are the polynomial models associated with each of the seven accents statistically different?

➡ MANOVA

Dependent variables

AVERAGE (c_0)
SLOPE (c_1)
PARABOLA (c_2)
WAVE (c_3)

Independent variable

NUCLEAR ACCENT TYPE

NUCLEAR ACCENT TYPE highly significant

AVERAGE	$p < 0.001$
SLOPE	$p < 0.001$
PARABOLA	$p < 0.001$
WAVE	$p < 0.001$

Post-hoc tests (Tukey)

17 of the 21 accent pairs highly significantly different in one or more coefficients.

A further two pairs differed at at $p < 0.05$.

The late rise
L* H% (London ↘—↗)

did not differ significantly from

L*H % (rise plateau, especially Belfast ↘‾↗)
and
L*H H% (rise, all dialects ↘—↗).

The analysis also showed:

three coefficients would have been sufficient to distinguish between the nuclear accents.

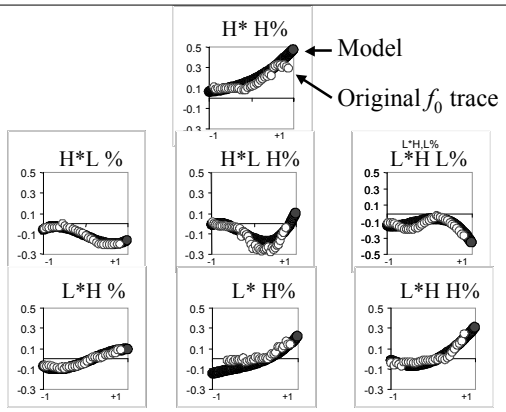
We found significant differences between contours in the fourth, but the information was redundant.

Finally, we reconstructed average f_0 patterns for each accent shape, using the coefficients.

The reconstructed f_0 models summarise the salient characteristics of each accent type.

Superimposed: one original, normalised f_0 trace from the corpus.

Traces show: the polynomial models – despite being an average – are representative of the data.



Discussion

The models did not distinguish between the late rise L*H %

and two other rising accents

Rise-plateau L* H%

Rise L*H H%.

Data sparsity?

12 tokens	late rise	L* H%
414 tokens	fall	H*L %

Neutralisation?

- Nuclear accents produced on two-syllable words with initial stress such as *limo*.
- Accented syllable followed by only one syllable.
- Not a lot of room for realisation of nuclear accent shape.

- Nuclear accent distinctions can be observed more clearly when accented syllable is followed by more syllables.
- More room for realisation of distinction between patterns.
- Additional work required.

Conclusion

Polynomial modelling can be of value to intonational phonologists.

Hand-labels can be supported by empirical acoustic evidence.

The combination of hand-labels and polynomial models can also be of value to speech technologists.

➡ Need empirically tested and implementable models of intonation filtered by linguistic insights.

Our approach may help in the building
of bridges between intonational phonologists
and speech technologists.

Thank you for your attention