EXPLORING TIMING IN ACCENTS OF BRITISH ENGLISH

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ABSTRACT

This paper reports an investigation of speech timing in spontaneous speech of four British English accents spoken in Cambridge, Glasgow, Leeds and Bradford. We tested the effect of lexical stress, word boundary and syllable weight on syllable durations and found systematic differences between Glasgow and Cambridge on all factors, with Glasgow being the most conservative about lengthening. Differences were also observed between Leeds and Cambridge in terms of syllable weight, and between Leeds and Bradford with respect to word-final lengthening. A new rhythm metric, the multi-factorial dispersion coefficient, was found to effectively separate the four accents by capturing the effects of not only structural lengthening but also phonetic variability. This proposed measure seeks to combine the elegance of acoustic rhythm metrics with the exploratory power of prosodic timing research.

Keywords: speech timing, rhythm metrics, dialects, British English

1. INTRODUCTION

Speech has a hierarchical prosodic structure: it is organised into successively larger constituents, ranging from the syllable or its subcomponents, up to the intonational phrase or utterance. This structure is well known to have important implications for timing, e.g. [13]. This study investigates variation in British English dialects at intermediate levels of the prosodic hierarchy, namely syllables and words, which have been little explored with respect to dialectal variation.

So far, dialects have mainly been described in terms of segmental timing, i.e. as systematic durational differences in the realisation of consonants or vowels as measured by temporal indices (known as rhythm metrics, e.g. [8]). Accents of British English have been shown to differ mostly on vocalic metrics [14]: %V (proportion of utterance comprised of vocalic intervals), VarcoV (the variability coefficient of vocalic intervals) and to a lesser extent nPVI-V (a normalised index of durational variability between successive pairs of vocalic intervals). Standard Southern British English displayed the typical properties of a stress-timed language, i.e. higher variability coefficients and lower vocalic proportions. In contrast, other accents (from Bristol, Shetland, Orkney, Welsh Valleys *inter alia*) had higher %V scores and lower variability coefficients, a result that pointed rather towards the syllable-timed end of the assumed timing continuum [3].

Beyond these merely phonetic descriptions, some work has explored structural influences that contribute to dialectal timing variation. This research shows that dialects can differ with respect to low-level timing processes (e.g. adjustment of vowel duration to varying morphological contexts [11]), as well as high-level timing (e.g. demarcation of phrasal edges [15] or prosodic prominence [7]).

Little attention has hitherto been paid to intermediate levels of the prosodic hierarchy. However, Abercrombie [1] addressed dialectal timing differences at these levels. In his approach, the basic rhythmic unit is the foot, consisting of a lexically stressed syllable (S, strong) and any following unstressed syllables (W, weak). Feet are further classified with respect to word boundaries and syllable weight (Tab. 1). Dialects of British English were observed to have different timing patterns for word-internal trochaic feet with a heavy first syllable (“B feet”).

Table 1: Classification of timing categories in Abercrombie (1979). # indicates word boundary.

Structure	S_{light} W#	S_{heavy} W#	S # W
Timing	short-long (RP)	equal-equal (RP), long-short (Yorks), short-long (Scots)	long-short (RP)
Example	*city*	*seedy*	*seed a / sit in*
Foot	A	B	C

These dialect-specific observations have never been followed up empirically, partly because Abercrombie’s theoretical approach to rhythm, which depended on the idea of isochrony, has lost currency. Nevertheless, they motivated us to investigate whether the specified dialects differ with respect to the temporal realisation of the following factors: *lexical stress* (S vs. W), *syllable weight* (light vs. heavy) and *word boundary* (present or absent after S).

Our study is an initial exploration of timing variation in dialects of British English. The focus is on whether we can systematically capture such variation by considering the three structural factors mentioned above. Following [1], we compared *Standard Southern British English* (as spoken in Cambridge, <Camb>) with both *Standard Scottish English* (as spoken in Glasgow, <Glas>) and *Yorkshire English* (as spoken in Leeds, <Leed>).

Additionally, we included *Panjabi Asian English* (from Bradford, <Brad>) which has been suggested to sound rather syllable-timed [4] and is therefore expected to show less pronounced differences in syllable durations on all three factors.

We further explored whether the structural influences we investigated could be incorporated into a rhythm metric, given the advantages of metrics in terms of exact phonetic description, despite their limitations in terms of lacking explanatory power.

2. METHOD

We analysed productions from 7-10 (male and female) middle-class speakers of the four accents. The data for Cambridge, Leeds and Bradford were taken from the IViE map task and free conversation corpus [5]. Speech samples for Glasgow were free conversations from a socio-phonetic corpus [12]. For each accent, we collected 40-50 disyllabic feet tokens from medial positions in fluently spoken, non-overlapped phrases. For every speaker, we found the same number of 2-10 tokens per factor. For each level of the three factors, we found a total of at least 30 tokens. Since segmental composition strongly influences syllable duration [10], only feet with 4 or 5 segments which had 2 or 3 segments in their strong syllables were used.

Syllable weight was defined with respect to segmental composition and phonological vowel quality, i.e. light syllables end with lax vowels whereas heavy syllables have tense vowels or lax vowels followed by consonants. We operationally defined weight on the basis of the SSBE vowel system. Syllabification was guided by the maximal onset principle. Labelling was done using EMU, and data processing and statistical analyses using R.

Three ANOVAs were fitted for each fixed factor *lexical stress, syllable weight, word boundary* in combination with *dialect*. *Subject* and *token* were treated as random factors. Additionally, t-tests were run to test planned contrasts for three dialect pairs *Camb/Leed, Camb/Glas, Leed/Brad*. As these data sets were used twice, α was set at 0.025. Lengthening coefficients were calculated based on obtained mean durations for each factor and dialect separately.

3. RESULTS

3.1. Word boundary

Strong syllables were about 1.13 times longer across accents if followed by a word boundary than if word-internal (henceforth *+WB, -WB*: 198 ms vs. 175 ms; F=13.7, p<0.001). Table 2 shows that the lengthening coefficient on this factor was relatively small and similar across accents, with Leeds having a slightly higher value. Nevertheless, the interaction of *word boundary* with *dialect* was significant (F=4.8, p<0.01). Cambridge had significantly longer –WB syllables than both Leeds (t=2.6, p<0.025) and Glasgow (t=3.8, p<0.001) but no difference was found for +WB syllables. In contrast, Leeds and Bradford did not differ for –WB syllables, but Bradford had significantly shorter +WB syllables (t=3.3, p<0.01).

Table 2: Raw durations of strong syllables with or without word boundary (N = number of cases).

Measures	Boundary	Camb	Leed	Brad	Glas
S (ms)	+WB	205	221	170	199
	-WB	196	170	159	162
N	+WB	43	27	26	34
	-WB	77	71	68	74
Lengthening		1.1	1.3	1.1	1.2

3.2. Lexical stress

In all accents, lexical stress went hand in hand with longer duration (F=177.1, p<0.0001). Strong syllables were on average 1.4 times longer than weak ones (182 ms vs. 131 ms). However, Table 3 shows that this lengthening co-efficient was higher in Cambridge and Leeds and lower in Bradford and Glasgow, as reflected in a significant interaction of *lexical stress* and *dialect* (F=7.0, p<0.001). According to t-tests, the interaction was mainly triggered by the systematic difference between Glasgow and Cambridge in the duration of both strong (t=3.2, p<0.01) and weak (t=-2.3, p<0.025) syllables. Neither *Camb/Leed* nor *Leed/Brad* comparisons were significant.

Table 3: Raw durations of strong and weak syllables in four accents (number of cases is indicated by N).

Measures	Camb	Leed	Brad	Glas
S (ms)	199	184	167	173
W (ms)	129	121	127	145
N	120	98	94	108
Lengthening	1.5	1.5	1.3	1.2

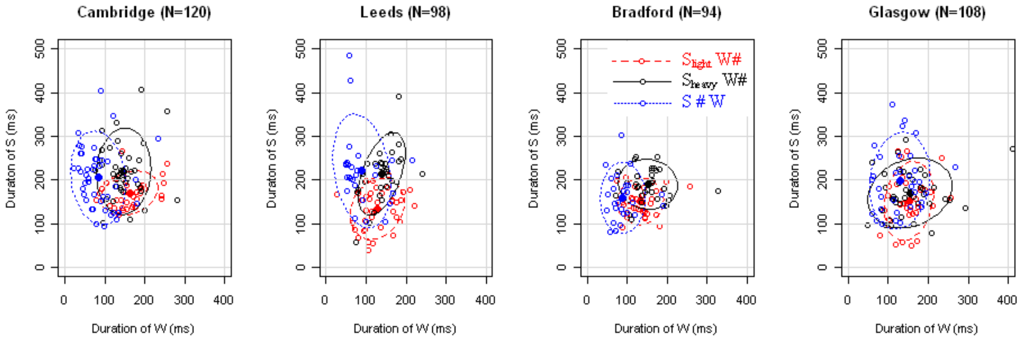
3.3. Syllable weight

Table 4: Raw duration of light vs. heavy strong syllables in four accents (N indicates the number of tokens).

Measures	Syllable weight	Camb	Leed	Brad	Glas
S (ms)	heavy	220	214	190	170
	light	170	134	151	152
N	heavy	40	32	33	39
	light	37	39	35	35
Lengthening		1.3	1.6	1.3	1.1

Across accents, heavy syllables were about 1.3 times longer than light ones (199 ms vs. 152 ms; F=102.8, p<0.0001). Table 4 shows that Leeds and Glasgow had the highest and lowest lengthening coefficients, respectively. Again, we found a highly significant interaction with dialect (F=7.4, p<0.001), which was attributable to the *Camb/Leed* difference on light syllables (t=4.3, p<0.0001) and *Camb/Glas* difference on heavy syllables (t=3.9, p<0.001). In both cases, syllable durations in Cambridge were longer.

Figure 1: Durational variability of strong and weak syllables in three conditions for each accent separately (N = number of tokens).



3.4. Rhythm class and rhythm metrics

On all factors investigated, Glasgow surprisingly showed a nearly constant and relatively low lengthening coefficient – a result we had expected to find in Bradford. On average, syllables were found to lengthen slightly more in Bradford. Leeds had the highest grade of lengthening on all factors. How do these observations relate to standard rhythm metrics looking at the overall variability of duration? Fig. 1 shows the distribution of strong and weak syllables across accents and conditions. Remarkably, Bradford data has the lowest variability compared to Glasgow, Cambridge and Leeds.

3.4.1. Variability coefficient

A common statistical measure of the data dispersion is the coefficient of variation which represents the ratio of the standard deviation to the mean:

(1) $$CV(x) = \frac{s(x)}{\bar{x}}$$

If applied to vocalic intervals (VarcoV), this coefficient reliably separates between accents of British English [14, 15]. Since structural factors have never been investigated in the metrics approach, it was appealing to look at which factor would reduce the data dispersion within an accent most effectively compared to its overall variability coefficient (Table 5). In the following, the variability coefficient was applied to syllable durations (VarcoS).

Table 5: Variability coefficients calculated on syllable durations (VarcoS) for the whole data set and for each factor separately.

VarcoS		Cam	Lee	Bra	Gla
General		0.42	0.45	0.34	0.37
Lexical stress	strong	0.30	0.40	0.26	0.36
	weak	0.43	0.38	0.38	0.37
Word boundary	absent	0.29	0.37	0.23	0.33
	present	0.33	0.38	0.32	0.35
Syllable weight	heavy	0.29	0.28	0.19	0.30
	light	0.19	0.33	0.22	0.37

As expected, the three factors under investigation helped to reduce the variability. However, none of the factors captured durational data in Glasgow as its VarcoS remained fairly high. As for the other accents, the weight of a strong syllable seemed to induce the most variability. Similarly, syllables whose weight had not been controlled for (i.e. weak syllables and strong syllables followed by a word boundary), showed higher VarcoS.

3.4.2. Multi-factorial dispersion coefficient

The multi-factorial dispersion coefficient (Cmd or MDC) was created to take into account both the structural factors contributing to syllable lengthening and the durational variability on those factors. It is calculated as follows:

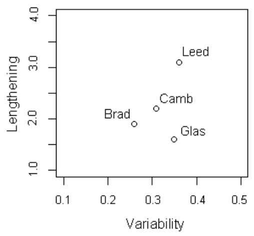
(2) $$Cmd = \prod_{i=1}^{n}\left(\frac{\bar{x}_i}{\bar{y}_i}\right)\sqrt{\frac{1}{2n}\sum_{i=1}^{n}(CV(x_i)+CV(y_i))^2}$$

where n is the number of syllable-lengthening factors considered relevant, and x and y are the lengthened and shortened durations measured on those factors, respectively. Based on the three structural factors (lexical stress, word boundary and syllable weight), the outcomes of (2) are displayed in Tab. 6 and Fig. 2. The first term of the equation corresponds to the joint lengthening coefficient (y-axis in Fig. 2) whereas the second term of the equation represents the joint variability coefficient (x-axis in Fig. 2). First of all, the MDC creates a clearer picture of the accent-specific timing patterns than the general VarcoS shown in Tab. 5. We found that Leeds was characterised not only by the highest degree of lengthening on the three factors but also by the highest variability. In contrast, Glasgow had the least lengthening and one of the highest variability levels. Lengthening was pronounced in Bradford but accompanied by a low joint variability coefficient. Finally, Cambridge positioned itself right in the middle of this two-dimensional timing dispersion space.

Table 6: Inter-dialectal differences on three metrics.

Timing metrics	Camb	Leed	Brad	Glas
Joint lengthening coefficient	2.2	3.1	1.9	1.6
Joint variability coefficient	0.31	0.36	0.27	0.35
Multi-factorial dispersion	0.65	1.15	0.49	0.56

Figure 2: Placement of four British English accents in the two-dimensional timing dispersion space as captured by MDC.



4. DISCUSSION

In this study, several factors were shown to contribute to the systematic timing differences within and across dialects. Lexical stress, intervening word boundary and syllable weight induced systematic syllable lengthening in all accents as also reported for other languages and dialects, e.g. [10, 13].

Inter-dialectal comparisons showed only limited support for Abercrombie's observations [1]. Heavy syllables in Leeds were not longer than in Cambridge, but the overall high degree of lengthening in the Leeds accent may explain the perceptual impression of a long-short trochaic rhythm. In Glasgow, strong syllables were not shorter than weak ones. However, strong syllables were shorter and weak syllables longer than in Cambridge. Combined with the low degree of syllable lengthening on all three factors, these timing properties could create the impression of a short-long trochaic rhythm. Surprisingly, Bradford and Leeds differed less than expected with Bradford only showing a smaller degree of word-final lengthening. [4]'s classification of Bradford as a syllable-timed variety may be connected to the overall low variability in syllable durations observed here.

We found that a standard rhythm metric (the variability coefficient) was sensitive to all factors but seemed to be mostly influenced by syllable weight, i.e. syllable structure (CV vs. CVC) and vowel category (tense vs. lax). This finding can be reconciled with the results presented in [7] for four accents of German showing that intrinsic duration of segments explained up to 58% of durational variability within each accent. However, syllable weight failed to show any effect in Glasgow. This might be explained by the fact that duration in Scottish vowel systems lacks the clear dichotomy of Southern British long (tense) and short (lax) vowels [11], which was not taken into account by Abercrombie. In future work, syllable weight needs to be defined with respect to the language- or dialect-specific properties of the corresponding vowel system.

The multi-factorial dispersion coefficient proposed here was more explanatory than the common rhythm metric Varco since MDC looked beyond temporal variability and integrated structural lengthening. The three factors investigated here are however not exhaustive and we assume that the more factors corresponding to the higher levels of prosodic hierarchy are fitted into the calculation of the coefficient, the higher the explanatory (and discriminatory) power of the MDC will be. In particular, factors related to the demarcation of prominence and grouping, which are considered core functions of perceived rhythm (e.g. [6]), should be taken into account. Ongoing work is further investigating how stable the MDC measure is and testing its discriminatory power on larger data sets.

Our study has shown that dialects can diverge on two components of MDC and have more syllable-timed behaviour on one but not on the other. These findings support the view that rhythm classes do not demarcate opposite ends of a continuum but are orthogonal dimensions and can co-exist in a language [9].

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