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Changing sounds in a changing city: An acoustic phonetic investigation of real-time change over a century of Glaswegian[1]

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1. Introduction

Language change in progress has been shown to be as intricately linked with particular peoples and places, as with the linguistic systems within which they exist (e.g. Milroy 1992; Labov 1994, 2001; Eckert 2000, 2012; Beal 2006; 2010). This is clear from numerous apparent-time studies of change in progress; real-time views of language change are less common (e.g. Labov 1994; Sankoff 2006). For example, if we consider sound change in Scottish English, previous apparent-time studies of Glaswegian vernacular have shown increases in TH-fronting and L-vocalization alongside reduction in local Scottish variants such as /x/ and /ʍ/ (e.g. Stuart-Smith et al 2007). At first sight these changes look as if the traditional connections between a dialect (urban Scots) and its place (Glasgow) are being weakened in favour of supra-local norms (Kerswill 2003). Closer inspection of the relationships between linguistic variation and linguistic constraints on the one hand, and recent urban regeneration, social practices and local language ideologies on the other, suggest that these sound changes are tightly bound to the dialect and the city itself (Stuart-Smith et al 2007; Stuart-Smith et al 2013; cf Beal 2006, 2010). But questions remain, both with respect to this dialect and more generally, as to whether place is always so closely connected with sound changes, for example, those characterised by continuous acoustic phonetic variation, like vowel quality, and whether such an impression would be gained from real-time views of change within a particular place.

This paper contributes some new findings towards answering these general theoretical questions about real-time sound change and place. Our study exploits the possibilities offered for a longer-term perspective on real-time change by combining archive recordings from the First World War with those from a real- and apparent-time corpus from the 1970s. We consider three aspects of urban Scots, vowel quality and duration, and the realization of word-initial /l/, using acoustic phonetic measures. The real-time comparisons reveal change in progress in all three features. The direction of the changes is intriguing, since despite the substantial geographical and social changes which have taken place across the UK during especially the second half of the 20th century, and the impact of these in terms of contact-induced changes on urban British accents (e.g. Foulkes and Docherty 1999), it appears that linguistic and social factors to do with the dialect and its location have played a stronger role.

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2. Materials and resources

2.1. The Sounds of the City (SoC) corpus (1970-2010)
The *Sounds of the City* (*SoC*) corpus (http://soundsofthecity.arts.gla.ac.uk/) is a controlled-access, force-aligned, electronic corpus of audio recordings and orthographic transcripts, stored in a *LaBB-CAT* database (Fromont and Hay e.g. 2012). The recordings are of spontaneous speech, and include oral history and sociolinguistic interviews, conversations between friends, and extracts of broadcast speech. The informants are all working-class speakers of Glasgow dialect, as determined by factors such as socio-economic background, education, and occupation. The corpus currently holds recordings of different lengths from 142 male and female speakers (around 730,000 words), and is structured by decade of recording and generation of the speaker; see Table 1. The real- and apparent-time structure of the corpus allows investigation of stability and change effectively across the entire 20th century.

Decade of Birth *Speaker Age*	**1890s**	**1900s**	**1910s**	**1920s**	**1930s**	**1940s**	**1950s**	**1960s**	**1970s**	**1980s**	**1990s**
Older 67-90	[70s]	[80s]	[90s]	[00s]							
Middle 40-55				[70s]	[80s]	[90s]	[00s]				
Young 10-15								[70s]	[80s]	[90s]	[00s]

Table 1. Stratification of the Glaswegian *Sounds of the City (SoC)* corpus by age and decade of birth (decade of recording is given in square brackets; shaded columns indicate the period of Glasgow's urban regeneration).

2.1. The Berliner Lautarchiv (BL) sample (1916/17)[2]
The *Berliner Lautarchiv* (*BL*) recordings, now held in digital form at the British Library, were made by language teacher and sound pioneer, Wilhelm Doegen, and a Professor of English, Alois Brandl, during visits to Prisoner of War camps in various parts of Germany between 1916 and 1917, to document soldiers' languages and dialects. There are 17 recordings of Scottish soldiers, eight from the Central Belt (there is no recording from Edinburgh). Here we consider the speech of two men from Glasgow and one from a small village, Newarthill, in the countryside of Lanarkshire about 15 miles east of Glasgow (a few personal notes were recorded for each speaker):

Glasgow William Bryce states that he and his parents were from Glasgow. He was born on 14 January 1891, and was recorded aged 25, on 21 July 1916 in Sennelager. He was educated in a 'public' (probably state-funded) school and was in the army since the age of 18. He gives 'Scottish' as his mother tongue and regards English as an 'additional language'.

Maryhill John Johnstone appears to be more aspirational middle-class. He states that he was educated at a boarding school in Glasgow, and describes himself as an 'accountant', after

[2] For more information, see Stuart-Smith and Lawson (in press).

being previously at clerk in a railway company. We include him in our sample because his recording is clearly in Scots, though unlike Bryce and Fulton, he only admits to speaking in ‘English’. Johnstone was born on 4 April 1896, and was aged 21 when he was recorded on 15 June 1917 in Quedlinburg. Johnstone’s father is from Dumfries and his mother from Stirlingshire.

Newarthill Hugh Fulton, a ‘van man’, was slightly older than the other two men when he was recorded, aged 34 (born 4 March 1883) on 3 July 1917 at Gustrow. Fulton and his parents were both from Newarthill. He states that he was educated at a ‘public’ (state) school and that he could read and write in both ‘English’ and ‘Scottish’.

Short recordings were made from each speaker. Here we present analyses of the men reciting the passage, the *Parable of the Prodigal Son* (Luke chapter XV, verses 11-32). The few photographs of the recordings in progress, as shown in Figure 1, suggest that speakers had a text in front of them as they spoke (Doegen is holding the text above the recording horn for the speaker). They also had a rather diverse audience.

Figure 1: Wilhelm Doegen (right) recording a speaker in a German Prisoner of War camp (from *The Doegen Records Web Project*, http://doegen.ie/about; © Humboldt- Universität, Berlin).

3. Method

For both corpora, time-aligned transcriptions were made for each recording in Praat (Boersma and Weenick 2013), breaking the speech down into shorter utterances, usually intonational phrases aligning with major or minor syntactic boundaries. Transcripts and .wav files were then uploaded to *LaBB-CAT*, and an automatic phonemic transcription was generated by *LaBB-CAT*'s link with CELEX. After correction and addition of any new words, the recordings were then force aligned using HTK in *LaBB-CAT*, providing an automatic phonemic segmentation of the waveform. Segments were located for measurement by using orthographic or phonemic search strings, against other parameters such as lexical stress.

The sound quality of the recordings is variable in the *SoC* corpus but all can be analysed acoustically. Given that the *BL* materials are digitised versions of audio recordings made around a hundred years ago on shellac discs, their quality is poorer. The recordings were lowpass filtered to remove high-frequency hiss above 7KHz; thereafter noise-cancelling was carried out using Audacity (Audacity Project 2005). All automatic segment boundaries for the *BL* recordings were handcorrected using the filtered and noise-cancelled sound files. A broad transcription of stressed and unstressed vowel qualities was also carried out, replacing those produced automatically through the links with the CELEX databases, to ensure more accurate searches.

Our selection of variables for considering the evidence for real-time change using continuous acoustic phonetic measures was motivated by three factors. The first was practical: the quality of the *BL* recordings means that sounds characterized by higher energy regions, such as formants, are more amenable to acoustic analysis than others. The second was their possible status in terms of variation and change in Glaswegian over the course of the 20th century. The third was that each had already been investigated in a *SoC* subproject. This led us to select vowel quality (José et al 2013), vowel duration (Rathcke and Stuart-Smith under revision), and the realization of word-initial /l/ (Macdonald et al 2014). Here we only give an outline of the *SoC* studies since they are reported in detail in the references listed above.

4. Vowel quality

4.1. Vowel quality in Scottish English

Scots and Scottish Standard English generally share a vowel inventory, e.g. typically one vowel where Anglo-English has two for TRAP/BATH, FOOT/GOOSE, and COT/CAUGHT (Wells 1982), but deploy it differently for systematic lexical alternations (e.g. *aff/off* /a ɔ/, *heid/head* /i ɛ/, *oot/out* /ʉ ʌʉ/, e.g. Stuart-Smith 2003), and show some socially-stratified differences in phonetic realization (e.g. fronter /a ʉ/ in vernacular than standard; e.g. Macaulay 1977). Earlier descriptions of particular vowel qualities in particular dialects, especially by contrast with Scottish Standard English, Anglo-English and RP, can be gleaned from the elocution manuals (e.g. Grant 2012; McAllister 1938), and from studies on Glaswegian by Macaulay (1977) and Macafee (e.g. 1994). Johnston (1997) is the most comprehensive account of vowel variation in Scots, based on auditory analysis of the materials from the *Linguistic Survey of Scotland*.

Following Johnston and Macaulay we expected that over time, the acoustic qualities of the stressed vowels /i e a ɔ o ʉ/ might be fairly stable, with the possible exception of /ʉ/. /ʉ/ corresponds to Anglo-English GOOSE and FOOT, both of which are known to have undergone fronting during the 20th century, most especially GOOSE (Harrington et al 2011). Our question is whether the Scottish vowel quality, which was already much fronter than that of Anglo-English, would also be fronting, or whether it might have lowered over time, as suggested by Scobbie et al (2012).

4.2. Vowel quality in the Sounds of the City corpus

José et al (2013) analyzed the six unchecked monophongs /i e a ɔ o ʉ/ (MEET/BEAT, MATE/BAIT, CAT, COT, COAT, BOOT) in a subset of four speaker groups from the *SoC* corpus: (1) older men born in the 1890s and recorded in the 1970s; (2) older men born in the 1920s and recorded in the 2000s; (3) adolescents born in the 1960s and recorded in the 1970s; and (4) adolescents born in the 1990s and recorded in the 2000s. José et al used automatic search, extraction and measurement of first and second formants, followed by data pruning to remove outliers and problematic measures (cf Labov et al 2013). The formant measures were then normalized using the Lobanov method, for comparison and also because Rathcke and Stuart-Smith (2014) have shown that Lobanov normalization is an effective way of reducing the effects of noise and poor spectral balance on formant measures. Statistical analysis used Linear Mixed Effects modelling using the lme4 package in R to investigate the evidence for change over time for each vowel. F1 and F2 were the dependent variables, with fixed factors of Preceding and Following Context, and Group, and random factors of Speaker and Word. The results showed significant patterns consistent with change across apparent- and real-time for three vowels, BOOT, COT and COAT; we discuss these results together with the extended real-time comparison afforded by the BL recordings in 4.4 below; Figure 4.

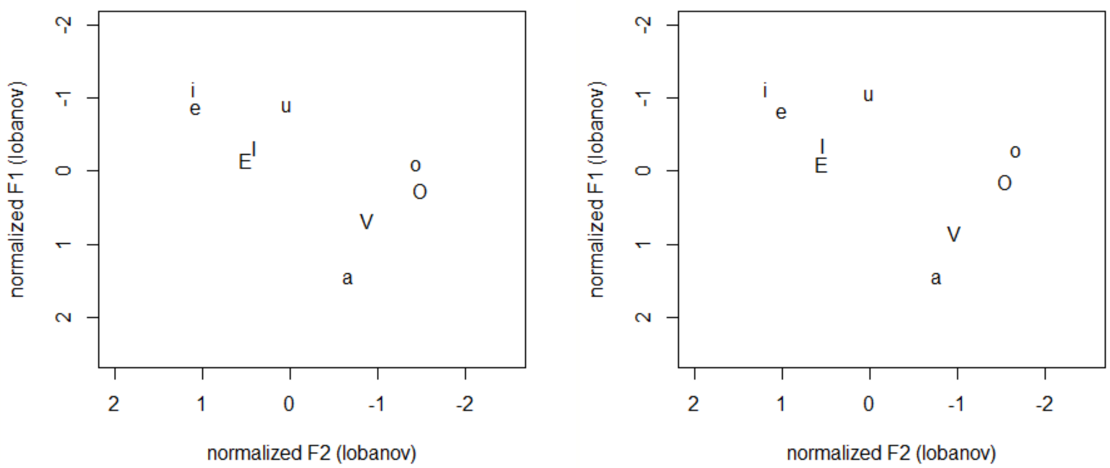
4.3. Vowel quality in the Berliner Lautarchiv speakers

All instances of the stressed vowel monophthongs were identified in the *BL* recordings, so /i ɪ e ɛ a ʌ ɔ o ʉ/ (MEET/BEAT, BIT, MATE/BAIT, BET, CAT, CUT, COT/CAUGHT, COAT, BOOT); n = 794. Vowels before /r/ were excluded because they constitute a separate subsystem in terms of quality (e.g. Lawson et al 2013). While we coded for Scots lexis, i.e. /i/ selected for Scots *heid* 'head', /a/ for Scots *aff* 'off', to see if vowel quality might vary in Scots words, the small numbers made it difficult to test for this statistically. Following José et al, the first three vowel formants were measured at 25%, 50% and 75% through the vowel duration in *LaBB-CAT*, which uses Praat's default settings. All measures were inspected and hand-corrected by consulting the spectrogram and/or vowel spectra. We also coded for the place of articulation of preceding and following segments.

Formant measures were taken from sound files which had not undergone filtering or noise cancellation, because the subsequent real-time comparison was made against measures from José et al which also had not been altered. As a precaution, a sample of formant measures was taken from the Glasgow speaker for stressed /i o ʉ/ from the sound files with and without noise cancellation and filtering. The measures from the two sound files were highly correlated, suggesting that the additional noise in the unaltered file may be less problematic for higher energy resonances in the lower formants: F1 (t = 31.25, df = 142, p < 0.001, R = 0.93); F2 (t = 28.24, df = 142, p < 0.001, R = 0.92). To facilitate the real-time comparison and minimize further the effects of noise, we normalized the measures using the Lobanov method.

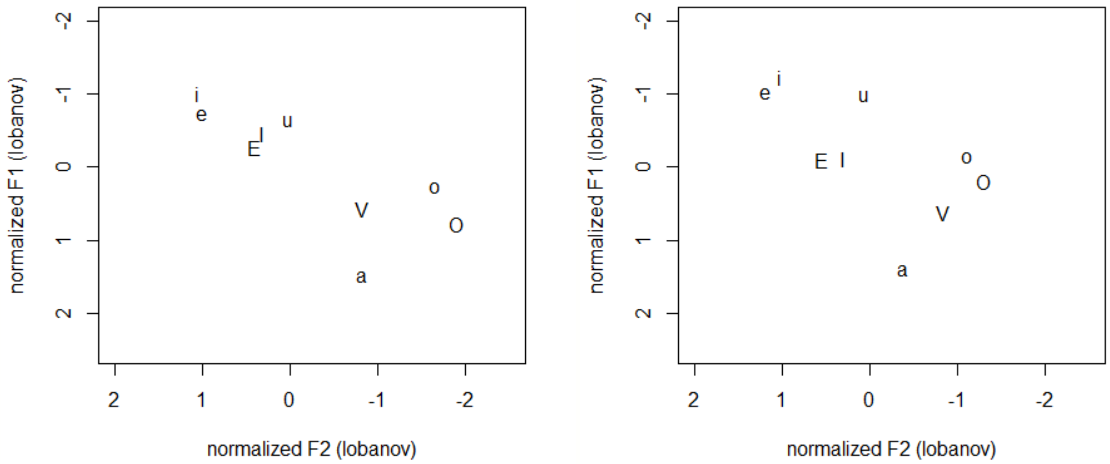
Figure 2 shows the Lobanov-normalized first and second formants of these vowels for all three speakers together (a), and for each speaker separately (Glasgow (b), Maryhill (c) and Newarthill (d)). We used LME modelling as in José et al, in order to ascertain the relative relationships of the vowels in the F2-F1 vowel space, so here the dependent variable was F1 or F2, and the fixed factors were Vowel, Preceding and Following Segment (interactions could not be included given the low numbers of tokens).

Vowel was a significant factor for both F1 and F2 (F1: F= 126.26, df = 8, p < 0.001; F2: F = 131.34, df = 8, p = 0.001). Place of articulation of the following segment was only significant for F2 (Preceding: F = 2.96, df = 3, p = 0.03; Following: F= 4.79, df = 3, p = 0.003). We report comparisons as significant after applying the appropriate Bonferroni correction to account for multiple comparisons.



(a) All *BL* speakers

(b) Glasgow speaker



(c) Maryhill speaker

(d) Newarthill speaker

Figure 2: Vowel plots for stressed monophongs /i ɪ e ɛ a ʌ ɔ o ʉ/ <i I e E a V O o u>, showing means of Lobanov-normalized F1 and F2 for (a) the three *BL* speakers recorded in 1916/17 (n = 794), and the speakers from (b) Glasgow (n = 289), (c) Maryhill (n= 239), and (d) Newarthill (n=266).

Overall, in terms of normalized F1, reflecting vowel height, the vowels fall into four groups from low to high: /a/, /ʌ/, /ɛ ɪ o ɔ/, and /i e ʉ/; /ɛ ɪ o/ are marginally higher than /ɔ/. In terms of normalized F2, reflecting vowel front-backness, there are effectively four groups from back to front: back /o ɔ/ and /a ʌ/, central/front /ʉ/, and the front vowels, which cluster as /ɛ ɪ/ and /i e/. So the vowel space for the *BL* speakers shows the following configuration: /a/ is a low vowel, retracted and close to /ʌ/. /o ɔ/ are back vowels, statistically almost merged in terms of height. /ʉ/ is a high vowel, which is fronter than /a ʌ ɔ o/, but not as front as /i e ɪ ɛ/. /i e/ are front high vowels; /ɪ/ is mid and retracted, with /ɛ/. These qualities align with some observations from contemporary descriptions.

/ɪ/ Grant (1912: 49) notes that in ‘Scotch dialect ... *hill* is often pronounced as if it were *hull* or *hell* or something between these two’; cf McAllister (1938: 134). Here we find retraction of /ɪ/, also noted by Johnston (1997:470), but not the stereotypical lowering to /ʌ/ found by Macaulay (1977).

/e/ The very raised quality of /e/ in our speakers is similar to Johnston’s (1997:459) ‘Raised MATE’, which he finds in some Mid-Scots speakers, alongside more usual ‘Mid e:’ for this vowel.

/ʉ/ Grant also refers (p.56) to the fronting of **u** (the vowel in *food*) ‘from the full back position in normal speech’, noting that ‘In some parts of Scotland, viz. Gaelic districts and in and around Glasgow, this advancing is very marked and should be corrected.’ McAllister (1938:161) also notes an ‘advanced’ quality of /u/ in ‘Clydeside’ speakers, also found in working-class speakers in Macaulay's study, and is designated 'OUT-fronting' by Johnston (1997: 475).

/o ɔ/ Johnston (1997:480) notes that merger of COT with COAT is 'more or less complete in vernacular Scots'.

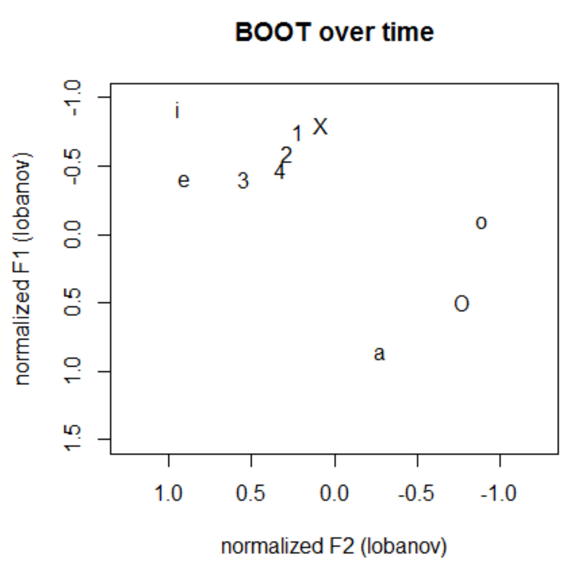
/a/ Both McAllister (1938) and Macaulay (1977) found retracted /a/ to be typical of 'local' and 'working-class' speakers respectively.

We can only make qualitative observations about the vowel qualities of the individual speakers. The country speaker from Newarthill shows the most lowered and retracted /ɪ ɛ/. The more aspirational Maryhill speaker shows the highest BIT and the most separation between COT and COAT, possibly reflecting some hypercorrection towards the standard. But he shares central /ʉ/ and retracted /a/ qualities with the other two men.

4.4. Vowel quality over the 20th century

The *SoC* findings of José et al indicate real-time lowering of BOOT and raising of COT and COAT since the 1970s. The apparent-time evidence of the elderly speakers suggests that these changes may have started much earlier in the century. The average decade of birth of the *BL* men and that of the older *SoC* men recorded in the 1970s is the same, the 1890s. The *BL* recordings enable us to check our inference of change with an extended, albeit cautious, real-time comparison. We remain cautious given the small number of speakers, the stylistic differences between the corpora, and the possibility of life-span shifts in the speakers recorded in the 1970s (cf Sankoff and Blondeau 2007).

The *BL* speakers were included as an additional group in the statistical modelling as described for José et al (4.2), for each of the six vowels. Indications of real-time change are confirmed for the three vowels; see Figure 4.



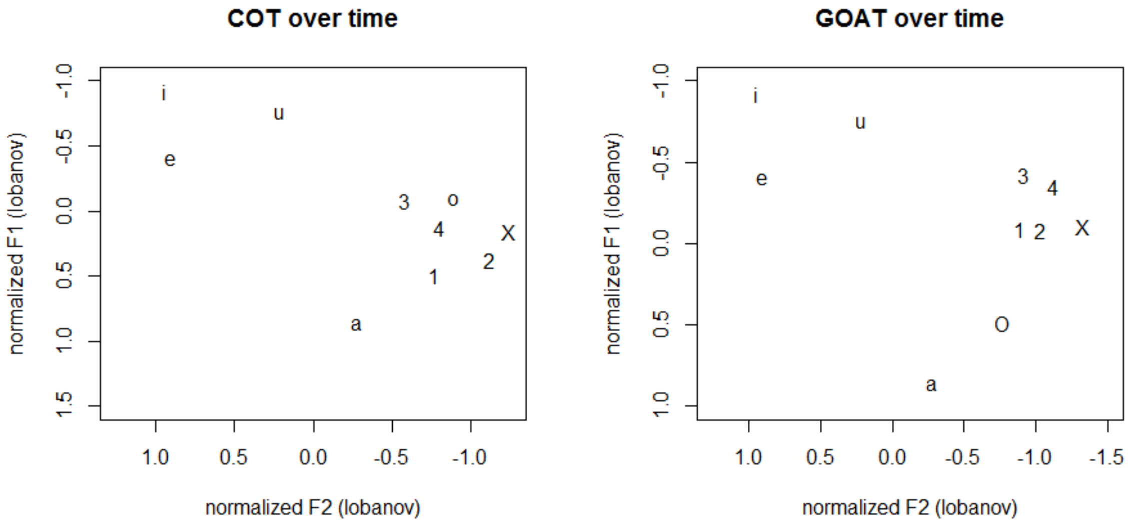


Figure 4: Plots of observed means of Lobanov-normalized F1 and F2 measures for stressed monophongs /i e a ɔ o ʉ/ <i e a O o u>, showing the relative position for each speaker group for (a) BOOT(n=1426), (b) COT (n=1261), and (c) COAT (n=913). 1 = older men born in the 1890s, recorded in the 1970s; 2 = older men born in the 1920s, recorded in the 2000s; 3 = adolescents born in the 1960s, recorded in the 1970s; 4 = adolescents born in the 1990s, recorded in the 2000s; X = the *BL* men born in the 1890s, recorded in the 1910s.

The clearest result is found for BOOT, which does indeed seem to be lowering over time (Group for F1: F =12.56, df = 4, p = 0.0002127). This finding is robust in the *SoC* sample, and is suggested by Scobbie et al's (2012) articulatory data. This new real-time comparison shows that the *BL* men show higher BOOT than all of the other groups except the older speakers who were also born in the 1890s, but recorded much later in their lives, in the 1970s. Thus, the lowering of /ʉ/ may have started after the First World War.

The results for COT and COAT are weaker, which probably also relates to the specific relationship between these two vowels. In Scots, COT is reported to be a higher vowel, often fully merged with COAT (Johnston 1997). The *BL* speakers also show a raised COT which is almost merged with COAT in terms of vowel height. But if we look at the relative means of COT and COAT for the *SoC* speaker groups 1 to 4 in Figure 4(b) and (c), we can see that COAT is higher than COT for all groups, indicating that this merger is not apparent for these speakers. Across real- and apparent-time, the *SoC* speakers show COT to be a higher vowel, whilst the *BL* speakers sit between them. Group is significant for F1: F = 3.38, df = 4, p = 0.04, but this reflects differences between Groups 1, 3 and 4. The *BL* men – with their almost merged COT/COAT – do not show differences in vowel height from any of the groups recorded later. We infer from this that COT probably has raised across the century, but that lowered variants of unmerged COT were also possible in vernacular speech even early in the 20^{th} century. What is more striking, and unexpected, is the fronting: Group is also significant for F2: F = 8.77, df = 4, p = 0.003, such that the *BL* men show backer COT than all of the other speaker groups.

COAT, on the other hand, shows significant real- and apparent-time raising in the *SoC* speaker groups, but there is only a tendency for raising in comparison with the *BL* speakers, possibly because of the low number of tokens for this vowel. Having said that, the distribution is more focussed in the F2 dimension, and the *BL* men do show a marginally more retracted COAT vowel than the adolescents born in the 1960s and recorded in the 1970s (F = 3.37, df = 4, p = 0.04).

5. Vowel duration – the Scottish Vowel Length Rule

Scottish English shows a distinctive pattern of phonologically and morphologically-conditioned vowel duration with respect to many varieties of Anglo-English, known as the Scottish Vowel Length Rule (SVLR). This is thought to have applied to all vowel monophthongs in the history of Scots (Aitken 1981; cf Johnston 1997). Grant's (1912:84) earlier comments on the shortening of tense vowels before plosive consonants in 'Standard Scottish', is followed by the observation that '[t]his shortening is specially marked in the high vowels, but is less noticeable with lower vowels'. He gives examples for /i/, /ʉ/ and /o/, e.g. *greed/agreed; brood/brewed, brew; road/rowed.* More recent durational analyses have found evidence for SVLR only for the vowels /i ʉ ai/ (Scobbie et al 1999). Further erosion in the direction of the Anglo-English pattern of vowel duration conditioned purely by voicing of the following consonant (the Voicing Effect) has also been found in varieties of Scottish English with higher levels of contact with Anglo-English, for example in Edinburgh (e.g. Hewlett et al 1999).

We expected that the SVLR would be robustly maintained in Glasgow over the twentieth century, though the impact of contact with Anglo-English through increased geographical and social mobility might also predict some contact-induced weakening, especially for the second half of the 20th century. We also wanted to see whether the *BL* recordings would show the SVLR in more vowels than /i ʉ ai/. Phonetic research on the effects of prosody on vowel duration points to weakening of durational patterns in particular prosodic contexts (e.g. Beckman et al1992; Nakai 2013). Previous studies of the SVLR have only considered citation forms in read speech. Both our corpora comprise connected speech, and so we were also able to investigate prosodic factors on the SVLR over time.

5.2. The SVLR in the Sounds of the City Corpus

Rathcke and Stuart-Smith (2014) examined the SVLR in /i/, /ʉ/ and /a/ in a real- and apparent-time subsample of 16 speakers from the *SoC* corpus, in four groups: 70M: middle-aged men born in the 1920s and recorded in the 1970s; 00M: middle-aged men born in the 1950s and recorded in the 2000s; 70Y: adolescent boys born in the 1960s and recorded in the 1970s; and 00Y: adolescent boys born in the 1990s and recorded in the 2000s. All possible tokens of the three vowels were extracted and the vowel durations were hand-corrected in EMU (Harrington 2010). Contexts were coded as SVLR 'short' unless the vowels were followed by a voiced fricative or /r/ (phonologically 'long') or a morpheme boundary (morphologically 'long'). Lack of difference between the two 'long' categories led to a single 'long' category. Voicing Effect contexts were coded according to the following context:

‘short’ if followed by a mono-morphemic voiceless obstruent, ‘long’ if followed by a mono-morphemic voiced obstruent, and ‘unspecified’ if morpheme final. Because vowel duration is sensitive to a range of other factors, tokens were also coded for properties of the word (number of segments in the word; number of syllables in the word) and prosodic factors (position of the word in the phrase: initial, medial, final; and prominence: stressed, accented, nuclear).

Previous phonetic studies of the SVLR have considered citation forms in read speech which make direct comparison of durations in SVLR and Voicing Effect contexts more straightforward (e.g. SVLR: *fleece* vs *please*, voicing effect: *seat* vs *seed* in Hewlett et al 1999). Given that the *SoC* data were from spontaneous conversational speech, we needed a statistical analytical strategy which would allow comparison of vowel durations according to the relevant contexts for SVLR and Voicing Effect, but which would also take account of other key factors. Rathcke and Stuart-Smith therefore used Linear Mixed Effects Modelling in lme4 in R to find the best fitting model. The dependent variable was vowel duration and the fixed factors were SVLR, Voicing Effect, and factors capturing prosodic and word-level factors. We also included random factors of Speaker and Word to control for lexical and speaker-specific effects, such as global speaking rate.

The results confirmed the SVLR for /i/ and /ʉ/ (see Figure 7 below), but not for /a/. Rathcke and Stuart-Smith also found evidence for weakening of the SVLR, both in a general reduction of the SVLR contrast in less prominent syllables (cf Beckman et al 1992), and in the shortening of SVLR long syllables in prominent syllables over time (cf Nakai 2013). Interestingly, this suggests that dialect-internal factors, especially prosodic, are promoting this change. There was only weak evidence to suggest that contact with Anglo-English varieties may be triggering a shift to the Voicing Effect patterning, and no significant Voicing Effect, contrary to Edinburgh English (e.g. Hewlett el al 1999).

5.3. The SVLR in the Berliner Lautarchiv recordings

We used the protocol developed by Rathcke and Stuart-Smith to analyse the *BL* recordings. Corrected segment boundaries were used to extract durations for the stressed monophthongs /i e a o ɔ ʉ/ and /ai/ to assess evidence for the SVLR in these three speakers (n = 517). The same coding for SVLR, Voicing Effect, and all prosodic and word-level factors was applied. We also used the same strategy for our statistical analysis, with modifications to account for the nature of the *BL* dataset. The fixed factors were SVLR, Voicing Effect, Number of segments, Vowel, Phrase position and Prominence, random factors were Speaker and Word. Possible interactions were limited by small numbers, but we were able to test for the three-way interaction of SVLR*Vowel*Prominence. We had hoped to be able to consider SVLR in all vowel qualities, but low numbers of tokens for GOAT and CAT in some contexts meant that our analysis was restricted to /i ʉ ai e ɔ/.

As expected, vowel durations were significantly longer in phrase-final position (by 26ms, F = 17.55, df = 1, $p < 0.001$), and in nuclear syllables (by 22ms, F = 17.62, df = 1, $p < 0.001$), but were shorter as the number of segments in the word increased (F = 6.9, df = 1, p = 0.009). Vowel was also a significant factor (F = 3.007, df = 4, p = 0.02), reflecting shorter durations of both /i/ and /ʉ/ than /ɔ/ and /ai/. Durations were longer in general in SVLR long contexts by 27 ms ($F = 21.45$, df = 1, $p < 0.001$), but particularly for certain vowels in nuclear syllables (Prominence*SVLR*Vowel: $F = 7.89$, df = 1, $p < 0.001$). The results of this three-way interaction are shown in the two charts in Figure 5. Overall much longer durations are found in nuclear syllables (upper chart), especially for /i ʉ/. SVLR is found for three vowels, /i ʉ ai/, though to different degrees. /ʉ/ shows the greatest lengthening (by 53ms, $t = 25.85$, $p < 0.001$), followed by /i/ (by 31ms, $t = 9.42$, $p < 0.005$) and /ai/, though only just longer statistically (by 34ms, $t = 1.37$, $p < 0.04$). Neither /e/ nor /ɔ/ shows statistical evidence for SVLR in these speakers, though /e/ is numerically longer by 12ms in nuclear SVLR contexts. There is no evidence for the Anglo-English Voicing Effect.

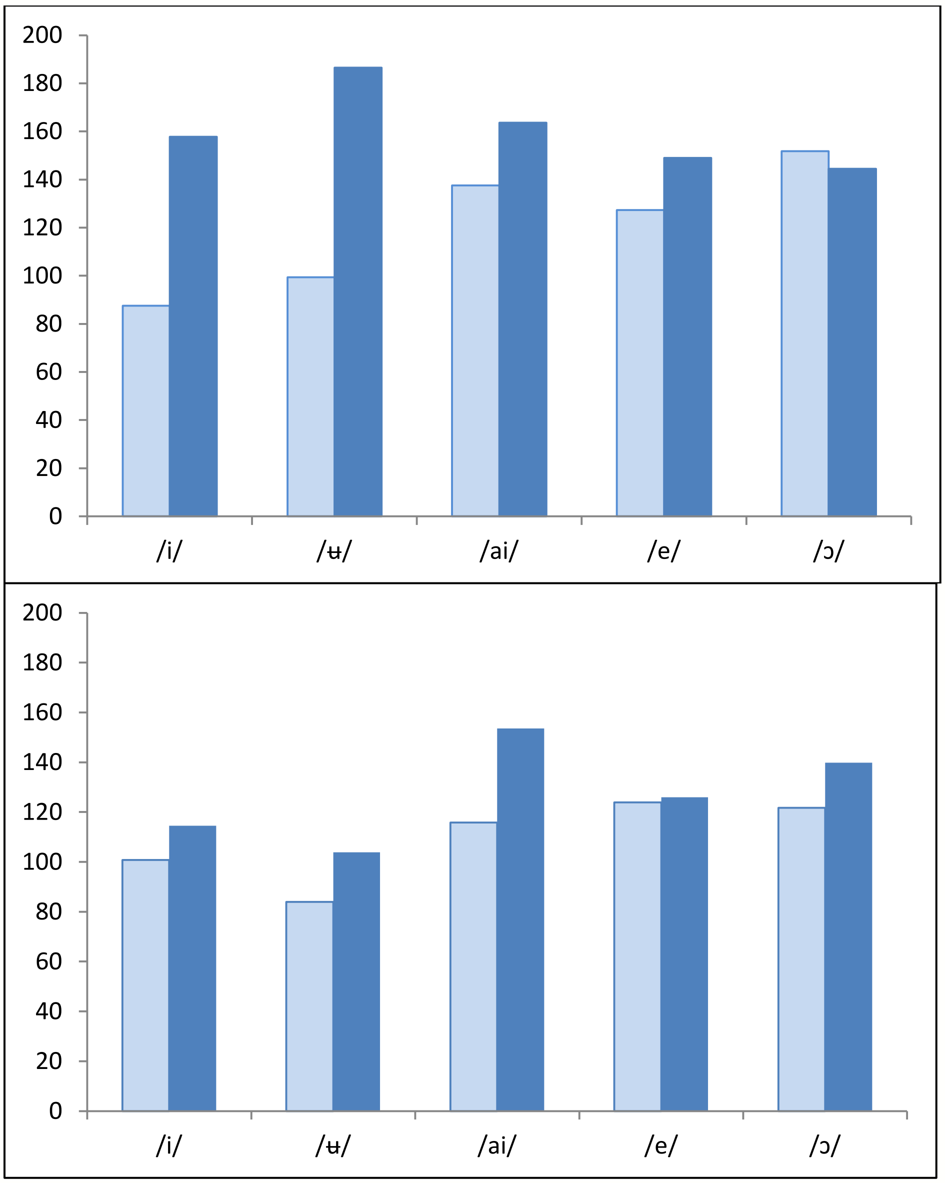
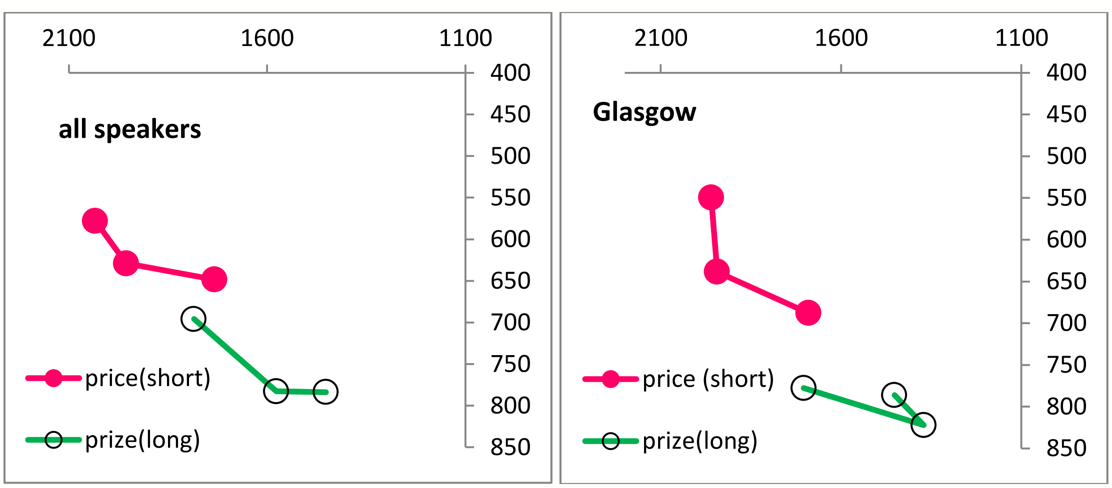


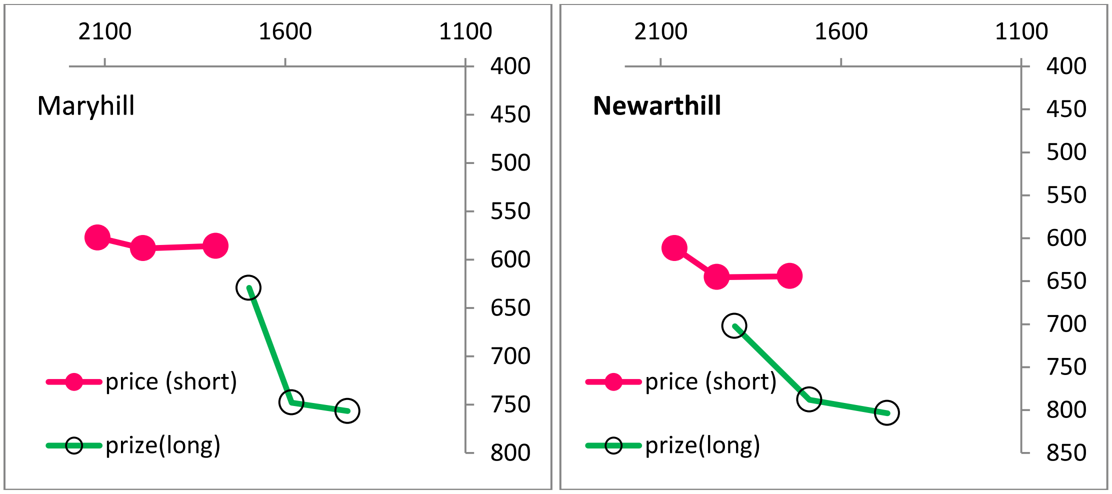
Figure 5: LME estimates of vowel durations in milliseconds for the *BL* speakers for vowels in nuclear syllables (top) and non-nuclear syllables (bottom). Light bars show SVLR short contexts, dark bars long contexts (n = 148).

Our results confirm Grant's observations for /i ʉ/, and align with those of Scobbie et al (1999) for Glasgow for /i ʉ ai/. We were unable to consider /o/ properly, given the low number of SVLR long tokens in nuclear position. Comparison of raw means shows that /o/ in SVLR long contexts is 12ms longer than short contexts. It is possible that these results, taken together with those of /e/, may reflect an erosion of the SVLR for /e/ and/o/ such that by the turn of the 19th century, consistent SVLR patterning no longer occurred for these vowels in Glasgow.

The situation for /ai/ seems to be different. PRIZE is longer in SVLR contexts, but the difference is only just significant. Scobbie et al (1999) found /ai/ to be proportionally longer than /o ɔ/ but shorter than /i ʉ/. In a subsequent study on the same Glasgow data, Scobbie and Stuart-Smith (2012) found vowel quality to be important, with the 'short' diphthongs produced as [ʌi/ɪi/əi], while the 'longer' diphthong is produced as [ai/ae]. Differentiation between short and long versions of the diphthong with these changes in quality also varies with differences of socio-economic background. We therefore also measured F1 and F2 across the duration of the diphthong, taking measures at 25%, 50%, and 75% across the vowel. Mean Hz tracks for /ai/ are shown in Figure 6. Consideration of the acoustic vowel quality suggests that for these speakers at least, the main difference between the SVLR long and short contexts is one of vowel quality, very much as shown later by Scobbie and Stuart-Smith (2012). Interestingly Grant (1912: 63) even seems to prescribe the SVLR-conditioned difference. He notes first that 'many speakers use **ə** as the first element in the diphthong in *rice, light*, etc. instead of **a**', reflecting the 'local' pronunciation observed by McAllister (1938:184). But then he goes on: 'This is allowable except when the diphthong ends the syllable or stands before **r, z, v, ð**.'



(a) (b)

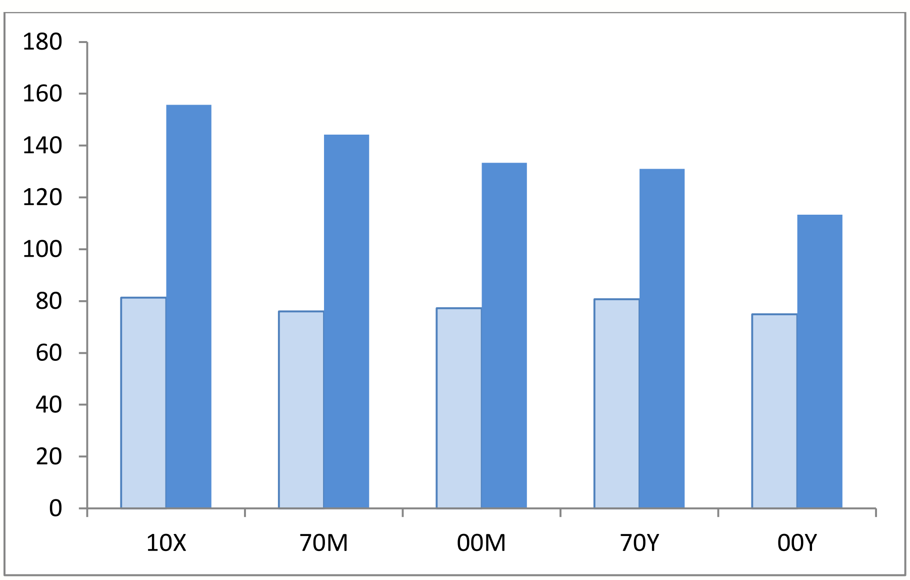


(c) (d)

Figure 6: Plots of mean F1 and F2 (Hz) measured at 25%, 50%, and 75% of the vowel duration for /ai/ according to SVLR short contexts (PRICE) and long contexts (PRIZE), for (a) all three speakers; (b) Glasgow; (c) Maryhill and (d) Newarthill (n = 37).

5.4. The SVLR over the 20th century

In order to carry out the real-time comparison across the *SoC* and *BL* data for SVLR, we ran Linear Mixed Effects models for the duration for /i ʉ/ for all five speaker groups, with fixed factors of SVLR, Voicing Effect, Group, Number of Segments, Prominence, together with a three-way interaction of Prominence*SVLR*Group, and random factors of Speaker and Word.



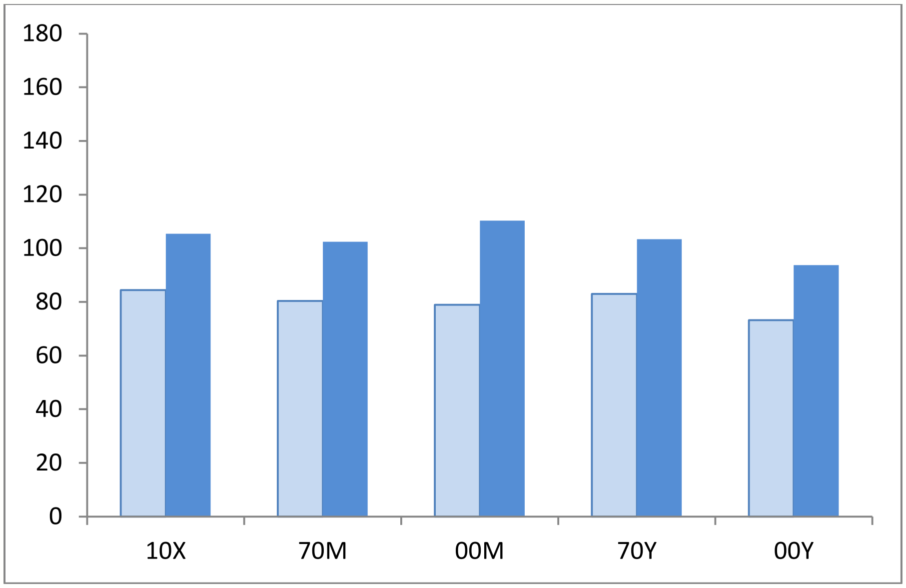


Figure 7: LME estimates in milliseconds for /i ʉ/ in SVLR contexts in five speaker groups, in nuclear syllables (top) and non-nuclear syllables (bottom). Light bars show SVLR short contexts, dark bars long contexts (n = 1130). 10X = *BL* sample born in 1890s, recorded in 1910s; 70M = middle-aged men born in the 1920s and recorded in the 1970s; 00M = middle-aged men born in the 1950s and recorded in the 2000s; 70Y = adolescent boys born in the 1960s and recorded in the 1970s; and 00Y = adolescent boys born in the 1990s and recorded in the 2000s.

The expected general prosodic effects were found to hold for the real-time dataset as a whole. Vowels were longer in phrase-final position (F = 124.23; df = 1; p < 0.001) and in nuclear syllables: F = 41.6; df = 1, p < 0.001), and a little shorter the more segments there were in the word (F = 10.23; df = 1, p = 0.002). SVLR long contexts also conditioned longer durations (F = 211.32; df = 1, p < 0.001). There was no evidence of the Anglo-English Voicing Effect.

The three-way interaction was also significant (F = 3.12, df = 4, p = 0.02), such that – as can be seen from Figure 7 – durations are longer in nuclear syllables, but those of the *BL* speaker group (10X) are longer than those of all speaker groups other than 70M, who were born in the 1920s and recorded in the 1970s. It looks as if the weakening of the SVLR in this prosodic position may have begun during or after the Second World War, which is consistent with the suggestion put forward by Rathcke and Stuart-Smith (2014) that weakening of the SVLR may have been additionally promoted by changes in social network structure during the process and aftermath of urban regeneration from the 1950s to the 1990s.

6. Word-initial /l/

6.1. Word-initial /l/ in Scottish English

Much attention has been paid to coda /l/ which is known to have vocalized historically in Scots, and more recently across urban British accents (e.g. Stuart-Smith et al 2006). Less is known about the realization of onset /l/, which is typically clearer in many varieties of Anglo-English, and dark in most varieties of Scottish English and especially Glaswegian (e.g. Johnston 1997:510; Stuart-Smith et al 2011). At the same time, while Johnston emphasizes the pharyngealized quality of Scots /l/, he also suggests that dark /l/ is – in the long term – the innovation ('the dark /l/ variant has won out except around the periphery'). The question is then whether there has been any shift in resonance over the 20th century.

6.2. Word-initial /l/ in the Sounds of the City Corpus

Macdonald and Stuart-Smith (2014) analysed the acoustic characteristics of word-initial /l/ according to preceding and following phonetic context and real-time in a subsample of the *SoC* corpus, three older men and three older women (aged 67-90) recorded in the 1970s, 1980s, 1990s, and 2000s. Darkness of /l/ was considered in terms of relative F2 values, assuming darker /l/ shows lower values (e.g. Carter and Local 2007). All possible instances of /l/ were segmented following Carter and Local (2007). Hand-corrected F2 measures of the steady state were subjected to Linear Mixed Effects modelling using the lme4 package in R, looking for the best fitting model with fixed factors of Decade and Preceding and Following Context and random factors of Speaker and Word. The results showed expected significant conditioning effects of adjacent phonetic context. They also showed a significant effect of decade of birth/recording with F2 being darker in speakers born in the 1920s (and recorded in the 2000s) than the other three speaker groups (Figure 8).

6.3. Word-initial /l/ in the Berliner Lautarchiv recordings

All instances of stressed word-initial /l/ were located (n = 23), and the first three formant measures were taken at the midpoint of the steady state of the lateral. Obtaining reliable formant measures for /l/ was more difficult in the original sound files, and so for these measures, formant measures were taken from the noise-cancelled files, where visual inspection showed that that formant tracking was more accurate. Even so, every measure was hand checked. Preceding and Following context was also coded. The second formant values of possible instances of word-initial /l/ in the *BL* speakers are shown in Table 1.

Speaker	*Before high vowels*	*Before non-high vowels*	*All contexts*	*N*
Glasgow	1143	1009	1054	9
Maryhill	n/a	1294	1294	6
Newarthill	1410	1288	1319	8
Mean	1250	1197	1208	23

Table 1: Mean F2 in Hz for word-initial /l/ in the *BL* sample by following vowel height.

The overall average F2 Hz value falls into the higher end of Recasens and Espinosa's (2005) 'dark' lateral group, or the lower end of their 'clear' group. The speaker from Glasgow shows the lowest values, the rural speaker in Newarthill shows the highest values. The Maryhill accountant has high F2 values even before non-high vowels. This accords with the later advice from McAllister (1938:115): ‘Scottish speakers who aim at shedding cruder local characters from their speech [e.g. dark l] should make the use of clear **l** habitual’.

6.4. Word-initial /l/ over the 20th century

Our real-time comparison for /l/ can only be qualitative. We show the average F2 Hz values for each of the five speaker groups in Figure 8.

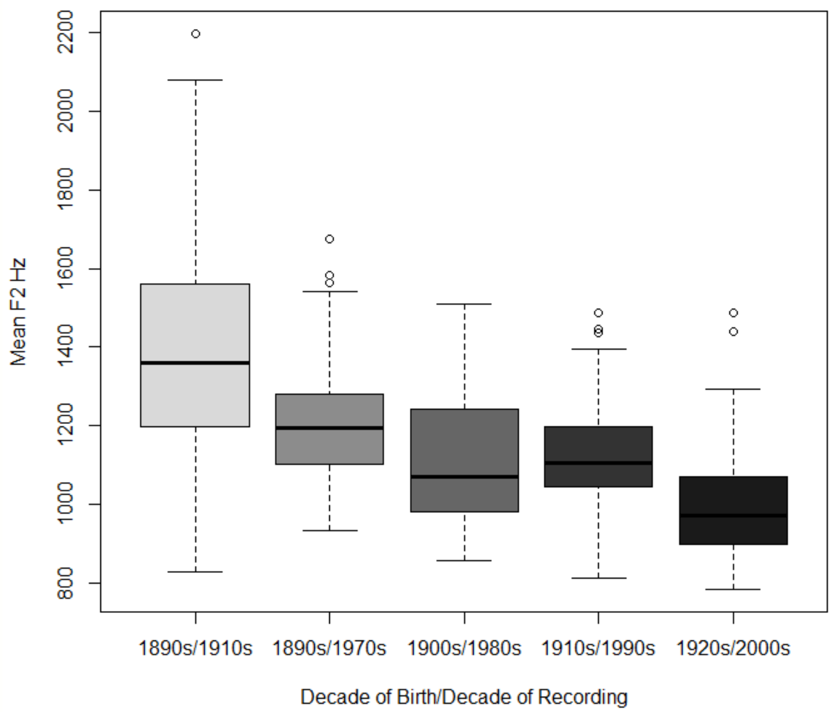


Figure 8: Mean F2 Hz values for word-initial /l/ across all phonetic contexts in the *BL* sample (1890s/1910s) and the male speaker groups from the *SoC* sample (n = 845).

The lowering of F2 values across the decade of birth/recording over the entire real-time sample clearly evident, with the older men born in the 1920s and recorded in the 2000s showing values similar to those of the dark, velarized laterals found in Russian and Portuguese (Recasens and Espinosa 2005). At the same time, whilst the mean value for the *BL* sample is higher than those of the *SoC* speaker groups, the range for these 23 tokens is also extensive, both overlapping with the much darker /l/s of the later *SoC* speaker groups, but also showing some much higher F2 values (clearer instances). The general pattern looks consistent with the assumption of the darkening of /l/ over the 20th century, as implied by Johnston (1997). But we also note that the *BL* Glasgow speaker (Table 1) shows a lower average F2 Hz value than the older *SoC* men, who were also born in the 1890s but recorded much later in their lives, in the 1970s. This suggests that this change may also have shown age-grading, such that younger speakers led the darkening (the Glasgow soldier was 25).

7. Perspectives on real-time change and place from Scottish English

Our analysis of acoustic variation across the 20th century in Glasgow dialect yields the following findings:

- BOOT has lowered over time. The *SoC* data also show that COT and COAT are raising, but the Scots merger of COT/COAT evident in the *BL* speakers prevents further inference from the early recordings. This is consistent with assumptions made from articulatory data by Scobbie et al (2012). But it seems to be a different kind of change from those observed in the fronting of Anglo-English GOOSE and BOOT (e.g. Harrington et al 2011). This looks more like evidence of a chain-shift (Labov 1994), which is progressing within this dialect, and which may have begun after the First World War.

- the SVLR is now restricted to /i ʉ ai/ and is reduced in prosodically weaker syllables (Beckman et al 1992). It has also weakened over time in prosodically strong positions, consistent with Nakai (2013)'s observation that quantity differences can give way to prosodic timing effects. At the same time, there is no clear shift to the Anglo-English Voicing Effect. This also appears to be a dialect-internal change, promoted by prosodic factors, which – given the available time sampling – may have begun during or after the Second World War, possibly promoted by fragmentation of tight-knit social networks during the process of urban regeneration from the 1950s to 1970s (Milroy and Milroy 1985).

- Word-initial /l/ has become darker, confirming Johnston's (1997) observation also for the early 20th century for this variety of Scottish English. This change may also be dialect-internal because the trend for such a dark onset /l/ is in the opposite direction to clear onset /l/s in many Anglo-English varieties (cf Carter and Local 2007).

Together these changes are informative in terms of our perspective on change, in terms of time depth and analytical resolution, and for considering the role of place in sound change.

Increasing the resolution of our real-time window by including the *BL* archival evidence confirms these as changes across the 20th century. Our view of their progress across this period is necessarily affected by our sampling, but suggests shifts in vowel and lateral quality may have preceded those in vowel duration. Stability and shift is also observed if we consider the real-comparison for the auditory derhoticisation of coda /r/ in words like *car*, also made between across *BL* and *SoC* corpora by Stuart-Smith and Lawson (in press). There, the six *BL* speakers show similar levels of derhoticisation to the middle-aged men born in the 1940s and 1950s and recorded in the 1990s and 2000s, indicating stability in this feature for the first half of the century. It is difficult to know whether the impression of stability in derhoticisation versus change in the features considered here, is simply because of the time resolution of our 'window' and/or the sampling within that window (Milroy 2003).

It may also relate to the change itself. Stuart-Smith and Lawson (in press) also show that derhoticisation did increase, in Glaswegian at least, towards the end of the century. The

Glaswegian adolescents born in the 1980s and 1990s show much higher usage of weak /r/, suggesting either an age-graded increase, or that the change may taken off somewhat later than supposed. This took place in conjunction with the other consonantal changes, TH-fronting and L-vocalization, and all three seem to have acquired locally salient social meanings and accelerated around the same time through the interplay of several factors especially social practices and personal psychological engagement with TV (Stuart-Smith et al 2007; Stuart-Smith et al 2013; cf Jansen 2014). These consonantal changes look like instances of supralocal diffusion (e.g. Kerswill 2003), but show weaker evidence for dialect contact, and stronger indications that the changes are strongly constrained by the 'local', the city and its dialect (Stuart-Smith et al 2103). This is highlighted by derhoticisation, which is now established by Lawson and Stuart-Smith (in press) as a local variant at the start of the century, and yet one which is also promoted by 'external' influence of the broadcast media, yet with no dialect contact, at its end. These changes appear to have long trajectories which relate to their locales (Beal 2006; 2010).

This brings us back to the questions posed at the outset. We have found evidence consistent with long-term real-time change for these three features. But despite the substantial geographical and social changes known to have taken place across the UK during especially the second half of the 20th century, we do not appear to have evidence for the influence of Anglo-English norms on any of the changes considered here. While this may be an erroneous impression in the absence of relevant data, these changes appear to have been promoted by dialect-internal factors, both linguistic and social, relating to the city of Glasgow itself.

Exactly how changes to the local context over the 20th century relates to these fine-grained shifts in speech remains a question for future research, though we have some hints from previous studies and the data themselves. Stuart-Smith et al (2007) argued that the social-spatial changes undergone by Glasgow during the period of urban regeneration between the 1950s and 1970s led to the fragmentation of previously dense social networks which was then followed by the re-formation of new tight-knit networks in the inner city districts from the mid-1970s on. The suggested impact on consonantal variation, following Milroy and Milroy (1985), was twofold: first, the weakening and reduction of the maintenance of some local variants, such as the Scottish consonants /x/ and /ʍ/ and the admission of new non-local variants such as TH-fronting and L-vocalization; second, the acceleration of the new array of variation fuelled by local language ideologies (cf Andersen 1988).

Of the changes considered by comparing the *BL* and *SoC* corpora, the timeframe for the subtle erosion of the SVLR and derhoticisation of coda /r/ also seems consistent with this version of events, though both processes are evident in the dialect from the turn of the 20th century. The lowering of BOOT (and possibly then the raising of COAT and COT) and darkening of word-initial /l/ also seems to have started early in the century, but may well also have been accelerated by the social and linguistic impact of the urban regeneration and its aftermath. Future work will help us to refine and revise these suggestions, both by filling in the gaps by sampling more of the *SoC* corpus for these changes, and by considering the development of standard variety which accompanied the vernacular across the same period.

Finally, how important is the lens through which we observe change, i.e. via auditory (discrete) versus acoustic (continuous) data? The changes considered here are all phonetically gradient, even word-initial /l/, and they all look thoroughly local in their trajectories for change and structural embedding. The consonantal changes which took off in the 1980s are considered in terms of discrete auditory data, and look supralocal, especially TH-fronting and L-vocalization (Kerswill 2003). But we also know that in this dialect, structural linguistic factors were the strongest factors for these changes too (Stuart-Smith et al 2013). The distinction does not seem to be to do with whether the features are vocalic or consonantal, or whether they are structurally embedded (they all seem to be), nor is it easily related to the nature of the evidence (discrete/continuous; auditory/acoustic). We suspect it lies rather in the ways in which linguistic variation and locally-relevant social meanings may or may not become connected and established (Agha 2003; Eckert 2008). Much more research is needed to understand why some aspects of linguistic system seem to develop ideological associations relating to place more easily than others.

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