Articulatory Insights into Language Variation and Change: Preliminary Findings from an Ultrasound Study of Derhoticization in Scottish English

Eleanor Lawson, Jane Stuart-Smith, James Scobbie

1 Derhoticisation in Scottish English

Scottish English is widely assumed to be almost uniformly rhotic, both in the popular imagination and in general linguistic descriptions. However, over the past few decades, researchers have observed a process of derhoticisation in the speech of Central Belt Scots. In this paper, the preliminary results of a socially stratified articulatory and auditory study of the loss of coda /r/ in one variety of Scottish English will be presented.

1.1 The History of coda /r/-loss in Scottish English

Any study of r-loss in Scottish English must take into account the possibility of nonrhoticity spreading north from Anglo-English speech. That Anglo nonrhoticity has had an impact on Scottish speech is without question; however its influence has been socially restricted and levels of nonrhoticity have changed according to socio-political conditions since the 1800s. Researchers studying Edinburgh speech in the late 1970s and early 80s identified a movement amongst the Middle classes (MC), especially young females, away from semi-/nonrhoticity towards rhoticity[1] (see Romaine 1979, Speitel and Johnston 1983 and Johnston 1985). At the same time, researchers observed that many Working class (WC) speakers in Edinburgh and Glasgow, especially males, were using a form of coda /r/ that had been weakened to a pharyngealised vowel (Romaine 1979, Macafee 1983).

Ridicule of MC Anglo-Scottish accents in popular culture and an increase in nationalism may have lead to the MC shift towards rhoticity (see Romaine 1979 and Johnston 1985), however, the WC loss of /r/ appeared to be a slow-moving,

[1] MC Scottish coda /r/ today is typically an approximant with strong retroflection.

system-internal change, unconnected with Anglo nonrhoticity. Recently, Stuart-Smith has highlighted a large increase in levels of nonrhoticity among younger WC speakers in Glasgow (Stuart-Smith 2003, Stuart-Smith 2005, Stuart-Smith *et al* 2007).

1.2 Using ultrasound to supplement auditory and acoustic analysis

To date no effort has been made to explain the mechanism that might lie behind the vernacular derhoticisation process in Scottish English. Auditory and acoustic analyses of /r/ do not provide a clear picture of how /r/ is being lost with even trained phoneticians disagreeing about the nature of the reduced /r/s they hear (see Stuart-Smith 2007). Our study follows those of Delattre and Freeman (1968) and Alwan and Narayanan (1996) in using imaging techniques to gain insight into how the /r/ articulation is formed. Ultrasound tongue imaging (UTI) is particularly useful in our study of Scottish coda /r/, because it is a safe and portable technology and, as Gick (2002: 113) stated, it has proved to be an invaluable tool in studying dynamic tongue movement and enabling measurement of elusive tongue root movement, clearly important for this study where /r/ is being heard as a pharyngeal vowel. Its ability to dynamically image the tongue root to tip is also essential for the study of timing and synchronization of lingual gestures.

1.3 The Pilot Study: identifying a temporal lag

A preliminary UTI study conducted by Scobbie and Stuart-Smith identified an articulatory feature that accounted for the difficulty researchers faced when they attempted to identify coda /r/ variants from an auditory perspective. It was a covert tongue-raising gesture that occurred after voicing had ceased. Pilot subjects that formed part of the current study confirmed the presence of this covert gesture in other speakers (see figure 1).

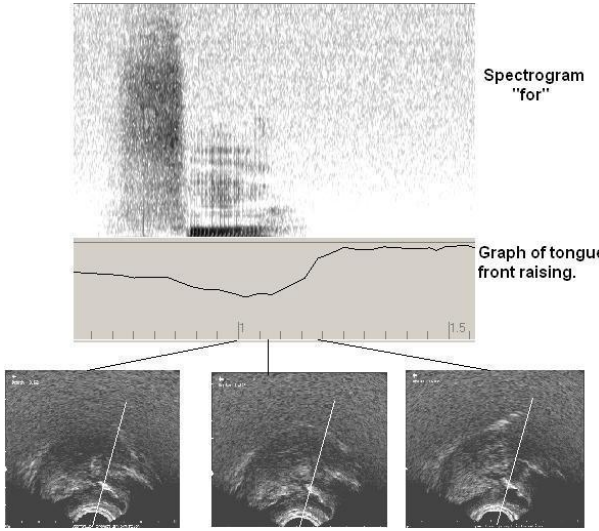


Figure 1: Key UTI frames of Pilot 2 (24 year old male from West Lothian) saying FOR (heard variably as [fɔ] and [fɔɻ]).

In the spectrogram in figure 1 above, the characteristic sharp rise in F2 and dip in F3, usually found in Scottish postvocalic /r/ (see Figure 2:1,3), are not evident – although subtle raising of F2 and falling of F3 are present towards the end of the voiced section. The graph of tongue front raising was generated by fitting a spline to the tongue surface using an edge-detection tool with manual correction. The graph shows at what distance the tongue-surface spline crosses a fixed line which is superimposed on the tongue image and radiates outwards from the ultrasound probe position (represented by a white line on each of the keyframes). The graph and the UTI keyframe images below it show that tongue front raising begins just as voicing is coming to an end, during a breathy period. The tongue front reaches its maximum height position after phonation and the breathy stage have finished. Tongue raising that occurs when formants fade may evidently be audible in the breathed period after voicing has ceased. Listeners sometimes have the impression that there is some sort of /r/ there, but not one that is easy to classify or even describe from an auditory basis alone (see figure 2).

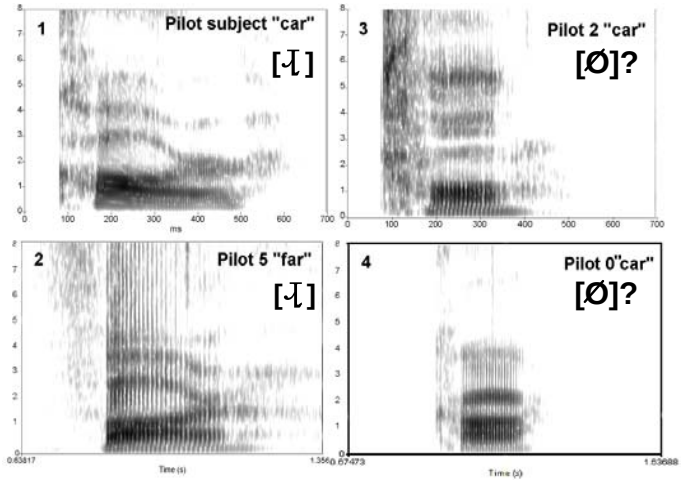


Figure 2: Spectrograms from the project pilot study showing four separate speakers producing words with coda /r/. Left hand images are of rhotic pronunciations; right-hand images show derhoticisation and are heard variably as rhotic or nonrhotic, depending on the system of the listener.

Images 1 and 2 in Figure 2 show retroflex rhotic [ɻ] spoken by female and male MC Scottish speakers respectively. They have characteristic rising F2 and lowering F3 and F4. Images 3 and 4 are from male WC speakers and show apparently nonrhotic pronunciations with little variation in formant values throughout the voiced section, yet some listeners still report hearing an /r/. It is possible that the retracted vowel quality contributes to the impression that /r/ is present; however, UTI movies of these utterances also show a covert tongue-raising gesture in the silent period after voicing.

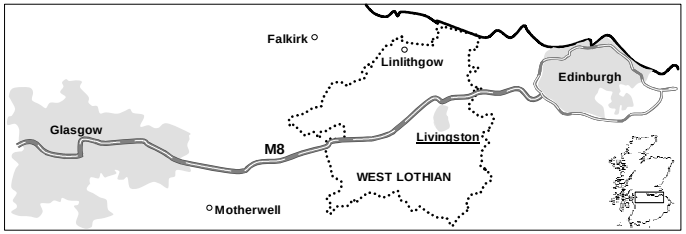
Derhoticisation in Scottish English is clearly a change from below (in the social sense) and so the most informal types of speech must be investigated. Increasingly lightweight ultrasound machines and developments in probe stabilisation in relation to the speaker's head are making sociolinguistic UTI fieldwork a possibility. Nevertheless, the psychological impact of the ultrasound machine, probe, associated hardware and the essential stabilising headset on informants' speech style is unknown. This first attempt at using UTI as a sociolinguistic fieldwork tool must have a twofold function: to provide useful

information about tongue movement in coda /r/ in younger speakers, and to assess the impact of the instrumentation on speech style. Thus, our research goals are: to gain insight into the articulatory processes involved in r-loss and to assess how useful UTI is as a sociolinguistic fieldwork tool.

2 Methodology

2.1 Location and informants

Our study involved 14 male[2] High School pupils aged 12-13 from a New Town in West Lothian called Livingston. The town is situated in the populous "Central Belt" region of Scotland (see map 1). It is 13 miles west of Edinburgh and 25 miles east of Glasgow, sitting next to the M8 motorway that links these main Scottish cities. Previous (sociolinguistic) research has been carried out in this area by Pollner (1985) and Robinson (2005), (see also Macafee 1997). The school used in the study (cf Robinson 2005) serves some of the most deprived areas in Livingston, which allowed us to gather informants from lower socio-economic groups.



Map 1: Map showing the location of Livingston and other major towns and cities in the central belt and the boundary of West Lothian.

2.2 Procedure

[2]Preliminary investigations by the researchers suggested that, in the Lothians region, males were more likely to exhibit derhoticisation than females

Informants were recorded in friendship pairs. Each pair was recorded in school on two separate occasions (Phase 1 and Phase 2). On both occasions, informants were recorded having a conversation for 20 minutes and reading a word list aloud. Phase 1 recordings were audio only, but for Phase 2, four speakers ('control' subjects) were recorded for a second time with audio only and the ten remaining speakers were recorded with audio and UTI. It was possible to record UTI data from only one informant in each pair during the conversation; however, both informants were led to believe that they were being recorded.

The audio recording was continuous; however, due to the large file size of the UTI recordings, they were made using automatic sampling throughout the conversation. Around 15 seconds of speech were recorded followed by 10 seconds of saving. This process was repeated continuously throughout the 20 minute conversation.[3] Analyses of the UTI images obtained were carried out using the *Articulate Assistant Advanced* software package. For an alternative UTI methodology, (see Miller-Ockhuizen 2000 and Gick; 2002).

2.3 Audio and Ultrasound equipment

Recordings were made in a quiet school room using lapel microphones and a digital audio recorder. Informants were asked to chat together for 20 minutes and later to read a word list aloud. This process was repeated the following day as described above.

Participants were encouraged to drink juice while they chatted; swallowing liquid is also a good means of obtaining a palate trace on the UTI image (Gick 2002:117).

The ultrasound machine used was a 9Kg portable Concept M6, fitted with two probes with 100° and 120° convex angles (imaging the root to the tip[4] of the tongue). The participants recorded under UTI conditions were asked to wear a headset made from lightweight aluminium in order to hold the probe in

[3]During one recording session, this continuous saving option was not selected (human error) and so only audio data was collected.

[4]As the tongue tip raises, it becomes harder to image as the ultrasound waves do not easily pass through the pocket of air under the tongue tip.

a fixed position under the chin. This ensured that there would be little lateral movement of the probe and no probe rotation. It also allowed the participants freedom of movement while they talked. Adjustable sections allow the headset to be fitted securely to an individual's head. Although the headset can cause discomfort after long periods of use, it might be considered preferable to holding the probe by hand, which can be tiring for the informant (see Gick 2002) and allows the probe to move, rotate and lose contact.

In this paper, we report preliminary findings on the potential psychosocial effects of the UTI recording context. Speech style might be affected by the recording scenario. We predicted that aspects of speaking might be affected by the UTI equipment, specifically the amount/nature of conversation between informants and variants used.

3 Results

3.1 Quantitative analysis of auditory data: levels of derhoticisation in Livingston English

This section presents some preliminary findings for the degree of derhoticisation amongst the Livingston informants, based on the first audio-only recordings. Post-vocalic /r/ was labelled in its phonological context for fifteen minutes of each 20 minute spontaneous speech recording (missing out the first five minutes). For the Phase 1 recordings, a total of 1283 tokens of postvocalic /r/ were identified in spontaneous speech.

For the practical purpose of transcribing a large number of tokens from spontaneous speech, the auditory continuum of variation for all tokens of /r/ was categorized into 'rhotic', i.e. those variants heard as articulated forms of /r/, including approximants, trills and taps (cf Stuart-Smith 2007), and 'non-rhotic', for which no articulated /r/-sound seemed audible – this included pharyngealised vowels. Figure 4 below shows the percentage of rhotic and non-rhotic tokens of /r/ for each informant for the initial audio-only recording.

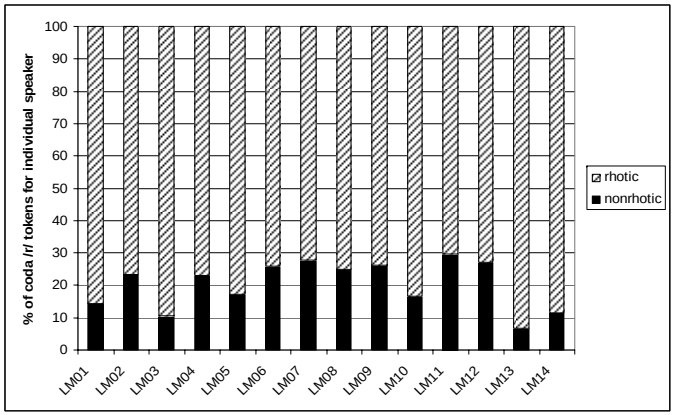


Figure 4: Percentage of vocalised and rhotic /r/ used by each speaker in spontaneous speech (Phase 1 spontaneous); n = 1283.

The pattern of derhoticisation in Livingston is somewhat different, and in particular less advanced, than that observed in Glasgow, where in 1997, 13-year old adolescents showed around 63% non-rhotic tokens in spontaneous speech (Stuart-Smith 2003; Stuart-Smith *et al* 2007). Amongst the working-class Livingston informants, the average percentage of non-rhotic tokens is much lower at 20%. We also note a further difference. Some working-class speakers in Livingston use high levels of retroflex rhotic variants of coda /r/ alongside typical low overt-prestige features e.g. TH-/DH-fronting, historical L-vocalisation [bɔ:] "ball"; Scots vowels [hem] "home", [hʉs] "house" and Scots constructions such as "cannae" for "can't" and "the morra" for "tomorrow". This is very different from working-class Glaswegian speech where retroflex variants occur far less frequently with the features mentioned above, and are rather associated with MC speech.

It was impressionistically observed that nonrhotic and derhoticised forms tended to occur in particular environments and so we recorded whether the syllable containing each coda /r/ token was stressed (primary and secondary) or unstressed and whether the token occurred utterance-finally or not. Figure 6 below shows the correlation between these conditions and the percentage of nonrhotic tokens obtained.

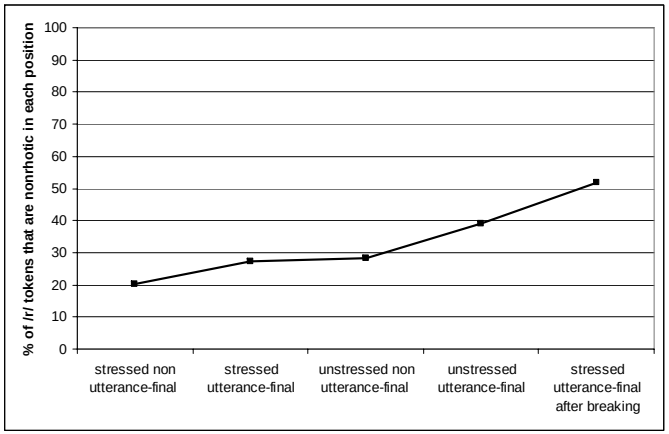


Figure 6: Percentage of (un)stressed tokens in utterance-final and non utterance-final position that were nonrhotic. n=1248

Stressed environments, with one key exception, occupy the lower end of the cline of nonrhoticity, while unstressed environments occupy the higher end.

Whilst overall the tendency to use non-rhotic variants is less in Livingston than Glasgow, there seems to be a similar patterning according to phonetic environment, as in Glasgow too, derhoticisation was more common in unstressed syllables (Stuart-Smith 2003). This association of unstressed syllables and nonrhoticity in turn corresponds with the earliest forms of Anglo nonrhoticity around 1700. Dobson observed from written evidence that r-less pronunciations were first evident in unstressed syllables (Dobson 1968: §427). It is possible that, as with many other coda consonants, deletion of /r/ is more likely in a reduced, unstressed syllable.

Nevertheless, in Figure 6 above, the environment yielding the greatest percentage of non-rhotic pronunciations is "utterance-final after vocalic breaking" e.g. "It's near here [ˈhiʌ(ɹ)]"[5]. This environment was impressionistically noted as being particularly associated with nonrhoticity and so was separately labeled in the spontaneous speech data. (Romaine 1979: 45, Speitel and Johnson 1983:28 and Stuart-Smith 2003)

[5]See Aitken (1979:103-4) on the history of vocalic breaking before /r/ in Scots speech.

have also flagged up what is variously called utterance-final "level-stress" or "prepausal" environment as important in the r-loss process.

Breaking confirms that there is a secondary pharyngeal constriction in Scottish /r/. Even though Delattre and Freeman (1968) concluded that this secondary gesture was absent from prevocalic British /r/, and this conclusion has been much repeated, analysis of ultrasound data gathered from the preliminary pilot study and the main data set shows tongue root retraction beginning before the tip-raising gesture when coda /r/ occurs in a stressed syllable.

The qualitative evidence (identification of delayed tongue tip raising) and quantitative evidence (identification of high levels of nonrhoticity in stressed utterance-final position) presented here suggest that the derhoticisation process in Scottish English might in part be a case of gestural lag due to coda lengthening at a major boundary (see Sproat and Fujimura 1993). More analysis of the data must be undertaken in order to confirm or refute this hypothesis.

3.2 Effect of ultrasound on style: word lists

We now turn to a preliminary assessment of the effect of the ultrasound recording conditions on speaker style. The assessment is based on a comparison of percentages of a limited number of variables in the initial and repeat word list task.

A quantitative analysis of non-standard variants such as T-glottaling e.g. [kaʔ] for "cat", and [bɛʔʌɹ] for "better", non-standard variants of TH – e.g. [hɪŋk], [fɪŋk], and [ʔɪŋk] for "think" – and nonhistorical vocalisation /l/ to a high back (un)rounded vowel, e.g. [wɪo] for "will" was carried out for both word list recordings for each informant. Comparison of levels of these variants could indicate whether speakers are modifying style between the audio-only and ultrasound conditions. The control group (audio-only for both recordings) were compared with speakers who were recorded with UTI for the second set of recordings.

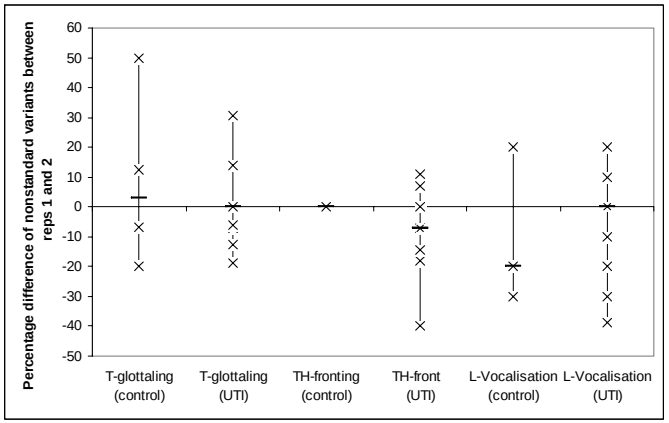


Figure 8: Plot showing the variation (increase/decrease/lack of change) in the use of nonstandard variants of T, TH and L between the first and second repetition of the word list (i.e. %Rep2 - %Rep1).

Figure 8 above shows the increases/decreases in nonstandard variant use. For the purpose of comparison, separate plots are situated side by side for the two speaker groups: 'control' and UTI condition. Individual speaker values are marked by crosses (some crosses are situated on top of one another). The group median is indicated by a dark horizontal line.

There appears to be no clear pattern of variation between the UTI group and the controls. For T-glottalling and TH-fronting the control group show higher median scores than their UTI-condition counterparts. This shows that, although some speakers decreased their use of non-standard variants in both groups, on average, the control group increased their levels of non-standard variants during the second Rep. or kept their levels the same, whereas the UTI group on average reduced their use of non-standard variants during the second Rep. However, the reverse is true of L-vocalisation where the control group on average decreased their use of vocalised variants more than the UTI group did on average. Values of increase/decrease in the percentage of the non-standard variants used do not show consistency within speaker groups, with the exception of the TH-fronting control group, all four of whom neither increased nor decreased their use of non-standard TH variants between

Reps 1 and 2. The T-glottalling UTI group is also fairly consistent, with most speakers showing a small percentage decrease in T-glottalling between Reps 1 and 2. It would seem that there is a good deal of individual stylistic variability between first and second repetitions of the word list in both the control and the UTI groups. On listening to Rep. 1 and Rep. 2 conversations, the use of non-standard features does not seem – impressionistically, at least – to have been affected by the ultrasound condition, which may be due to the normalising influence of talking to a friend. An analysis of the use of non-standard variants in spontaneous speech must also be undertaken.

4 Conclusion

Vernacular /r/-loss in Scottish English does not seem to be a result of Anglo-English influence. The sound change has a recorded history of two to three decades in the Central Belt cities of Edinburgh and Glasgow. Among the Livingston speakers in the present study, /r/-loss seems to be in its early stages. Young working-class males from Livingston are using fewer non-rhotic pronunciations than their Glaswegian counterparts. Nevertheless, on average, around a quarter of coda /r/ realisations in conversation were heard as non-rhotic.

This UTI study suggests some possible answers to the questions of why nonrhoticity is arising in Scottish English based on its quantitative and qualitative results. Nonrhoticity occurs most often in particular environments; in unstressed syllables and in utterance-final position – the latter especially in combination with vowel-breaking. Shortening of syllables which are unstressed may have led to the deletion of /r/ in coda position. On the other hand, lengthening of syllables that have utterance-final stress may cause separation of the tongue-root retraction gesture and the tip-raising gesture of approximant /r/ to the point that the anterior gesture occurs after voicing has ceased, making it less audible or inaudible. UTI confirms the presence of a delayed tongue raising gesture in many apparently nonrhotic pronunciations. Nonrhoticity may have spread from these restricted environments.

At this stage in our work, it appears that UTI conditions do not have any material impact on speaker style. This may be because the speakers were recorded in friendship pairs and/or

because they were recorded in their normal school environment, so that the a priori intrusiveness of the technique was mitigated, and did not appear to be different in effect to the presence of audio recording equipment. The precise factors required to ensure comparable data from field acoustic recordings, field articulatory recordings, and laboratory-based recordings of both types remain to be determined. For UTI at least, it is clear that obtaining articulatory data for sociolinguistic research in the field is methodologically feasible.

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Eleanor Lawson
James Scobbie
Department of Speech and Hearing Sciences
Queen Margaret University
Edinburgh
EH21 6UU
elawson@qmu.ac.uk
jscobbie@qmu.ac.uk

Jane Stuart-Smith
Department of English Language
12 University Gardens
University of Glasgow
G12 8QQ
J.Stuart-Smith@englang.arts.gla.ac.uk