Highlights

An acoustic analysis of rhoticity in Lancashire, England

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- First systematic instrumental analysis of a rhotic Anglo-English accent
- /r/ is weakening in non-prevocalic position as a change over time: younger speakers display much weaker /r/s
- Non-prevocalic /r/ is still present for most speakers but weaker than the rhotics reported for Standard Scottish English and General American English

An acoustic analysis of rhoticity in Lancashire, England

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Abstract

This paper presents the first systematic acoustic analysis of a rhotic accent in present-day England. The dataset comprises spontaneous and elicited speech of 28 speakers from Blackburn in Lancashire, Northern England, where residual rhoticity remains, having never been lost in the earlier sound change which rendered most of England non-rhotic. Although sociolinguistic studies of rhoticity in England exist, we have almost no description of its phonetic properties. Moreover, most sociolinguistic studies focus on the South West of England and relatively little is known about rhoticity in the North. Our study is timely because Northern rhoticity is predicted to disappear in the next few generations, a process which is now complete in many areas of the South West. Our results demonstrate that rhoticity is still present in Blackburn, although non-prevocalic /r/ is weaker when compared to other rhotic varieties of English such as those in Scotland and North America. We find that non-prevocalic /r/ is phonetically weakening in apparent time, with the F3-F2 difference being larger for younger speakers as well as females. We present additional social and linguistic factors affecting its potential demise, and discuss how our results contribute to our understanding of historical /r/-loss in Anglo-English.

Keywords: /r/, rhoticity, varieties of English, sociophonetics, sound change

1. Introduction

Rhoticity, the presence or absence of non-prevocalic /r/ in words like *ca**r*** and *bi**r**d* (Wells 1982), has been widely investigated by both phoneticians and phonologists and is one of the most comprehensively studied variables in English. Rhoticity is the major divider between the two most prominent national varieties of English either side of the Atlantic, as spoken in England and North America (Maguire et al. 2010), and has been shown to be subject to a large degree of variation over time and space. In England, most speakers are non-rhotic, which means

in accents such as Received Pronunciation (henceforth RP), words like *ca**r*** or *bi**r**d* are realised as r-less [kʰɑː] and [bɜːd] (as opposed to r-ful [kʰɑːɹ] and [bɚd]). For speakers of these non-rhotic varieties, non-prevocalic /r/ is categorically realised as a vocalised variant, rather than a consonantal /r/. This observation stands in contrast not only to the accents of General North American English (GenAm), but also other standard varieties in the British Isles such as Standard Scottish English (SSE) and Irish English, which are also rhotic (Wells 1982; Hickey 1999; Stuart-Smith et al. 2007).

Whilst the standard and the majority of speakers in England may be non-rhotic, there are some areas of England which remain rhotic today. These varieties, particularly those of the South West of England, are fairly well-described in the sociolinguistic literature (e.g., Blaxter et al. 2019), but no systematic instrumental or auditory phonetic descriptions exist. Sociophonetic research on rhoticity is largely focussed on sound change, and this, coupled with the fact that the rhotic speakers in Lancashire in the North West of England are particularly neglected in the existing literature, was the motivating factor behind the formation of this project. In this study, we present the first ever detailed analysis of these /r/s, including both a quantitative sociophonetic approach and a descriptive acoustic approach. Our investigation contributes to our phonetic and phonological understanding of rhotics more generally, which is important from both descriptive and theoretical perspectives, not least because rhoticity was the variable of the first-ever published sociophonetic study: William Labov's investigation of New York City (Labov 1972). Our study also plugs a long-standing gap in the sociophonetic literature by providing a detailed analysis of this under-studied variety.

Providing a missing piece of the puzzle by analysing an Anglo-English rhotic variety for the first time will be of interest to many linguists working on sound change who appreciate /r/'s quality of being 'extraordinarily sensitive to any measure of social or stylistic stratification' (Labov 1972: 169). In addition, we also note the theoretical contribution of this work, which concerns both sound change and dialectal documentation. Observing trends in progress today may give us some insight into how such changes happened in the past. While it is likely that the loss of /r/ in England was highly variable and took place over a long period, we are not able to measure the phonetics of the past. Our analysis affords us a window into the path of sound change by capturing a moment in time where rhoticity is still present, but changing. Charting how acoustic change unfolds synchronically may give us some insight into historical change in English. Our paper also speaks to dialectal micro-typologies and documentation by observing one of the few remaining places in England that still use this pronunciation. This enables

us to better understand the social and linguistic motivations behind such changes. Now is the time to study such surviving varieties to document evidence of the vernacular before it dies out altogether. Doing so will provide insight into just how accents change, who leads the change, and what the linguistic conditions affecting change are. The loss of conservative dialect features before documentation means that linguists will have missed out on the chance to study and analyse possible language typologies and the mechanisms of change. In addition, the loss of /r/ has catastrophic repercussions for the vowel system more generally (Wells 1982; Lightfoot 1999), so tracking /r/ loss in progress could help us understand the early stages of larger shifts.

Using spontaneous speech from sociolinguistic interviews with 28 speakers from the town of Blackburn, we provide a quantitative and descriptive analysis of Lancashire rhoticity, documenting the realisation of rhotics in this under-described variety and providing an up-to-date analysis of the status of rhoticity today.

The research questions and scope of the paper are as follows:

1. Are Lancashire rhotics undergoing a change over time? i.e., is non-prevocalic /r/ undergoing phonetic weakening or loss, in line with the rest of England?
2. What are the acoustic and auditory qualities of Lancashire rhoticity and how does this compare with other rhotic varieties of English? What does this mean for the speakers' representation of a segmental /r/?
3. What are the linguistic and social factors affecting potential change? e.g., age, gender, position in word, preceding vowel, length of rime, and speech style.

These research questions are addressed in two separate results sections, one providing a quantitative analysis of acoustic measurements (Section 4), and another focussing on a more detailed description of Lancashire rhotics from a selection of speakers (Section 5). We then provide a discussion summarising these findings with reference to the research questions, alongside matters arising from our analysis (Section 6).

2. Background of rhotics and rhoticity in English

Rhotics in English are exceptionally well-researched, spanning work in phonology and sociolinguistics, as well as phonetics. From a phonetic perspective, investigations comprise auditory (e.g., French 1989; Brown 1988; Foulkes and Docherty 2001), acoustic (e.g., Espy-Wilson et al. 2000; Docherty and Foulkes

2001; Carter 2002; Heselwood 2009; Kirkham 2015) and articulatory research (e.g., Delattre and Freeman 1968; Alwan et al. 1997; Campbell et al. 2010). In terms of the English-speaking world, we know a great deal about the phonetic properties of rhoticity in North America (Delattre and Freeman 1968; Zhou et al. 2008), Scotland (Lawson et al. 2014, 2018) and even in the Southland region of New Zealand, which largely retains historical rhoticity despite the common assumption that New Zealand speech is entirely non-rhotic (Hay 2005; Hay and MacLagan 2010; Marsden 2017; Villarreal et al. 2021). This wide-ranging collection of research (of which we have cited only a few examples) makes it particularly notable just how little we know about the phonetic properties of the remaining rhotic areas in England. This omission in the literature is likely due to the relatively isolated location of these areas compared to the major urban varieties that are more widely studied in sociophonetics in the UK,the general absence of rhoticity from middle-class speech (e.g. Sullivan 1992; Blaxter et al.), and the challenges faced in capturing the rapid decline that rhotic South-West England has experienced in recent decades, as we discuss below.

2.1. A brief history of rhoticity in England

Rhoticity in England saw its major decline in the 18th century (Wells 1982: 218), although its origins have been argued to begin anywhere from Middle English up to the 17th and 18th centuries (Wyld 1920; Matthews 1937; Hill 1940; McMahon 2000; Barber et al. 2009). Compiling dialectal evidence from Ellis (1889), Kurath and Lowman (1970), and Orton (1962), Gordon et al. (2004: 320) demonstrate that for speakers born in the mid-to-late 18th century, most of England had some kind of rhoticity, albeit variable or contextually restricted. Thus, as described by Lass (1997: 287), non-rhotic and rhotic realisations were likely co-existing in the same regions or speech communities for hundreds of years.

In direct contrast to the situation in North America, Scotland and Ireland, rhoticity in England in the present day is heavily stigmatised (Foulkes and Docherty 2007), representing a national rural stereotype (Barras 2011) and employed in media representation of characters for 'comic effect' (Trudgill 2000: 10). This is the opposite situation to the social meaning of derhoticisation (the process of phonetic weakening of non-prevocalic /r/; e.g. Stuart-Smith 2007) back in the 18th century, when the lack of non-prevocalic /r/ was subject to negative judgements (Carpenter 1868; Jones 1989; Mugglestone 2003). This direction of social evaluation, which is also seen in present-day North America, likely switched after the first few decades of the 1800s (Beal 1993). More recent research suggests that older speakers from once-rhotic areas in the North of England tend to link

the social meaning of rhoticity in England to tradition and older ways of life, and non-rhoticity to modernity and mobility (Dann et al. 2022; Ryan et al. 2022). Such social pressures may have contributed to rhoticity's demise in the minority areas which retained it just decades ago. Evidence from sociolinguistic and dialectological studies shows that rhoticity in the South West of England is levelling out in favour of the standard non-rhotic realisation (Williams and Kerswill 1999; Piercy 2012; Blaxter et al. 2019). This change, fairly rapid in the previous generations, is highlighted in the maps from Leemann et al. (2017), and Leemann et al. (2018), shown in Figure 1. These maps show the 2016 results of the English Dialect App (Leemann et al. 2018; a smartphone-based app where users can indicate their pronunciation of a range of words), alongside the original data from the Survey of English Dialects (SED; Orton 1962). As the maps demonstrate, rhoticity has undergone considerable decline in both the South West of England and areas in the North over the past 60 years.[1]

The North West of England has received very little attention in the published literature, particularly when compared to the South West (cf. Heselwood 2009, Barras 2015, and Ryan et al. 2022, discussed alongside various unpublished descriptions, in Section 2.3). Although Figure 1 shows a similar decline in the rhotic area of the North West, there remains a small pool of bright yellow, suggesting a strong, albeit highly localised, hold on rhoticity in this part of East Lancashire. This area on the map, between the labels of Preston and Bolton, has been described as an 'island of rhoticity' by Britain (2002: 56) and is the location of Blackburn, the speech community under analysis in the present paper. Given the evidence from Figure 1, it is possible that these speakers cannot hold the fort for much longer. This is particularly relevant in view of the related concepts of geographical diffusion of prestige variants (i.e., non-rhoticity in England) and supra-

[1] We note that the SED (Orton 1962) and the English Dialect App (EDA; Leemann et al. 2018) target very different speakers. The SED focusses on Non-Mobile Older Rural Males ('NORMs'; Orton 1962; Chambers and Trudgill 1980) and the EDA attracts younger upwardly mobile informants. Nevertheless, the picture of the decline still represents a dramatic loss. It is also important to note that the EDA collects self-reported productions, with the authors themselves pointing out the susceptibility of the data to participants' own intuitions about their language behaviour (rather than their actual behaviour), or the fact that they may be nostalgically reporting traditional variants that they no longer use (Leemann et al. 2018: 15). Finally, a reviewer notes that, in the later EDA map, the slightly lighter-coloured areas in the South and East of England may suggest an increase of rhoticity over time. In fact, this simply reflects the higher granularity of the data sampling in the EDA compared with the SED map, as pointed out by Leemann et al. (2018: 11): the EDA has different colour grades for each 5% bin, whereas the SED only has 20% colour bins.

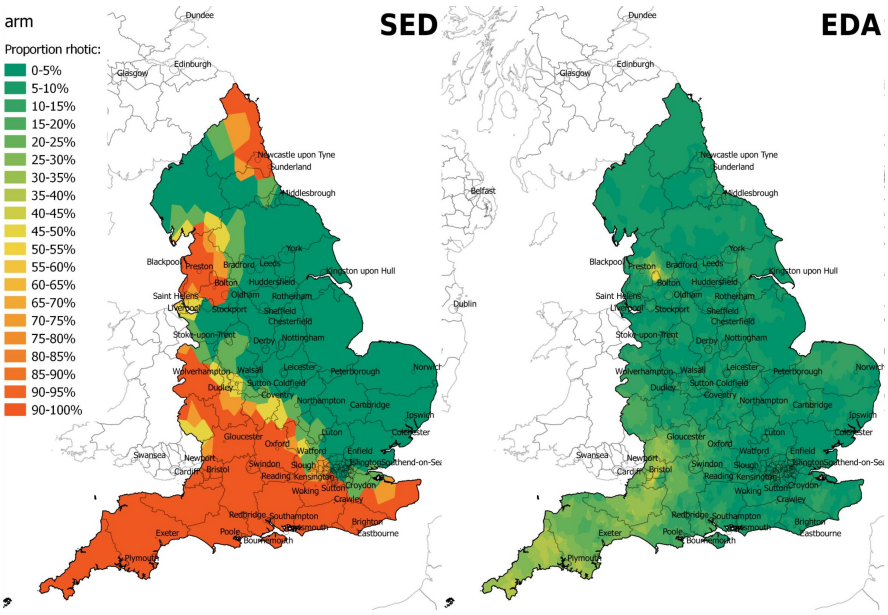

Figure 1: Rhoticity in the word ***arm*** in the Survey of English Dialects (SED; Orton 1962) and the English Dialect App (EDA; Leemann et al. 2018). Figure adapted from Leemann et al. (2018). Darker red areas are rhotic.

local dialect levelling (Britain 2002; Kerswill et al. 2003). Indeed, Wells stated in 1982 that Lancashire rhoticity is 'ever shrinking under the pressure of the non-rhotic majority'. Our analysis of these /r/s is timely, as rhoticity in Blackburn may soon disappear altogether. We return to a more detailed social overview below, but we first consider the optimal phonetic measurements to take when analysing rhoticity acoustically.

2.2. The phonetic properties of English /r/

The primary acoustic correlate of most rhotics in English is said to be a lowered F3 (Ladefoged and Maddieson 1996: 244), which is close to F2 (Delattre and Freeman 1968: 37; Lindau 1985: 165; Stevens 1998: 535-7; Espy-Wilson et al. 2000; Cruttenden 2001: 207; Johnson 2003: 111).[2] Stuart-Smith (2007: 1449) states that lowering of F3 is 'the most widely-recognized acoustic characteristic...of /r/'. Fujimura and Erickson (1997: 81) find that /r/ is characterised by an 'unmistakably low F3' which can be observed in different phonetic variants of

[2]Exceptions to this are taps, trills, and labiodental realisations.

/r/, as well as when in syllable initial and syllable final position. A lowered F3 has also been found to be the single best predictor of post-alveolar /r/ in some perception studies of English (Hay and MacLagan 2010).[3] With /r/ for most varieties of English, energy above (and sometimes around) F3 tends to be very weak, as there are two anterior constrictions in the vocal tract; from the tongue-tip or blade as well as lip narrowing (Stevens 1998: 539). However, at least for North American varieties, acoustic-articulatory work has shown that the relative positions of F3, F4, and F5 can reflect whether the tongue is in retroflex (where the tongue tip is raised upward towards the alveolar ridge, or curled upwards and back) or bunched (where the tongue front and/or dorsum is bunched upward) configuration (Zhou et al. 2008; Mielke et al. 2010; see also Lawson et al. 2014, 2018, for discussion of the acoustics of bunched vs. retroflex /r/ in Scottish English). Acoustic models of vowel production state that F3 should be low if there is constriction in the palatal region, or the lower pharyngeal region, as well as lip rounding (Delattre and Freeman 1968; Fant 1968; Ladefoged and Maddieson 1996).

While it is not the focus of this paper, it is important to understand the articulatory aspects of /r/, particularly as recent articulatory work in Scotland has shed new light on sound change involving rhotics (e.g., Lawson et al. 2008, 2014, 2018). Pronunciation texts (e.g. Cruttenden 2014: 222-8; Roach 2009: 49) largely describe Anglo-English /r/ as post-alveolar, with slight tip-up retroflexion, accompanied by some slight lip rounding and protrusion. Research from King and Ferragne (2020) shows that, at least for some non-rhotic speakers in England, a retroflex strategy (both tip-up and curled tongue variants) is most common for onset /r/, as opposed to a bunched-tongue strategy. More importantly for our purposes, many studies have sought to unveil how articulatory strategies manifest acoustically. The low F3 as discussed is thought to be due to the cavity space between the lips and the constriction in the palatal area. However, Hay and MacLagan (2010) argue that, regardless of articulatory matters, if a speaker increases the magnitude of articulatory gestures associated with /r/, producing a more /r/-like realisation, a lower F3 will be found (see also Guenther et al. 1999 on articulatory 'trade-offs'). Finally, British English prevocalic /r/s are not thought to be as pharyngealised as American English /r/s (Delattre and Freeman 1968), and pharyngealisation is a feature which contributes to a lower F3.

[3] Hay and MacLagan (2010) investigate New Zealand English and do not speculate on the most likely articulatory correlates of a lower F3, but simply refer to /r/s with lower F3s as having an increased constriction, whether that is increased retroflexion or increased bunching.

Despite the importance placed on the role of F3 by many studies, others argue that the proximity between F2 and F3 is more important than their individual frequency values. Heselwood et al. (2010) suggest that auditory integration occurs when F2 and F3 'fuse' into a single perceptual formant, which is hypothesised to happen when formants are within 3.5 Bark of one another (Hayward 2014: 156). The resultant strong perceptual peak around Z2 on the Bark scale (which is near F2) is said to be the most important acoustic feature for audibly strong rhoticity (Bladon 1983). However, we should also note the possibility of an influence on the formant patterning caused by resonance from the sublingual cavity in some configurations of /r/ (e.g. retroflex /r/, as noted by Stevens 1998). Heselwood's various works on this topic (see also Heselwood 2009; Heselwood and Plug 2011) are particularly important for our purposes, not only because they constitute the first phonetically-informed account of Lancashire /r/ to date, but also because they provide experimental support for the relevance of the peak in the Bark scale for audible rhoticity strength. Heselwood (2009) argues against the claims of the predominance of F3 alone for strong percepts of audible rhoticity, by presenting evidence for perceived rhoticity in approximant /r/ in English even when F3 is removed. By applying a low-pass filter to word tokens with /r/, he removed all acoustic energy above F2 during the vocalic portion, and phonetically-trained listeners still reported a rhotic quality. Furthermore, when presented with canonically non-rhotic sounds with F3 removed, Heselwood reports that 70% of listeners say the filtered token sounded rhotic. He argues that the primary acoustic correlate of /r/ is not necessarily a low F3, but in fact a sufficiently high F2 such that it is distant from F1[4]. Indeed, because of these results, Heselwood suggests that the presence of a strong F3 close to the F2 frequency range may in fact have the unexpected effect of inhibiting the perception of rhoticity in Anglo-English approximant /r/. However, this is in opposition to the findings of Lawson et al. (2018) and Lawson and Stuart-Smith (2021), who report that a low F3 close to F2 increases the auditory percept of rhoticity.

In order to inform the present study, we briefly summarise Heselwood's (2009) phonetic description of rhotic tokens produced by a 79-year-old male from Accrington, Lancashire, which is just five miles from our informants' speech com-

[4]Another argument for the importance of the acoustic and perceptual prominence of formant 'peaks' – perhaps more than the relative frequencies of the formants themselves – is that a reported high F3 in labiodental /r/ is acoustically prominent in some way, despite the fact that it is not necessarily accompanied by a corresponding high F2 (Docherty and Foulkes 2001: 178; Knight et al. 2007).

munity in Blackburn. Heselwood carried out a dynamic formant analysis of the V+/r/ section of the rime of NORTH/FORCE[5] words, finding that low F2 and high F3 begin to converge from the end of the vocalic section, with a corresponding increase in rhotic perception. For this speaker's NURSE words, formants were much less dynamic, with F2 and F3 in close proximity throughout the rime. This early onset of proximity of F2 and F3 results in a perception of rhoticity throughout the vocalic portion. Due to the early onset of a perception of rhoticity, Heselwood claims that the phonetic facts support an analysis in which /r/ is syllabic [ɹ̩] (Heselwood 2009: 53). Hayward (2014: 167) also makes this observation for American English [ɚ].

Aside from Heselwood's work, there are a few descriptions of the phonetics of Lancashire /r/ in the literature. In his grammar of nearby Bolton (formerly part of Lancashire, now part of the urban conurbation of Greater Manchester), Shorrocks (1980: 477) describes more traditional speakers as being rhotic (for Shorrocks, the term 'traditional' means the 'oldest discernible level or speech indigenous to an area'; 1980: 37). He states that /r/'s 'retroflex character can be taken for granted if it occurs post-vocalically' and also uses [ɹ̣] as a narrow transcription. It is worth noting that in terms of IPA transcription, 'retroflex' does not necessarily refer to a retroflex articulation. We know that bunched variants of approximant /r/ can have a similar auditory quality to a retroflex approximant (Delattre and Freeman 1968). There has also been little awareness of bunched variants in British English until relatively recently, and no symbol on the IPA chart to represent a bunched /r/. Therefore, it is possible that the /r/s described by Shorrocks (1980) could have been bunched rhotic approximants.

In the late 19th century, Lloyd (1899) wrote that Northern English had a set of 'coronal vowels', which describe the quality of the V+/r/ portions in the open and open-mid environments SQUARE, NURSE, START, and FORCE.[6] Lloyd notes that the configurations of these vowels are shifted backwards, so that the exit is between the tongue-tip and the palate, instead of at the lips (Lloyd 1899: 22). This could be interpreted as Northern English speakers of the time having a lowered jaw

[5]Heselwood's (2009) Accrington speakers do not make a distinction between the lexical sets NORTH and FORCE, and since these are also merged in Blackburn (unlike nearby areas in Greater Manchester, e.g. Baranowski 2022; MacKenzie et al. 2022), we will use the term NORTH/FORCE throughout the rest of this paper, when referring to these words in Blackburn.

[6]Interestingly, Lloyd (1899: 17) writes these with 'r' diacritics, to indicate their secondary quality (b*air*n ɛ̝ʳ, b*ur*n ʌʳ, b*ar*n ɑʳ and b*or*n ɔʳ) but makes no mention of the '*r*' in their orthography, which possibly indicates that non-rhoticity is already underway at that time.

for these vowels, or at the very least, that the lingual settings facilitate rhoticity. However, a more straightforward interpretation could be that this is a description of a rhoticised vowel with retroflection. If this latter interpretation were true, it could be one explanation for the progression of /r/ (through phonetic weakening) to a vocalic variant in England, in contrast to /r/ remaining consonantal in many varieties in Scotland, for example.

The various sources summarised throughout this section make use of analyses either focussing on the F3 midpoint or F3-F2 difference, and provide potentially important comparison points for our future research on articulation. This correspondence also has implications for phonological factors, which are of interest to us here, albeit not the main focus.

2.3. Sociolinguistic and variationist factors

Sociolinguists have long been interested in changing patterns of English rhoticity, as demonstrated by the wide range of studies in the British Isles (e.g., Williams 1991, Piercy 2012; Dickson and Hall-Lew 2017; Barras 2018), the USA (e.g., Labov 1966; Nagy and Irwin 2010; Becker 2014) and Southern Hemisphere Englishes (Hay 2005; Hartmann and Zerbian 2010). Many of these studies (an overview of which can be found in Blaxter et al. 2019) make use of the apparent time hypothesis, the sociolinguistic concept that older generations in a speech community use the linguistic forms they acquired in their youth – for most forms this means relative stability from around adolescence (e.g. Labov 1963, 1966; Sankoff and Blondeau 2007).

The sociolinguistic descriptive literature has closely followed the loss of rhoticity in England. For example, Trudgill (1986: 76) states that 'it is obvious that throughout England rhotic pronunciations are receding quite rapidly in the face of non-rhotic.' As indicated above, comments of this kind are corroborated by many variationist studies showing rhoticity's decline in apparent time. In an auditory analysis of the South West, Piercy (2012) compared four age groups in Dorset across both real and apparent time, finding that rhoticity has almost completely vanished in younger speakers, with females leading the change. Similar patterns of /r/-loss over time are reported in other studies of the South West counties of Dorset, Devon and Cornwall (Malarski 2017; Werner 2019). The same trend has been reported for various locations across the South of England over the years, including Reading (Williams and Kerswill 1999), Bristol (Blaxter et al. 2019) and the Isle of Wight (Williams 1991).

With the exception of Barras (2015, 2018), and the recent work on archival data by Ryan et al. (2022), sociolinguistic studies of North West rhoticity are

restricted to unpublished postgraduate and undergraduate dissertations (Vivian 2000; Austin 2007; Barras 2011; Kay 2011). Whilst most results from these studies of the rhotic areas of East Lancashire show rhoticity is on the decline (Austin 2007; Barras 2011), there is some evidence suggesting it is stable, with Vivian (2000) and Kay (2011) both noting a lack of change in rhoticity in apparent time studies. However, two of the East Lancashire towns surveyed by Austin (2007), Burnley and Crawshawbooth (which are only six miles apart), show dramatically different levels of advancement in terms of loss of rhoticity. Austin (2007) suggests that the low level of rhoticity in the largely working-class Burnley – compared with the more affluent Crawshawbooth, which had higher levels of rhoticity – was likely due to its greater distance from the East Lancashire 'island of rhoticity' (Britain 2002), rather than there being an effect of socio-economic status. The conflicting results presented by the unpublished studies cited here suggest a highly variable situation still in-flux, likely subject to variation and phonetic lenition. This is interesting because, if we accept the uniformitarian principle, that the changes which happened in the past operate in the same way in the present, (e.g. Christy 1983; Labov 1994: 21), our results may offer an insight into the mechanisms by which rhoticity may have been lost historically in England. This would mean that Blackburn in Lancashire potentially offers a snapshot in time providing some evidence as to the previously variable state of affairs in the rest of 18th century England. Of course, the sociolinguistic constraints have changed considerably since this time and although the linguistic constraints could be argued to have remained the same (in terms of position in word and preceding or following sound), English was different in many ways in the 18th century. Thus the system-internal forces that may or may not lead to sound change might have been different 300 years ago.

Sociolinguistic studies also give us an insightful picture into the internal constraints on rhoticity variation (again, see Blaxter et al. 2019 for a detailed summary). Because in some cases internal constraints apply in the same way regardless of the variety of English, it seems that the sociolinguistic factor of rhotic variation may be universal (at least in English), and not simply conditioned by a specific set of social circumstances applying to a single dialect. For example, pre-pausal *ca**r***-type tokens (as opposed to word-medial pre-consonantal *bi**r**d*-type tokens) are most commonly found to be a favouring environment for a rhotic realisation, and this includes studies in the US (Labov 1966; Nagy and Irwin 2010; Becker 2014) and in the UK (Barras 2011; Schützler 2010; Piercy 2012; Blaxter et al. 2019), where the rhoticity trends are heading in opposite directions. However, there are some exceptions, such as a preference for working-class Glasgow

speakers to produce non-rhotic variants in utterance-final position, following pre-/r/ breaking, which applies to high vowels in that variety, e.g. in words like *here* (Lawson et al. 2008; Bond 2013).

Whether or not we expect to find consistency across the English-speaking world in terms of rhoticity and preceding vowel, almost all auditory-coded sociolinguistic studies show that a preceding NURSE vowel favours the retention of /r/ (cf. Nagy and Irwin 2010) and the vowel context which finds least rhoticity is FORCE. *Lett*ER also ranks as the most non-rhotic context, but this likely reflects an effect of word stress, as the *lett*ER vowel is always unstressed. That said, Shorrocks (1980: 480) states that /r/ in nearby Bolton (13 miles away from our speech community of Blackburn), which is today likely completely non-rhotic (see also Millar 2012: 13), is 'most resilient' after the START vowel.[7] In terms of stress, all 10 studies surveyed by Blaxter et al. (2019) that looked at syllable stress found a favouring effect i.e., stressed syllables favoured a rhotic realisation. French (1989) found that turn-taking had an effect on rhoticity, such that word-final retroflex /r/ was used exclusively directly before the end of a turn, and argues for an interactional analysis to be considered.

2.4. The present study

The present study utilises a systematic acoustic analysis to investigate Lancashire rhoticity. Note that the sociolinguistic studies mentioned in the previous section are predominantly auditory analyses of rhoticity – as mentioned, until now there have been no instrumental measurements of present-day rhoticity in Lancashire (or in England, to our knowledge) on a community level. Whilst auditory studies have provided us with invaluable information on the status of rhoticity in

[7] A reviewer asks whether some well-known UK media personalities from Bolton – e.g. Peter Kay, Paddy McGuinness and Sara Cox – could be considered impressionistically rhotic. Whilst we do understand the motivation behind this question, we assert that these speakers are non-rhotic. On investigation, we hypothesise whether certain features of the Bolton accent give the impression of rhoticity when phonetically no [ɹ] is present. These features are i) the merger of *hair* and *her* towards *her* which, to the unmerged listener, creates a centralising effect on *hair* which could be perceived as rhoticity (and perhaps was the original phonetic motivation for the merger); ii) offglides in mainstream FORCE words which are better classified as CURE in some areas of the North West (and possibly Yorkshire) e.g. *door, four, more* may be interpreted as weakly rhotic by the mainstream listener who is unfamiliar with these words ever having an offglide (note these words do not tend to have an offglide in Blackburn like they do in Bolton). It is also possible that they do occasionally use their status as performers and include rhoticity as an exaggerated variant with the aim of projecting a traditional Bolton accent (e.g. Bell's Audience Design model, Bell 1984), but we cannot find any examples of this outside of specific character acting.

many varieties, some work, for example Stuart-Smith (2007), suggests that trained phoneticians might vary in their assessment of rhoticity (although there is consistency within, and between, the assessments of each listener; see also Plug and Ogden 2003; Yaeger-Dror et al. 2009; and Heselwood et al. 2010). It is important to state that we use the term 'derhoticisation' in the same way as Stuart-Smith, Lawson, and colleagues, who describe it as a process of phonetic weakening of /r/ (2007: 1449)[8]. The acoustic consequences of this are that the formant values of r-ful and r-less minimal pairs can be very similar, with a raising of F3 in pharyngealised or uvularised derhotic variants (Lawson et al. 2018; Lennon et al. 2015). This varies from treating /r/-loss as a categorical 'deletion', which is more common in the sociolinguistic literature (e.g. Labov 1966). As we shall see, conducting a more fine-grained acoustic approach to Lancashire rhoticity affords a window into the mechanisms behind this under-reported sound change.

3. Methodology

3.1. Speakers

This paper is based on the acoustic analysis of the speech of 28 informants born and raised in the Blackburn with Darwen area (which is the full name of the council borough) in East Lancashire, Northern England. Following Labovian sociolinguistic studies, we required informants to have been raised in Blackburn between the ages of 3-18 at the very least. The age range of our informants is 17-81 (mean age 43, median age 47) and is plotted in the histogram in Figure 2 by gender. Speakers are equally divided between females and males and have been given pseudonyms to preserve their anonymity.

The ethnic background of all of our speakers is white. Pilot investigations and work from Kirkham and Zara (2017) suggest that the large South Asian population in Blackburn (28% of the community) are not rhotic – or if they show occasional rhoticity, it is a heritage language effect (Nance et al. 2023). Because of this, we only analyse speakers from the white population who, with the exception of one or two, report that their parents and grandparents were from the same area, indicating long-standing generational links to the speech community. More detailed comparison between different ethnic identities will be the topic of a future investigation.

[8]The authors primarily use the term in reference to their articulatory work on Scottish derhoticisation, in which alveolar contact and pharyngealization are reduced over time

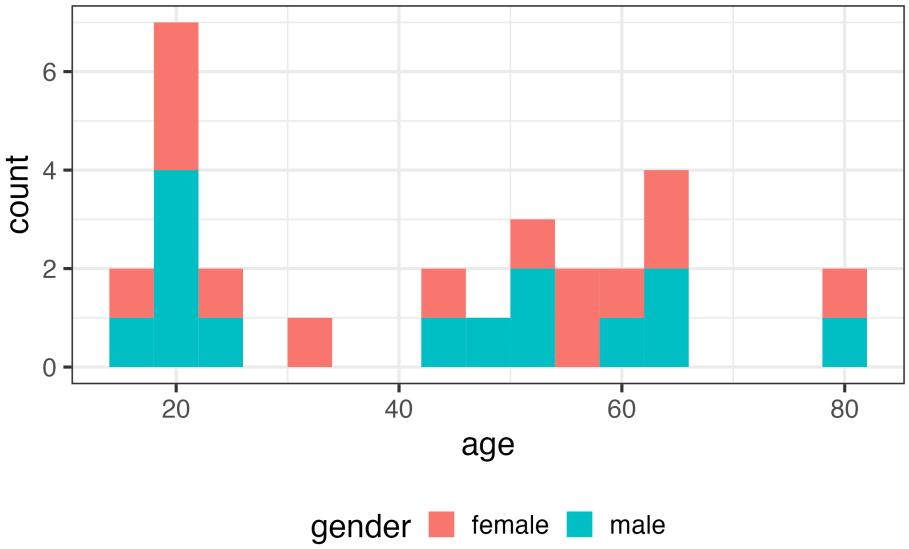

Figure 2: A histogram showing the age range and gender of speakers in the dataset.

3.2. Recording procedure

Speakers were recorded in sociolinguistic interview format (Labov 1984) in a place comfortable to them (usually their home), and, in all but one case, by an interviewer from Blackburn or the North West of England. In the sociolinguistic interview, questions are centred around the topics of growing up in Blackburn, eliciting narratives of personal experience. Spontaneous speech is supplemented by formal elicitation tasks at the end of the interview consisting of wordlists, followed by minimal pair tests. In our study, the wordlist contains many different words, including /r/ in a number of environments (see Appendix A), with speakers producing each word once. For the minimal pair test, the most formal speech style in variationist sociolinguistic research (Labov 1994), speakers are requested to: 'Read aloud the following words and indicate if they are the same or different: *spa* and *spar*'. The number of minimal pair tokens is variable per speaker, as some repeat the pairs multiple times whilst attempting to explain the difference, whilst others do not (see Section 3.5 for how we summarise our statistics so that speakers who talk more do not have additional influence on the plots). The elicited tasks specifically draw the speakers' attention to their own speech, which is why the spontaneous speech is collected first. The interviews were recorded on Zoom H4N recorders with Audio-Technica ATR3350 lavalier microphones, at a

sampling rate of 44.1 kHz at 24 bits.

3.3. Preparation

Interviews were transcribed and force-aligned in the FAVE suite (Forced Alignment and Vowel Extraction; Rosenfelder et al. 2014) for 25 of the interviews, switching to MFA (Montreal Forced Aligner; McAuliffe et al. 2017) for the final three. Note that no significant difference is found between the two aligners in terms of boundary placement (MacKenzie and Turton 2020: 9). Nevertheless, all force-aligned boundaries for /r/ were hand-checked and corrected by the second author. Hand-checking revealed a total of 1,693 tokens to be erroneous, requiring rejection. This was due to a range of issues including problematic aligner segments, overlapping speech or laughter from the interviewer, other background noises, and false starts, as well as segments misidentified by the aligner as non-prevocalic. A modified Praat script measured the first three formants in each V+/r/ sequence (Plug and Ogden 2003) at nine equally-spaced timepoints (between 10-90%), using Praat's formant tracker in the editor window to perform extractions. The script also extracted the duration of each V+/r/ sequence. In our Praat script, we set the formant ceiling at 5kHz for the male speakers and 5.5kHz for females. Given the size of the corpus, the only further step to ensure formant measurement accuracy was to remove 77 further tokens with an F3 below 1400Hz, as these were judged to be outside of the F3 range (Heselwood 2009) and therefore errors of measurement. This paper focusses on the static measurement of the F3-F2 difference (e.g. Lawson et al. 2013; Klein et al. 2013; Nance et al. 2023) at the point of minimum F3 in this sequence in spontaneous speech, wordlist items, and minimal pairs. Since the calculation of the difference between two formants does not require reference to other formant or vowel properties elsewhere in the speaker's productions, nor does it rely upon a formant's relationship to some arbitrary baseline, say, 0Hz, it is a feature-intrinsic normalising measure of rhoticity (see Adank et al. 2004 for a comparison of a range of vowel-intrinsic and vowel-extrinsic normalisation procedures).

Despite the F3-F2 difference measure's partially self-normalising nature, an anonymous reviewer is concerned that anatomical factors will not be eradicated with unnormalised measures, particularly for speaker sex. Since formants in males are on average lower than in females, this means that males' formants are potentially more compact. Thus a larger F3-F2 difference may not be down to sociolinguistic sound change towards weaker rhoticity, but may instead be down to physiological differences in the vocal tract resulting in greater formant separation in smaller vocal tracts. We note that the random effect for speaker in our

model (see below) takes care of this concern by allowing flexibility for all vocal tract sizes, which has been discussed recently in vowel normalisation papers (e.g. Barreda 2020, 2021; Voeten et al. 2022). Although the optimal model would include a normalisation method which eliminated all anatomical differences without eradicating real social ones, there exists no normalisation procedure for rhotic measurements that we are aware of that is not at risk of over-normalisation. Although it does seem that this is possible for vowels (**?**), as Mielke (2015: 2860) notes: 'the range of F3 values in rhotic vowels is far outside the typical F3 range of the other vowels in the system, and a transformation of F3 based only on F3 values would either be overly affected by rhoticity or based on too narrow a range of F3 values to be useful.' Thus, we follow recent papers in acoustic analyses of rhoticity (see also Sóskuthy and Stuart-Smith 2020; Lawson et al. 2013) by subtracting F2 from F3 and taking no further steps to normalisation.

3.4. Linguistic factors

In this paper, we analyse non-prevocalic /r/s including contexts represented by words like *bi**r**d* and *pe**r**son*, where the /r/ is non-final, and words like *ca**r***, when followed by a consonant or pause. Word-final /r/s followed by a vowel, e.g., *ca**r** alarm*, exhibit near obligatory linking-/r/, which occurs in most varieties of non-rhotic Englishes, so this context is beyond the envelope of variation for this paper (see Barras 2015 and also cf. Foulkes 1997).

The following words and contexts are very regularly realised without any rhotic in Blackburn, and were removed from our analysis. These are function words and unstressed contexts:

- copula *are, were*, *there*;
- other function words, e.g. *for*;
- demonstratives, e.g. *here, there*;
- unstressed word-medial syllables, e.g., *Saturday, advertise*.

These are frequently reduced and are in unstressed position, so it is likely they have a separate morpheme alternation stored with an unstressed, non-rhotic representation; e.g. *for* may have [fɔːɹ] and [fə]. Thus, these words are beyond the remit of investigation.

3.5. Statistical analysis

The statistical analyses reported in Section 4 are based on 12,252 tokens of non-prevocalic /r/, following the exclusion criteria outlined above. Table 2 shows the distribution of these tokens across the various factors built into the statistical analysis. The formant measurements are subjected to a series of mixed-effects linear regression analyses in R (R Core Team 2021), using the *lme4* package (Bates et al. 2015) to model F3-F2 at the F3 minimum, with a t-value of ±2 indicating a significant effect (shown in bold in the output tables). The following predictors, as detailed in Table 1, were chosen for inclusion in the final model(s), and were selected on *a priori* grounds. These were age, gender, positional context, lexical set (following the Wells's (1982) vowel sets – note in our context, this reflects preceding vowel class but also stress), rime duration and speech style. Speaker and word were entered as random effects. We tested for possible interactions between all fixed predictors, such as age and gender, lexical set and positional context, and style and duration.

Although previous studies (such as those listed by Blaxter et al. 2019) note that stressed syllables are a favouring environment for /r/, we do not include the factor of stress in our model in the same way. The reason for this, as alluded to above, is that once the unstressed tokens (in the categories listed above) were removed, the lexical set of *lett*ER accounted for the vast majority of remaining unstressed tokens. Encompassing stress within the *lett*ER lexical set turned out to be the optimal resolution from a statistical perspective, as including both the factors of lexical set and stress resulted in statistical issues arising from over-fitting of the model.

In model selection, we follow Barr (2013) in testing our random effects by including the maximal random effects structure as justified by the experimental design and reducing where appropriate. This involved testing by-speaker random slopes for style, lexical set and positional context to account for speakers who may show variability between these predictors. In all cases, the model failed to converge or showed over-fitting issues through singular fit warnings. Thus, we present a simple random effects structure as our best model in Section 4.

The dependent variable was centred around the mean, age was Z-scored in order to produce transparent estimates in the model output, and rime duration was log-transformed to avoid skew and to ensure the predictor conformed more closely to the normal distribution. Graphs are visualised using ggplot2 (Wickham 2016), and in the plots F3-F2 values are summarised (averaged) over speaker and word, to prevent influential speakers or words that have a higher number of tokens than others from skewing the overall effect. Confidence intervals are the 95%

default set by ggplot2. All figures incorporating waveforms and spectrograms are produced using a Praat drawing script (Plug 2021).

Predictor	**Factor levels/details**
age	continuous, z-scored
gender	*female* male
lexical set	*CURE* NORTH/FORCE *lett*ER NEAR NURSE SQUARE START
rime duration	continuous, log-transformed
positional context	*word-final pre-consonantal* e.g. *ca**r** boot* word-final pre-pausal e.g. *ca**r*** word-internal e.g. *bi**r**d*
style	*interview* word list minimal pairs

Table 1: Tested predictors and their factor levels. Baseline levels are italicised.

4. Quantitative analysis

We begin by considering variability from a quantitative perspective to investigate whether /r/ is changing over time, as may be predicted given the findings from the sociolinguistic literature. We provide an analysis of the F3-F2 difference at the point where F3 is at its lowest in the V+/r/ sequence, and we provide visualisations of our analysis of this difference. We fit statistical models using the methods described in Section 3 and the results of this can be seen in Table 2. This table demonstrates that significant predictors of more rhotic tokens, i.e., those which have a smaller F3-F2 difference, include the social factors of age, gender and style, the linguistic factors of lexical set and positional context, and the additional effect of rime duration. As explained more fully in Section 3, we tested for possible interactions between all fixed predictors, but none were found to be significant inclusions to the overall model. These effects are explored in detail below,

first exploring the social factors, then moving on to the linguistic and contextual factors.

We turn first to age to look at change over time through the lens of the apparent time hypothesis, introduced in Section 2. The idea behind the apparent time assumption for our current purpose is that if younger speakers have weaker /r/s in comparison to older speakers, this is indicative of a shift towards a more weakly rhotic realisation over time. The model shows exactly this: older people have a smaller distance between F3 and F2 (β = -81, t > ± 2; age is z-scored), which means their /r/s are acoustically stronger. This is visualised in Figure 3, where a smoothed, locally-weighted (loess) regression line is added to F3-F2 measurements, averaged over speaker and word, and shows the s-curve pattern which is often found in sociolinguistic and historical changes (e.g. Weinreich et al. 1968; Labov 1994; Chambers 2013). Note that the changing error bands in Figure 3 reflect differences in sampling density across speaker age (see Figure 2 for the age distribution of speakers). We will return to age effects after first looking at the effect of gender.

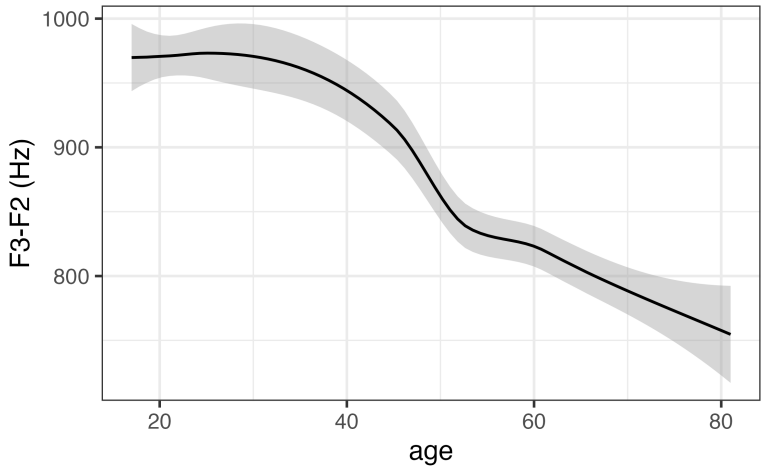

Figure 3: F3-F2 at F3 minimum across speaker age, averaged over speaker and word, demonstrating change towards weaker rhoticity in apparent time.

Figure 4 visualises the significant effect for gender reported in Table 2, demonstrating that males have a smaller F3-F2 difference, corresponding to acoustically stronger rhoticity. Table 2 shows that males have significantly stronger /r/s when compared to the baseline category of females (β = -101, t > ± 2). An anonymous reviewer has two concerns about the data points in Figure 4: i) that the

Predictors	Estimate	Std. error	t-value	N	Mean F3-F2
age (continuous, centred around mean)	-80.623	22.946	**-3.514**		
gender (baseline: *female*)				6283	927
male	-100.903	45.169	**-2.234**	5969	866
lexical set (baseline: CURE)				117	963
NORTH/FORCE	111.004	57.931	1.916	1956	1083
letter	-192.982	56.844	**-3.395**	4915	880
NEAR	-260.788	60.603	**-4.303**	787	698
NURSE	-201.497	58.273	**-3.458**	2251	818
SQUARE	-198.411	59.901	**-3.312**	743	798
START	18.159	58.422	0.311	1483	982
rime duration (log transformed)	-86.787	6.809	**-12.747**		
context (baseline: *word-final pre-cons*)				3415	941
word-final pre-pausal	-11.617	11.943	-0.973	2171	844
word-internal	-18.793	14.867	-1.264	6666	892
style (baseline: *interview*)				11654	903
minimal pairs	-88.290	32.496	**-2.717**	201	794
wordlist	-55.372	24.075	**-2.300**	397	795
(intercept)	-10.834	66.210	-0.164		

Table 2: Final model of all speech, including interview speech and elicited tokens of word lists and minimal pairs. Based on 12,252 tokens of non-prevocalic /r/. Higher values of F3-F2 (in Hertz) indicate weaker rhoticity. Model includes random effect of word (s.d. = 116.6) and of speaker (117.9). t-values above ±2 are indicative of a significant effect when compared to the baseline factor level and are highlighted in bold.

ranges show a great deal of overlap and that the statistical outlier points may be skewing the distribution and carrying the statistical significance and ii) that the difference between females and males may be anatomical. For the first concern, we can confirm that, alongside the robustness of mixed-effects models to such flukes even in data where the residuals violate normality assumptions (which ours do not; **?**, removing all outliers from the dataset and rerunning the models still resulted in the gender difference being significant (t = -2.2). Although Figure 4 shows a great deal of overlap between females and males, which may seem to indicate a lack of significance, this is often the case in a large corpus of natural speech that has not been controlled for vowel context, position in word, speech rate or style. If we accept that this is a change in progress, the model coefficients show that there is an effect size of females being around 101Hz F3-F2 ahead of males in the shift towards weaker rhoticity. The second point around anatomical differences concerns the fact that the more compact nature of formants from larger vocal tracts might mean that the smaller male difference is not social. In Section 3, we provide references and quotes outlining how random effects do a better job of any normalisation method for rhoticity by fitting to individuals rather than risking over-normalisation of all differences. We may never be able to rule the anatomical effect out completely, but we do note that the trend we observe is expected. Time and time again, women lead sound change and we find the same here. This is one of the Principles of Linguistic Change (Labov 2001).

This leads us to the overall interaction interaction between age and gender, which is visualised in Figure 5. This interaction is not a significant addition to the model, demonstrating that although women are ahead in this change over time, there is no evidence that they move at a different pace to men. Nevertheless, this visualisation adds to our understanding of the change. It shows that older males exhibit relatively strong non-prevocalic /r/s with a characteristically low F3-F2 difference, but their female counterparts do not show as low a difference, meaning their /r/s are not as strong. For the youngest generation, male and female speakers show similar rates of F3-F2, with relatively weak non-prevocalic /r/s, similar to that displayed by the older females. This is an indication of the typical situation often found in sound change as mentioned above when considering the cross-tabulation of age and gender: females lead and males of the next generation follow (Labov 2001: 309). For our data in particular, this means that the females have been more weakly rhotic from earlier generations (reflected in the older speakers' acoustic patterning), with younger females continuing to display this pattern, and the males, who were previously more rhotic, are now catching up.

An additional social effect of interest which further informs this change is that

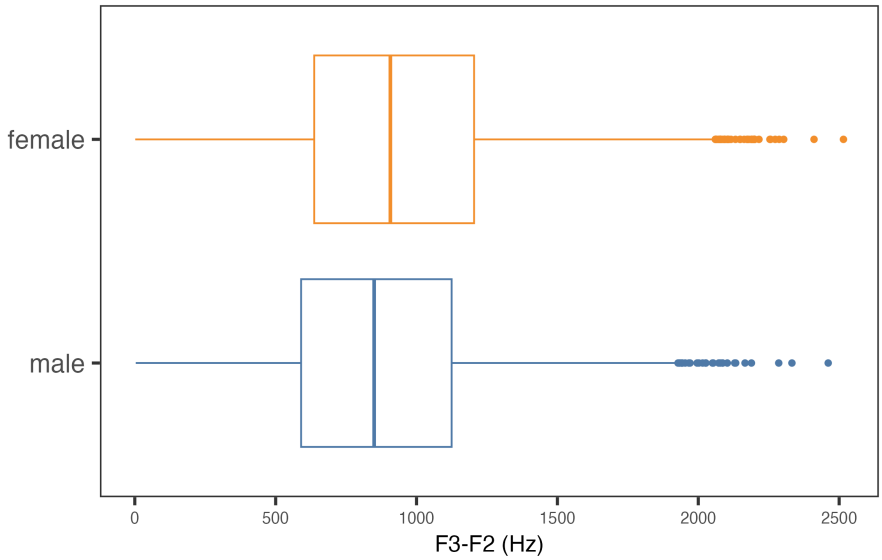

Figure 4: F3-F2 at F3 minimum across females and males

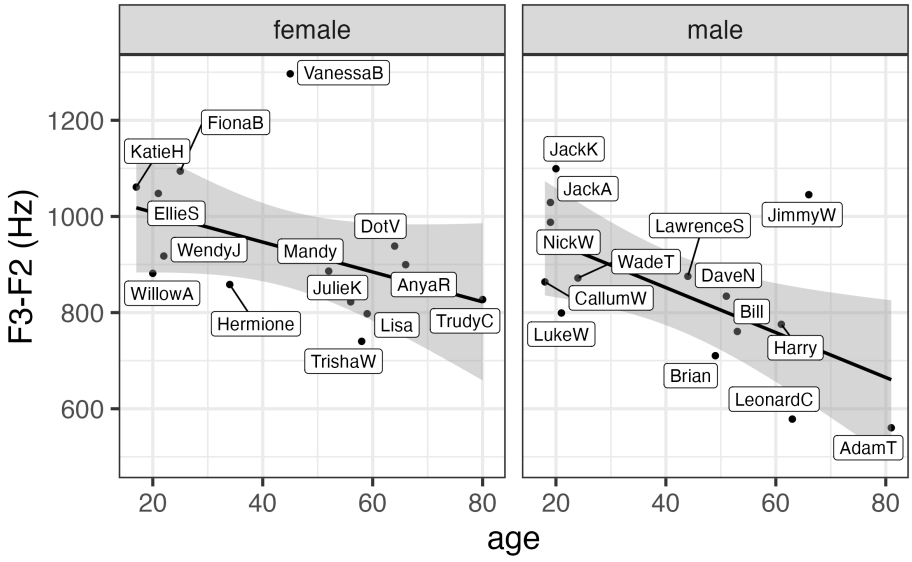

Figure 5: The interaction between age and gender on the realisation of /r/ in terms of F3 - F2 at F3 minimum, shown by speaker average. Dots show mean values for each speaker, and ribbons show 95% confidence interval.

of speech style, comparing natural speech from the interviews with elicited speech such as wordlists and minimal pairs. The minimal pair tests conducted at the very end of the interview (e.g., 'Read aloud the following words and indicate if they are the same or different: *spa* and *spar*') represent the task with the most attention drawn to speech. We might expect a stigmatised variant, as Lancashire rhoticity is claimed to be, to show lower rates or weaker realisation when more attention is paid to speech, as speakers are easily able to suppress non-standard forms (Labov 2001). Instead, we find the opposite of that here, as shown in Table 2, and visualised in Figure 6 in that drawing attention to the distinction results in speakers highlighting the difference. In the next section, we discuss this further, including the influence of prosodic factors, orthography, levels of conscious awareness and hyper-speech.

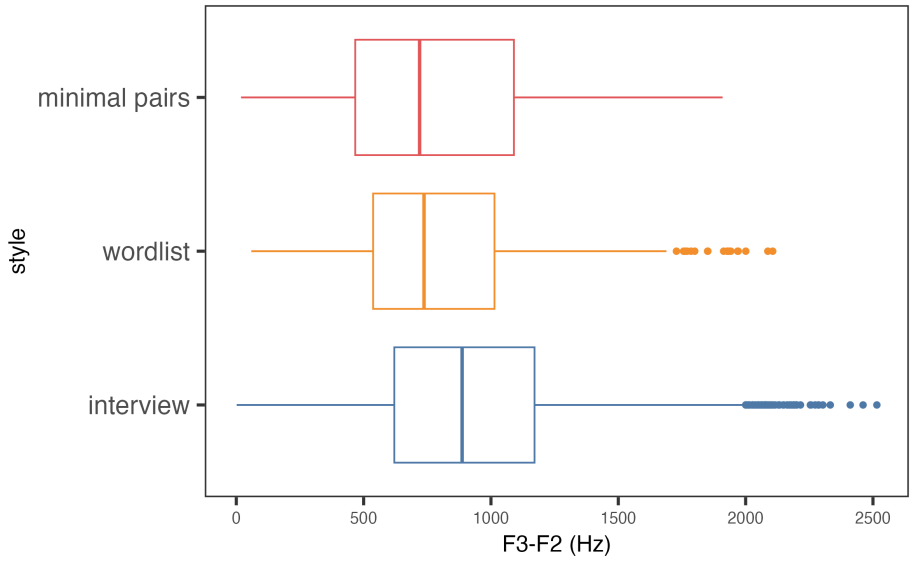

Figure 6: The effect of speech style on F3-F2.

Moving on from social factors, we turn to language internal factors. Preceding vowel in our model is operationalised as lexical set, the results for which are exactly as would be predicted by vowel quality: preceding front vowels have the smallest F3-F2 difference and back vowels have a larger F3-F2 difference. Thus, lexical set is really only informative in an auditory analysis which indicates the categorical presence or absence of /r/. In our model, it is important to include it, but primarily as a control factor, i.e., to prevent it from interfering with the results

of interest.

Next, we turn to positional context. This factor separates words into three categories: word-final pre-pausal contexts like *car*, word-final pre-consonantal contexts like *car boot*, and word-internal contexts like *bird* and *person*. The factor of context did not come out as significant in our model by likelihood ratio test (compared with a model without context included), but we include a short discussion of the factor of context here for comparison with other studies, indicating the general pattern of results. As shown in Figure 7, the order from strongest to weakest /r/s is as follows: *car* → *bird* → *car boot*. This is the expected order of strength based on phonetic and phonological predictions (a singleton coda consonant is less likely to be lenited as it has no other preceding or following consonant to immediately articulate) and is also the pattern found in almost all sociolinguistic studies, as discussed in Section 2.3. Note that, although the ranges are overlapping as we saw in Figure 4, the effect size is much smaller: less than 19Hz between the contexts shown in Table 2 compared to 101Hz difference between males and females.

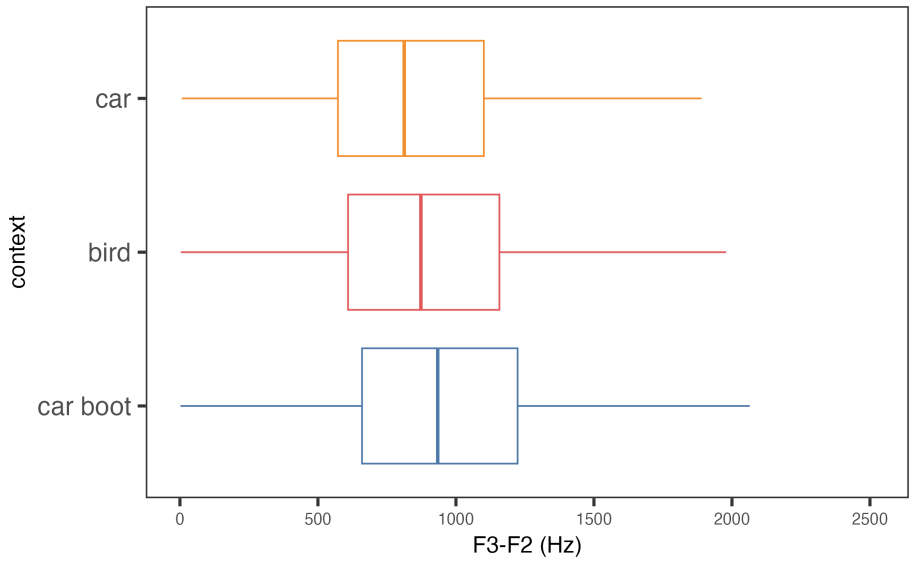

Figure 7: Positional context F3-F2 between word-final pre-pausal contexts (*car*), word-internal contexts like *bird* and word-final pre-consonantal contexts like *car boot*.

The remaining predictor is rime duration, which shows a clear and significant effect in the expected direction: the longer the rime, the smaller the F3-F2 difference i.e., the more rhotic the token is. One way to interpret this is that with a

longer duration, the speaker has enough time to reach their maximum articulatory target for /r/ (e.g. McAllister Byun and Tiede 2017). This makes sense from an articulatory point of view, however, another interpretation is that the longer duration provides Praat's formant tracker with more opportunities to detect a (potentially erroneously) smaller F3-F2 than in a shorter vocalic period, and this might not necessarily mean that the articulation is actually any different. We suspect that both adequate time to reach the articulatory/acoustic target and an effect of formant tracking accuracy may be at play here. A reviewer notes that the large t-value for duration could be interpreted as this being the most significant effect in the model (t > -12). Be that as it may, we note that this merely refers to the reliability of the estimate (β = -87), not that duration is more important as a predictor. There is a correlation between duration and pre-pausal position: pre-pausal *car*-type tokens are longer. This is unsurprising given that pre-pausal /r/s have no other articulation immediately following and have time to reach the maximum target. In fact, is has the name 'pre-boundary lengthening' in the literature to reflect the regularly observed phenomenon that stronger prosodic boundaries result in lengthened realisations (Lehiste 1980: 7). Statistically, this may explain why the pre-pausal positional context effect does not come out as significant in the model but is reported as being important in most other studies: the effect of pre-pausal lengthening on F3-F2 is absorbed by the duration predictor, rendering pre-pausal position statistically insignificant.

We can now summarise the major results of the predictors on F3-F2 in Blackburn /r/s as follows. We find that weaker /r/s in younger speakers, females, shorter tokens and casual speech, as well as a non-significant effect of word-final preconsonantal /r/s. We also find an effect (influenced by F2) of /r/ appearing weaker when preceded by back vowels than when preceded by front vowels; however, this effect is predominantly capturing the effect of the F2 value of the preceding vowel through consonant-to-vowel coarticulation. In the next section, we take a closer look at these rhotics in a thorough qualitative analysis.

5. Qualitative analysis

This section complements the statistical analysis by providing the first detailed account of Lancashire rhoticity, presenting word-final /r/s preceded by NORTH/FORCE[9] and START monophthongs. We have seen that rhoticity in Blackburn, Lancashire is

[9]In this section we discuss NORTH words, in order to facilitate comparison with Heselwood (2009), but as we described in Section 2, NORTH and FORCE are merged in Blackburn.

getting acoustically weaker over time. The speakers we have chosen to highlight in this section were selected because they are individuals who are representative of their age and gender across the change in rhoticity we saw in Section 4. While it is tempting to view these individuals as representative of their generation as a whole, we do note that, of course, some individuals do not neatly follow the trend as viewed in Figure 5.

Firstly, in order to demonstrate the most traditional examples of rhoticity in the corpus which may not be available in years to come, we wanted to show the reader the oldest versions of Lancashire /r/. We considered one of two options in order to do this: i) to select the oldest male in the corpus; this is the choice of dialectal studies of English who argue that older men represent the "purest", most untouched and unchanging form of the dialect (Orton 1962), or ii) to select the speaker with the strongest acoustic values i.e., the lowest F3-F2. Incidentally, or not, this is the same speaker: 81 year old AdamT.

We first present spectrograms of words produced by AdamT, then compare his productions with examples of words from two well-studied rhotic varieties, General American (GenAm)[10] and Standard Scottish English (SSE). Finally, we present spectrograms of words produced by three of the youngest speakers in our corpus (WillowA, KatieH and EllieS), in order to consider potential change over apparent time, and to examine variation within the younger age group.

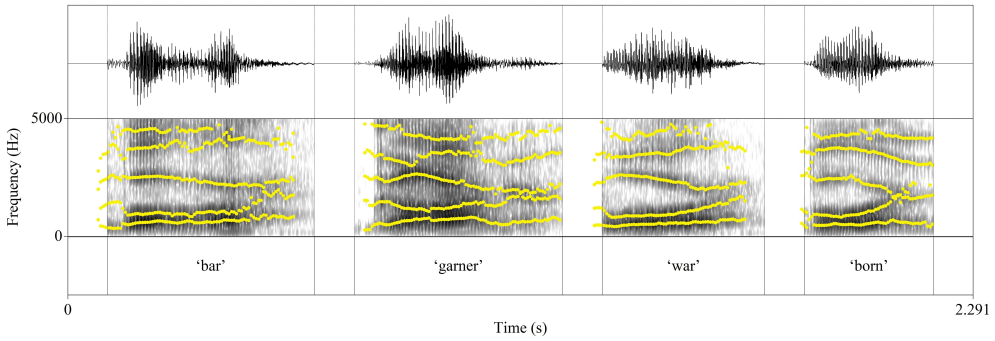

Figure 8: START and NORTH/FORCE tokens produced by AdamT, 81 year old male from Blackburn

[10]Instead of referring to any variety of US English in particular, we use the term 'General American' in order to refer to the strong rhoticity produced by the majority of standard American speakers. We note that individual variation in tongue shape for /r/ has been found to be affected by subject-specific factors more so than dialectal effects (Boyce et al. 2009).

In AdamT's productions of START words *bar* and *garner* (Figure 8), F3 starts high for the vowel, but then lowers through the V+/r/ rime towards F2, with F2 rising out of the vowel to meet it. Notably, F2 is relatively high for /r/ when compared to General American rhotics (note the relative positions of F2 in Figure 9), which seems to be a common feature of rhotic tokens in Blackburn, resulting in a rather clear quality to the segment. In the NORTH/FORCE words *war* and *born*, F3 lowers to an even greater degree than in the START words, with a corresponding rise in F2. Moreover, the NORTH/FORCE words are auditorily more rhotic-sounding than the START words.

Whilst AdamT is among the most strongly rhotic speakers in our corpus, his /r/ is not as strong as in GenAm or SSE, either auditorily or acoustically. Rhotic segments in GenAm and SSE are often produced with bunched tongue configuration (Delattre and Freeman 1968; Lawson et al. 2014), although some studies note that there is often a wide range of inter-speaker variability in tongue configurations for American English /ɹ/ (e.g. Westbury et al. 1998). Acoustically, both of these varieties exhibit a low F3 (Espy-Wilson et al. 2000; Lennon et al. 2015; Lawson et al. 2018). This is clear from Figure 9, which compares AdamT's production of *thirty* alongside a 23 year old male SSE speaker from Glasgow (analysed in Lennon et al. 2015) and a 37 year old male GenAm speaker from Los Angeles (recorded for this example), both producing the word *third*. Table 3 shows these tokens' values of F2, F3, and F3-F2 at the point of the minimum F3 in each case, and the SSE and GenAm values are comparable to those reported in Lawson et al. (2014) and Zhou et al. (2008) respectively. Each of these speakers produces the V+/r/ portions as the rhotic NURSE vowel schwar [ɚ]. Although the formant structures are very similar between AdamT and the SSE speaker, the bandwidth in the SSE speaker's F3 is less diffuse than in AdamT's production. However, it is possible that differences in bandwidth – as well as other acoustic parameters – are due to individual speaker characteristics; indeed, these two speakers are very different in age (AdamT: 81; SSE: 23). Auditorily, the SSE token is much more strongly rhotic than AdamT's production, but not as strong as the GenAm speaker, whose F3 is lower still, and could even be considered entirely converged with F2. It is important to remember that articulatory variation may be a factor which gives rise to the differences in the acoustic patterns between these speakers, such as the differences in the relative positions of F3, F4, and F5 in bunched vs. retroflex articulations in both GenAm (Zhou et al. 2008; Mielke et al. 2010) and SSE varieties (Lawson et al. 2014, 2018), as discussed in Section 2. However, at this stage we cannot speculate further on the implications of this for Blackburn rhotic variants.

	Blackburn	*SSE*	*GenAm*
F3	2228	1941	1470
F2	1651	1535	1384
F3-F2	577	406	86

Table 3: F3 and corresponding F2 values from F3 minimum in Hertz of /r/s from Blackburn, SSE (Standard Scottish English) and GenAm (General American) speakers. Values are taken from across vocalic portion of tokens shown in Figure 9.

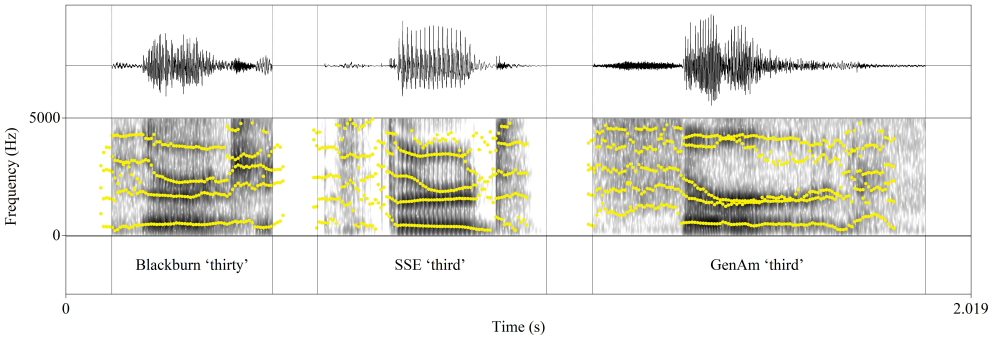

Figure 9: Tokens produced by Blackburn speaker AdamT, a Standard Scottish English speaker, and a General American speaker (all male).

We now turn our attention to the younger speakers in our corpus, which will allow us to see how the acoustics of rhoticity in Blackburn behave closer to the present day. Figure 10 shows the word *car*, produced by WillowA, a 20 year old female speaker, and the words *car* and *card*, produced by 17 year old female KatieH. Treating each rime as a V+/r/ sequence (as we have done so far in this paper), we can initially see a relatively low F2 and high F3 in the V section of *car* and *card*, then, in *car*, F2 and F3 both rise and very slightly converge towards the end of the vocalic period, indicating the /r/ 'section' of the sequence. F2 and F3 converge more noticeably in *card* before the final [d], although it is difficult to tease apart the contribution of an expected rise in F2 due to the alveolar closure for [d], from a vocalic offglide. In short, a schwa offglide is visible, to varying degrees, towards the end of the vocalic period in each of WillowA and KatieH's tokens. Heselwood (2009) also noted offglides in occasional non-rhotic productions of NORTH/FORCE words in his aforementioned analysis of a predominantly rhotic older Lancashire male, so this could indicate a more geographically-widespread strat-

egy for these types of V+/r/ sequences. The offglides produced by WillowA and KatieH are in contrast with the 'flat' formant structure (with high F3) in *farm*, as produced by 21-year-old EllieS, who is categorically non-rhotic in her interview.[11]

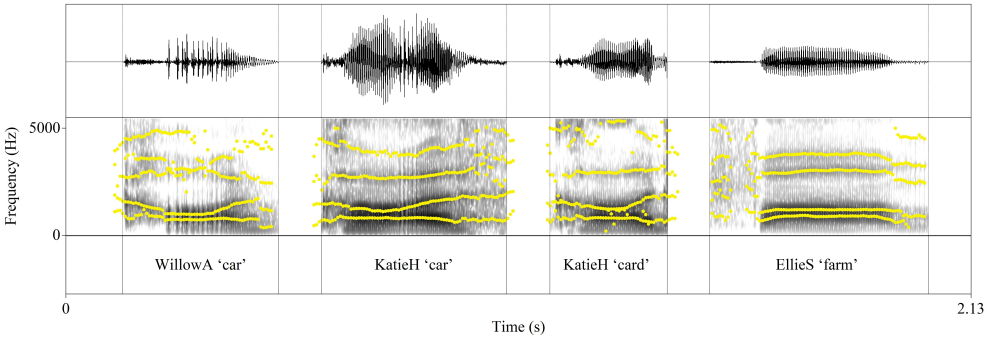

Figure 10: Tokens produced by three young females, WillowA, KatieH and EllieS

For WillowA, differences in fine phonetic detail between her productions of *spa* and weakly rhotic *spa**r*** can be clearly seen when they are placed side-by-side (Figure 11). Treating the rime as a V+/r/ sequence as we have done so far, we can initially see a lower F2 and higher F3 in the V section of *spa**r*** than in the V section of *spa*, suggesting a backer vowel in *spa**r***. Then, as the vocalic period in *spa* becomes creak, F2 and F3 in *spa**r*** converge slightly, with a corresponding reduction in amplitude (seen on the waveform), in an apparent case of a schwa-offglide or pre-/r/ breaking. It is possible that this represents a strategy for so-called non-rhotic variants in Blackburn – this is explored further in Section 6.

An important observation is that because the F3-F2 difference in AdamT's /r/ tokens is noticeably greater than in those of the American and Scottish speakers in Figure 9, this indicates a less strongly-rhotic production than in SSE and GenAm. Nevertheless, AdamT is still notably more rhotic than KatieH and WillowA, the two younger speakers discussed above. Since AdamT was born in 1937, we can be reasonably confident that his /r/ productions are a good representation of the

[11] We note that EllieS is privately educated and is the only one of our 28 speakers who was interviewed outside of the local speech community, in the university town where she was studying at the time. She displays very few local features, for example, unlike most of our speakers she has diphthongal FACE and GOAT rather than the local monophthongal realisation, and unmerged NURSE and SQUARE in minimal pair tests. It is likely EllieS could be classfied as a speaker of the pan-regional middle-class variety of General Northern English (Strycharczuk et al. 2020).

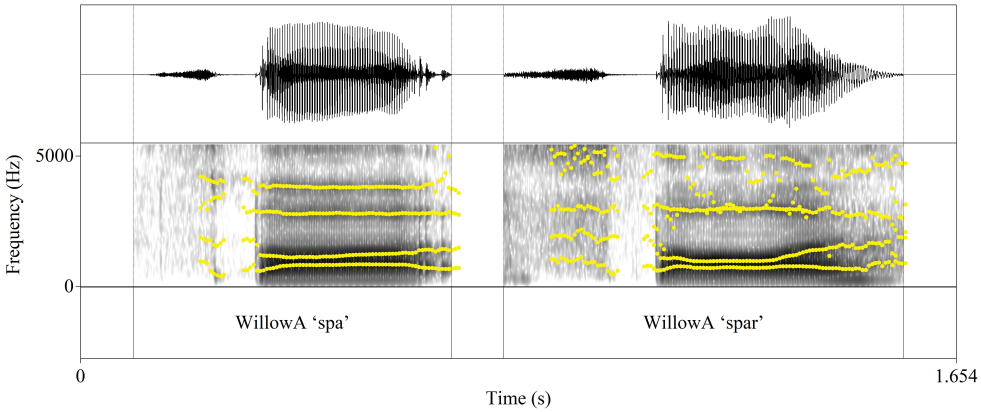

Figure 11: Elicited minimal pair productions of *spa* and *spar* by WillowA, a 20 year-old Blackburn female.

state of rhoticity in Blackburn when he was younger – indeed, relatively strong rhoticity in an Anglo-English speaker is indicative of a more traditional pronunciation (Orton 1962; Chambers and Trudgill 1980). This assumption follows the apparent-time hypothesis, as defined in Section 2.3. This qualitative indication is supported by the quantitative results presented in the previous section, which showed that a move towards weaker rhotics is happening in apparent time across the speech community surveyed here. We do note that this qualitative analysis is based on a very small number of speakers, so cannot be taken to represent the community as a whole.

Finally, although AdamT has the lowest F3-F2 value of all speakers (Figure 5) and is impressionistically the most rhotic speaker, we note that he does not have the lowest average minimum F3 overall. This is further evidence that, at least for Lancashire, the proximity between F2 and F3 – and not necessarily F3 height – seems to be the most important for a strong rhotic percept, in line with the findings reported in Heselwood (2009). This further justifies the measure we have used in our quantitative analysis described in Section 4. Impressionistically, AdamT indeed has more of a retroflex articulatory setting in general, which seems to be a relic feature of older Lancashire speech (Ken Lodge, p.c. May 2019; based on observations by Honikman 1964).[12] This may also accord with the late

[12]Note that Honikman (1964) referred to this articulatory setting in the presence of retroflex consonants in Indian and Pakistani speakers. We also note that AdamT has a whistled realisation

eighteenth-century Northern English 'coronal vowels' described by Lloyd (1899) as described in in Section 2.2).

This qualitative analysis shows that rhoticity in Blackburn can have variable realisation, and often appears to be weaker for some speakers than for others. At the very least, Blackburn is no longer categorically rhotic in the same way as many varieties of Scottish or American English, and acoustically is not as strongly rhotic. We note that there may be a difference between speakers like KatieH who have derhoticised offglides instead of /r/, and speakers like EllieS who are seemingly completely non-rhotic. We now move on to discuss the implications of the findings in this section and the previous one for phonetic change over time, as well as future directions for research.

6. Discussion

The aim of this paper is to describe a hitherto neglected system of rhoticity in English, that of Blackburn, Lancashire in Northern England. We set out to provide a variationist sociophonetic analysis of the speech community based on a quantitative analysis of natural and elicited speech, alongside a more descriptive examination of Lancashire rhoticity. Our research questions cover three major themes: i) whether Lancashire rhotics are changing over time, ii) what the acoustic and auditory qualities of Lancashire rhoticity are, and how this may be reflected segmentally and iii) which linguistic and social factors affect variation and change. We address each research question in turn here alongside our findings, and expand on some aspects of the discussion, as well as suggesting avenues for future research.

6.1. Change over time in Lancashire rhotics

Our first research question asks whether Lancashire rhotics are undergoing a change over time towards weakening or loss. In the review of the existing literature in Section 2 we provide evidence for this from sociolinguistic research in both the South West and North West of England, but note that none of these studies measured /r/ acoustically at the population level – that is, with enough statistical power to constitute a description of the speech community. Thus, part of our aim in this paper is not only to confirm whether weakening of /r/ is taking place, but also to add to our understanding of how rhotics might be lost by measuring them instrumentally. Our results in the quantitative and descriptive findings

of /s/ which may be linked to this overall articulatory setting.

in Section 4 and Section 5 demonstrate that rhoticity is certainly present in Blackburn, Lancashire, but also that it is in decline in terms of its phonetic strength. We demonstrate this both in presenting an apparent time analysis demonstrating how these rhotics are weakening over time, as well as a comparison to rhotics in speakers from more well-described varieties such as General American English and Standard Scottish English where rhoticity is the standard population norm. We confirm the result that Lancashire rhotics are undergoing a change over time towards derhoticisation – the phonetic weakening of /r/ over time (Stuart-Smith 2007). We discuss further implications for derhoticisation below and note here that the nature of this loss will be probed in future sociolinguistic research encompassing a larger number of speakers, in phonetic research with dynamic formant analysis, and with articulatory data from ultrasound tongue imaging.

We have demonstrated that older speakers from Blackburn are still fairly strongly rhotic in their production, especially in a more formal speech task (Figure 6). Nevertheless, even the most rhotic speakers in our corpus – for example AdamT – appear to have more vowel-like formant structures (i.e. F2 and F3 are relatively further apart) in their /r/ production than speakers in other more stereotypically rhotic varieties of English, such as SSE and GenAm, as demonstrated in Section 5. Given this fact, it would not be unreasonable to argue that speakers in Blackburn have had relatively weak rhoticity for a long time. By extension, this increased distance between F2 and F3 may be taken as evidence of historical loss of rhoticity in England more generally, with Blackburn (and some areas in the South-West of England) simply slower to show the same change as most of the rest of England. In other words, if the older Blackburn speakers afford us a glimpse of Anglo-English rhoticity prior to its diachronic loss, we might be able to use data from these speakers to form a theoretical standpoint about historical /r/-weakening in England.

For example, we could ask questions such as: 'Did the more vowel-like quality of Anglo-English /r/ – together with social driving factors – lend it to become more susceptible to /r/-loss or weakening than other varieties such as Standard Scottish English?', and: 'Which processes (internal, external, or both) were the most influential in their effect on /r/-loss or weakening in England?' (with reference to, and comparison with, historical records, e.g., Lockhart 1818; Sweet 1888; Walker and Longmuir 1894; Wright 1898; Lloyd 1899). The opposite might be said about, for example, Standard Scottish English, in that linguistic and social factors may have combined to strengthen rhoticity for certain speakers. In Section 4 we briefly discuss the issue of the unbalanced nature of different lexical sets, and their influence on the acoustic results. We could also look at this issue from

a perception standpoint, such that some lexical sets may have had an influence on the historical progression of the loss of rhoticity, or the lack thereof in Blackburn. For example, NURSE words, with their extended schwar [ɚ], may have had a role to play in the retention of /r/, due to the fact that through the whole duration of the vocalic portion, listeners have more of an opportunity to perceive the closer F2 and F3 of the rhoticised vowel (e.g. Lennon under review). Such questions would benefit from data and evidence drawn from perceptual testing.

6.2. Acoustic, auditory and segmental qualities of Lancashire rhoticity

In posing our second research question, we reiterate that no detailed phonetic description exists for a rhotic variety in England (although Section 2 summarises the small amount of research that exists on this). In Section 5, we note that /r/ in Blackburn can have variable realisation, with different speakers producing the V+/r/ sequence in different ways. We highlight examples from our interviews, beginning with AdamT, our oldest speaker at 81 years of age, noting that he is the most rhotic speaker in our corpus. However, AdamT's /r/ realisations are not as strongly rhotic – auditorily or acoustically – as those of either the SSE or the GenAm speakers in our three-way comparison, both of whom are members of stereotypically rhotic speech communities. F3 in AdamT's /r/ is not as low as in these speakers, so it is possible that /r/ may already have started to weaken by the time of AdamT's childhood in Blackburn in the 1930s and 1940s, a hypothesis which could be explored with older archival recordings. We also examine the speech of two of the youngest speakers in our corpus, WillowA and KatieH (20 and 17 years old, respectively). We note that their strategy for producing rhotic words in a non-rhotic way results in a consistent offglide. This is in contrast to a complete merger with the etymologically /r/-less counterpart of the minimal pair (e.g., *spa**r**/spa*), as found in the speech of 21 year old EllieS, who is non-rhotic. It is notable that the strategy employed by these younger speakers in their offglides includes a slightly backer quality in the vocalic portion in e.g. *spa**r***, than in the /r/-less counterpart *spa*. This could represent a phonemicisation of pre-/r/ vocalic variation that was allophonic and caused by the coarticulatory effects of /r/ when it was present. It is also possible that these speakers are differentiating in this way, simply in order to highlight the distinction between the /V/ and /r/ segments of the words, which would not be possible in productions of these words without offglides.

A supplementary part to our second research question prompts us to consider the segmental realisation of /r/ for speakers in this community. As we note in the introduction, the surface realisation of /r/ as being eroded certainly does not

entail that the underlying representation is /r/-less. In fact, the non-rhotic varieties of English in England retain /r/ across word boundaries and arguably still have an underlying /r/, resulting in linking-r phrases like *ca**r** alarm*. Nevertheless, it poses the question of whether this is derhoticisation (phonetic weakening of the /r/ towards eventual loss) or full vocalisation (categorical deletion of /r/) and the evidence indicates the possibility that either of these strategies may be at play. Going forward, work using ultrasound and acoustics can directly target a wide range of controlled phonetic environments which can compare phrase-final /r/s with linking conditions and everything in between.

In the minimal pair tests, WillowA reported that *spa* and *spa**r*** are different to her, indicating an awareness of the relatively fine phonetic detail seen in her offglides. Minimal pair tests have their drawbacks, but they are useful for trying to access some level of the phonology, although we accept they are not without their own issues. In this case, it is possible that the influence of orthography in words with non-prevocalic /r/ could emphasize a contrast. For our purposes, this is useful because it demonstrates that rhoticity is active in the phonology, even if it is weak in the phonetics. To support this point, note that fully non-rhotic communities, although they do have linking-/r/, almost never report a difference between forms like *spa* and *spa**r*** when presented with the orthographic forms (e.g., the nearby non-rhotic speech community of Manchester as studied by Baranowski and Turton (2015), just 40 miles away from Blackburn). Further evidence for this comes from the online dialect survey administered to British English speakers by MacKenzie et al. (2022), comprising minimal pair tests. Only 6% of respondents said that *spa* and *spar* were different.[13] Note also, many Anglo-English speakers insist they do produce the orthographic ¡r¿ in words like *car* because they believe the ¡r¿ represents a lengthening of the vowel.

The first and second authors of this paper are non-rhotic and rhotic respectively, and the first author could not initially hear an /r/ in WillowA's *spa**r***, whereas the second author could immediately hear a difference between her *spa* and *spa**r*** tokens. There could be an element of individual variation in the discrepancy between the first and second authors' impressions, but at this point it is worth considering the concept of the 'fluent listener', put forward by Sumner and Samuel (2009), whereby if a speech community has multiple variants for a phoneme –

[13]This underlying representation is also apparent in intrusive-/r/ contexts for such speakers, i.e., the appearance of non-etymological /r/ across morpheme and word boundaries, such as *the spa (r) in Buxton*.

such as variable rhoticity in the New York linguistic context – the listeners can be described as 'fluent' in perceiving these multiple variants as possible realisations. This could be the case for the rhotic author (who was raised in the West of Scotland, an area with a highly complex set of socially-indexed rhotic variants) but not the case for the non-rhotic author, which may explain the discrepancy in sensitivity to a phonemic contrast (Floccia et al. 2006; Adank et al. 2009; Lennon under review) cued by the fine phonetic detail in WillowA's production of *spa* and *spa**r***, which we examine in Section 5. As WillowA's position in Figure 5 indicates her as having overall weak rhoticity acoustically, this finding also highlights the value of the minimal pair test at accessing a level of the speaker's phonology not available from the analysis of spontaneous speech alone. In future work, we intend to conduct perceptual studies to test the influence that the listeners' own rhotic/non-rhotic status has on their perception of rhotic variants such as those found in some Blackburn speakers.

6.3. Linguistic and social factors affecting change

In our third research question, we ask how social and linguistic factors such as age, gender, vowel class, positional context and style-shifting would condition rhotic variation. Our discussion of change over time shows that age is a relevant factor in the realisation of non-prevocalic /r/ in Blackburn, with older speakers generally having stronger /r/s. A closer look at the gender patterning demonstrates that, for the most part, females of the oldest generation look very similar to young males today. We note that this is the most common pattern of change over time found in Western sociolinguistic studies: females lead, and males of the next generation(s) follow. In terms of linguistic predictors, we point out that our results for vowel class are difficult to compare with previous auditory studies, as our formant measurements inherently elicit crossover from the adjacent vowel. Instead of showing independent effects of the preceding vowel, they merely act as a control for the possibility of different tongue articulations producing the same acoustics in the formants of interest in this study. For example, although NORTH/FORCE words statistically look as though they have weaker /r/ due to the distance between F2 and F3, we note in Section 5 that these /r/s actually sound the strongest auditorily. What this demonstrates is that our analysis shows the effect of the formants of the rounded back vowels, rather than anything specific to the /r/. This is a drawback in comparing our study with other sociolinguistic ones, which is where a quantitative auditory analysis of /r/ would be useful. The other linguistic factor we consider is positional context, for which we note that the trend is in the expected direction, in that /r/ realisations in *ca**r*** tokens are strongest, *bi**r**d* tokens in the middle, and *ca**r***

boot-style tokens are the weakest (see Table 2 and Figure 7), but that this did not reach statistical significance. We find that longer tokens are more rhotic, which is expected given the fact that the articulation has more time to reach its maximum, but we also discuss potential effects on formant extraction.

An effect we did not originally expect to find arises in our style-shifting analysis. In Section 4, our statistical model shows that more formal styles of speech, such as minimal pairs and wordlists, result in stronger rhotics when compared to interview style. The fact that most of our speakers style-shift towards more rhotic variants in word lists and minimal pairs indicates an underlying /r/ which is lenited in casual speech. This observation is supported by the fact that, when asked, most of our speakers indicate that the words *spa* and *spa**r*** are different for them, which is not something speakers of a fully non-rhotic variety would do (see previous sub-section). What is arguably unexpected is that most speakers seem to be enunciating their rhotic realisation in the formal styles of word list and minimal pair elicitation (see Figure 6), despite rhoticity reportedly being a stigmatised feature by many speakers in the majority of England. When a variant is sociolinguistically stigmatised, speakers almost always move away from the stigmatised variant in formal speech. In this case, there are many reasons why speakers might go against the predictions based in stigma and prestige. The most obvious reason is that if these speakers are rhotic, however weakly rhotic some may be, the task where the most attention is drawn to speech is the task most likely to elicit hyperspeech and therefore stronger /r/s. Relatedly, the minimal-pair test is designed to force the speaker into making any potential phonological difference apparent, and this results in the /r/-ful token being articulated more clearly and carefully. Non-rhoticity may very well constitute "poshness" in Blackburn, but it does not signal clear speech. This is an important distinction to be made in sociophonetics, where often the two (social prestige and clarity of articulation) are conflated. Other factors may include orthography (which is also linked to the hyperspeech argument), signalling group identity or accent, the strong prosodic boundary at the end of the elicited tokens, and a longer duration (which we already know produces a stronger /r/, although recall that a style and duration interaction is not significant here). In addition, it is not evident that Blackburn rhoticity is actually stigmatised within the speech community. We have anecdotal evidence of speakers leaving the community and becoming aware of such stigma, but non-mobile members of East Lancashire rhotic communities typically have no idea that this pronunciation is non-standard in England (see Austin 2007 and Kay 2011). There may be interesting sociolinguistic changes in process in Blackburn, related to the interaction between sound change and levels of conscious awareness, that we intend to

explore in further study.

7. Conclusion

This paper has provided the first ever systematic acoustic analysis of contemporary rhoticity in England. We provide an in-depth acoustic description of the non-prevocalic rhotics found in an Anglo variety of English, including comparisons with more well-known English rhotics in North America and Scotland. We present a sociophonetic quantitative analysis of change over time in the accent, showing that rhotics are getting weaker in apparent time: younger speakers in Blackburn, Lancashire have much weaker /r/s than older speakers. Rhoticity is stronger in males, a pattern of results which suggests a female-led sound change, a widely documented phenomenon in the sociolinguistic literature. We note that the majority of our speakers become more rhotic in more formal styles, raising interesting questions about social prestige and clearness of speech, as well as the location of change in the speech community's consciousness. Overall, we demonstrate that the vast majority of speakers in this speech community are still rhotic, but many young speakers are very weakly so in their natural speech styles and may be producing a non-rhotic offglide as an intermediate variant of non-prevocalic /r/. The prediction for the future of this variable is clear: despite being a remaining stronghold as an 'island of rhoticity' (Britain 2002), if this change towards weaker /r/ over time continues, combined with the geographical diffusion of non-rhoticity in England, Lancashire may be non-rhotic within a matter of generations.

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Appendix A. Words in wordlist containing non-prevocalic /r/

- heard
- pour
- shearer
- brother
- blackburn
- beer
- born
- bear
- poor
- better
- hard
- purr
- batter
- banner
- spare
- pore
- master
- spar
- hanger
- nerd
- tear
- singer

- share
- pear
- fur
- dare
- worse
- chair
- care
- finger
- stronger
- nurse
- boar
- barm
- horn
- turn
- fair
- cord
- pair

Appendix B. Words in minimal pair tests including /r/

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- spar (vs. spa - main target for rhoticity)
- horse
- hair

- poor
- pour
- air
- wore
- girl
- over
- war
- bird
- soar
- purr
- pear
- bangor
- banger
- fair
- finger
- singer
- farce
- hare
- fur