Accent change in the wake of the Industrial Revolution:

Tracing derhoticisation across historic North Lancashire

Abstract

This paper applies a social model of historical dialect evolution in nineteenth century Britain (Kerswill, 2018) to analysis of sociophonetic data. Our aim is to assess where new dialect formation is likely to occur, and where it is not. Using recordings from 27 speakers we first analyse coda rhoticity in north Lancashire, UK. The speakers were born 1890–1917 in three urban settlements which contrast in social makeup and history. The quantitative analysis shows strong maintenance of rhoticity in speakers from Preston, less so in Lancaster, and almost no rhoticity in Barrow-in-Furness, an industrial boom town. We then use historical census data to analyse population origin, growth, occupation, and fertility rates to argue that new dialect formation occurred in Barrow during the late 19th century, leading to accelerated derhoticisation. Overall, our analysis supports a model of urban historical dialect change which includes population origins, social networks, and population dynamics.

Keywords: New dialect formation, Historical sociophonetics, Industrial Revolution, Rhoticity, Lancashire

1 Introduction

Understanding patterns of sound change in communities is one of the central questions for variationist sociolinguistics, and has been so since the inception of the field (Labov, 1966; Weinreich et al., 1968). Tracing progression of change is of course more difficult where historical recordings are not available. Where such recordings are available, historical speech corpora have been transformational in our understanding of the development of new varieties (Gordon et al., 2004; Hay et al., 2015; Trudgill, 2004), and the interaction of long-term, large-scale, changes with locally salient variables and communities (Labov et al., 2013; Rathcke & Stuart-Smith, 2016). In this paper, we take inspiration from the 'historical sociophonetic method' in particular to 'test hypotheses about the development of a particular variety' (Strelluf & Gordon, 2024:24). Our analysis focusses on dialect evolution during the Industrial Revolution in 19th century Lancashire. This globally significant period of socioeconomic change led to mass migration and urbanisation but is typically just outside the range of sound recording technology making investigation of dialectal change challenging.

In this paper, we apply a social model of historical dialect change proposed in Kerswill (2018) to analysis of linguistic and demographic data. Here, our contribution is to provide linguistic data as well as social data to test this model of historical dialect evolution. Our aim is to explain which social and linguistic conditions led to new dialect formation in 19th century Britain, and which did not. We test this model through a combination of phonetic analysis of speakers born in the later 19th and early 20th century, as well as demographic analysis of census data. Our linguistic analysis focusses on coda rhoticity, a significant ongoing sound change in English dialects. We analyse data from the dialect

landscape of north Lancashire, specifically Preston, Lancaster, and Barrow. These settlements cover an area of north-west England where the change from rhotic to non-rhotic is still ongoing (Barras, 2010; Turton & Lennon, 2023). They have distinct social and demographic makeups as a result of differing patterns of development and settlement during the Industrial Revolution. The remainder of the Introduction outlines Kerswill's (2018) model of historical dialect evolution (Section 1.1), before discussing rhoticity in England (Section 1.2), the social context of our settlements (Section 1.3), and Research Questions (Section 1.4).

1.1 New dialect formation, restructuring, and swamping

Kerswill's model of dialect evolution accompanying social change in the Industrial Revolution proposes three potential outcomes: new dialect formation, restructuring of the existing dialect, or 'swamping'. Crucially, these outcomes are derived from the extent and nature of face-to-face contact between people in an expanding urban community. The model relies on three factors: 1) the proportions of people from contributing dialects, 2) the nature of contact and attitude of speakers, and 3) existing linguistic varieties already present in a geographic location. The balance of these factors allows an examination of whether new dialect formation is likely to occur, or instead the existing dialect will be restructured, or completely replaced by another variety ('swamping' Lass, 2004).

Influential accounts of new-dialect formation are provided in Kerswill & Williams (2000); Trudgill (1986, 2004). These sources indicate a process by which a new dialect is formed over 2–3 generations: population and dialect mixing occurs, a new compromise variety is

adopted for between-group communication, and eventually the compromise variety is 'nativised' when children acquire it, though the new dialect is first discernible in the speech of adolescents when they begin to diverge from caregiver models. Trudgill's model especially focusses on the *proportions of people* from contributing dialects and *proportions of variants* they use, stating that the majority variants from the majority contributing community will be present in the eventual new variety, though salience and functional load also play a role in this process (Trudgill, 1986:126).

The *nature of the contact between speakers* is also argued to play a role. For example, Kerswill & Williams' work on Milton Keynes also highlights the role of speaker network density, how integrated any newcomers become, and the ratio of adults to children (Kerswill & Williams, 2000:84). In Milton Keynes, there was a relatively high proportion of children compared to adults and these children were involved in dense social networks through compulsory schooling (Kerswill & Williams, 2000:90). In the seventeenth century Fens however, new dialect formation took longer due to less dense child social networks (Britain, 1997). In terms of additional social differences, we draw on the typology of open/closed vs. endocentric/exocentric communities (Andersen, 1988; Kerswill, 2018). 'Open' communities have relatively greater contact with non-community members compared to 'closed' communities. 'Endocentric' communities retain a greater sense of local pride and distinct identity, leading to retention of local dialect in comparison to 'exocentric' communities (Kerswill, 2018:14). In this framework, new dialect formation is more likely in more 'open' and more 'exocentric' communities.

Where there is a large existing community, it is likely that *existing linguistic varieties* will be maintained, albeit subject to levelling. This is referred to as the 'Founder Principle' (Mufwene, 2001). To overcome the strong effects of the Founder Principle, then there must be a relatively high proportion of people coming to an area who are from different dialect regions. Kerswill (2018:20) gives a specific threshold, suggesting that for new-dialect formation to take place: 50% of the population should be born outwith the settlement within a 10-year period. Although it is difficult to put an exact threshold number on this complex phenomenon, the 50% figure allows us to gain some indication of conditions where new dialect formation could take place.

In the UK context, new dialect formation is relatively rare. Instead, population movement and growth typically result in modifications to the existing dialect. This is because most new dialects are formed when areas are settled by colonisers (e.g. New Zealand English, Gordon et al., 2004). It is unusual for entirely new settlements to be created in the UK, though Milton Keynes is a notable exception (Kerswill & Williams, 2000). Instead, existing towns have expanded (Pooley, 2001:436), leading to restructuring of existing varieties. Exceptions reported in the literature also include Liverpool and Middlesbrough. In Liverpool, huge demographic expansion from speakers of different varieties of English and other languages led to a new dialect developing (Honeybone, 2007; Nance et al., 2022; Watson & Clark, 2017). More recently, Multicultural London English has emerged as a new variety as a result of contact between L2 speakers from multiple different first language backgrounds living together in parts of London (Cheshire et al., 2011). Relevant to the context of our study, Kerswill (2018) provides an extended social comparison of 19th century population growth in Blackburn and Middlesbrough. Kerswill argues that the

population in Blackburn grew steadily, mostly came from Lancashire, and a new dialect was not formed. In Middlesbrough, on the other hand, the population grew by over 100% in three ten-year periods during the 19th century resulting in a new dialect (Llamas, 2015).

Our study applies this model of 19th century dialect change to linguistic and social data from the dialect landscape of north-west England, specifically north Lancashire. In this region, substantial demographic expansion occurred during the Industrial Revolution due to the cotton industry (Timmins, 2021). We provide analysis of coda rhoticity from speakers born in the later 19th century in order to test linguistic predictions for presence or absence of new dialect formation.

1.2 Coda rhoticity in Lancashire

The presence or absence of coda rhoticity, i.e. pronunciation of 'r' in syllable codas such as 'fa**r**m' and 'ca**r**', has been described as 'The most fundamental division in English dialects' (Lawson & Stuart-Smith, 2021:1). Coda rhoticity has been extensively studied using contemporary speech corpora and auditory judgements across the English-speaking world (Blaxter et al., 2019; Hartmann & Zerbian, 2009; Stuart-Smith et al., 2014; Tod, 2024) and indeed became emblematic variable for variationist studies (Labov, 1966). Our analysis builds on recent increased interest in rhoticity in the north-west of England using contemporary and archival recordings (Dann et al., 2022; Nance et al., 2023; Ryan et al., 2022; Turton & Lennon, 2023). This work notes the importance of rhoticity as a historical division in English dialects and investigates the remaining rhotic areas in Lancashire. Like the rest of the UK, Lancashire speech would have originally been rhotic in Middle English times. The change towards non-rhoticity has been ongoing since at

least the 1700s, though some claim the change has earlier origins in Middle English (Lass, 1997; McMahon, 2000; Wells, 1982). Analysis in Gordon et al. (2004:320) shows that most of England had some kind of rhoticity in the late 1700s, though this might have been contextually bound for some speakers.

Historical surveys give some insight into the detail of rhoticity in Lancashire during the 19th and early 20th century (Ellis, 1889; Orton & Halliday, 1962). Ellis notes coda rhoticity across Lancashire, commenting that that /r/ is 'strong' with the quality of a tap [ɾ] at Poulton, close to Preston (Ellis, 1889:353). In areas of north Lancashire closer to Lancaster and Barrow, /r/ is described as a voiced retroflex approximant (Ellis, 1889:543). However, Ellis appears to suggest some change in progress in northern Lancashire young people already in 1889: 'Old people rarely ever drop this consonant, but it is going out of use, when not before a vowel, among the younger folk' (Ellis, 1889:543). The Survey of English Dialects (SED) (Orton & Halliday, 1962) gives an indication of the speech from older rural non-mobile male speakers born in the late 19th to early 20th century. We analysed rhoticity in the SED transcriptions of 168 survey items which could possibly be rhotic across the fourteen locations in Lancashire, six in Cumberland, and four in Westmorland. This resulted in 3228 responses overall (mean 135 per location). Full details and visualisation of this analysis are in Supplementary Materials. The analysis indicates greatest production of rhoticity in central Lancashire, with lesser rhoticity in northern and southwest Lancashire. The closest location to Preston (Ribchester) is 77% rhotic and the closest location to Lancaster (Dolphinholme) is 61% rhotic. The closest locations to Barrow are Cartmel (56%) and Coniston (61%), but further north in Cumberland and Westmorland there is less rhoticity (11% in Gosforth, 38% in Staveley).

The SED data can be contrasted with large-scale survey data from the English Dialects App, plotting reported pronunciations of mainly younger, urban, female speakers born in the late 20th century (see map on p.12, Leemann et al., 2018). For the north-west of England, these data indicate that rhoticity is now mainly confined to the area around east Lancashire (Nance et al., 2023; Turton & Lennon, 2023). Rhoticity is still a salient feature of Lancashire speech (Barras, 2015:277; Wells, 1982:367), despite only now being present in a minority of Lancashire speakers and stigmatised in contemporary times (Turton & Lennon, 2023:2). In Oldham, South Lancashire, rhoticity was associated with traditional industrial occupations such as weaving, and non-rhoticity is associated with modernity and mobility. These associations are demonstrated in a detailed third-wave analysis of data from six Oldham speakers born 1907–1929 (Dann et al., 2022; Ryan et al., 2022). Their analysis also indicates that women are more advanced in the change towards non-rhoticity, a finding repeated in acoustic analysis of contemporary data from Blackburn (Turton & Lennon, 2023).

The historical and contemporary comparisons discussed here indicate that rhoticity is now being rapidly lost from most of Lancashire except east central Lancashire, where the change is still ongoing (Nance et al., 2023; Turton & Lennon, 2023). However, although historical surveys provide overviews of mainly rural speakers, it is not known how this change proceeded in different parts of urban Lancashire, or which sectors of the population were quicker or slower adopters of change. We now fill in this historical detail, focussing on North Lancashire.

1.3 North Lancashire

We have chosen three contrasting large settlements in north Lancashire, UK, as a case study to investigate the impact of historical population movement on dialect change. We consider data from Preston, Lancaster, and Barrow-in-Furness (Barrow).[1] Here, we provide a brief historical and social contextualisation. In Section 3 we analyse the extent of population growth and mixing in these three settlements during the latter part of the Industrial Revolution using census data and discuss the likely consequences for accent. The location of our settlements is shown in Figure 1.

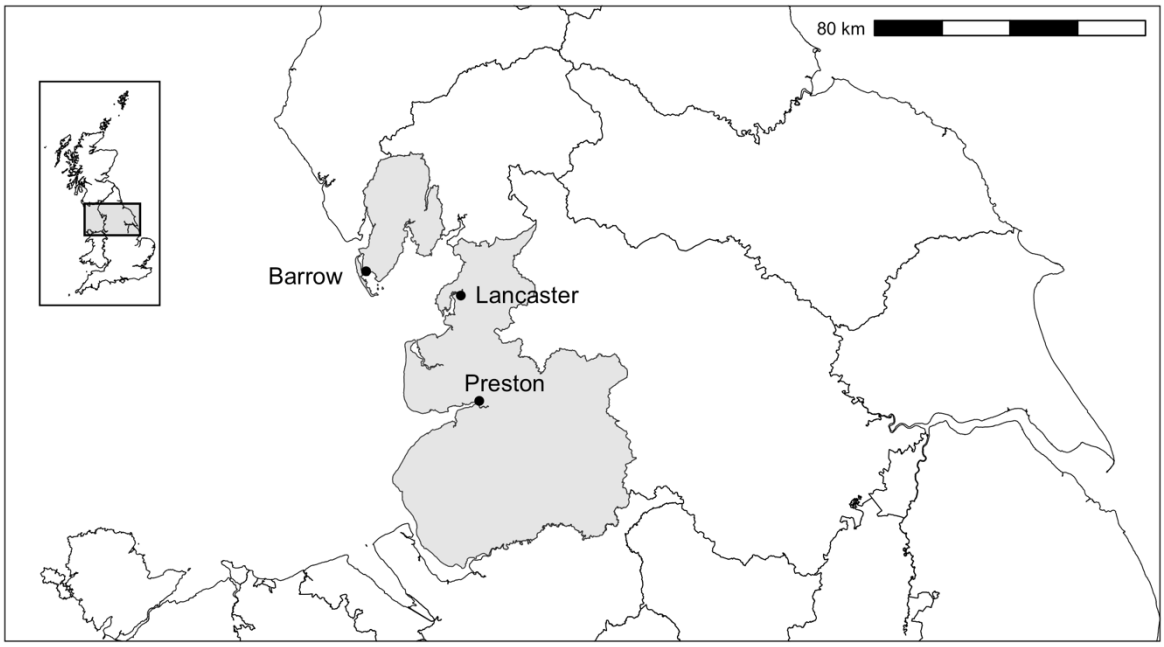

Figure 1: The location of Preston, Lancaster, and Barrow within the north-west of England. The shaded area shows the historic county of Lancashire. Historic county boundary data from https://reshare.ukdataservice.ac.uk/852942/.

Preston grew in importance as a port and market town during the Middle Ages (Johnson, 2024:11) and has been an important location for producing textiles since the 16th century

[1] Note that since 1974 Barrow is now in the ceremonial county of Cumbria. But during the period we analyse (1801–1931) Barrow was part of Lancashire. As such we analyse it as a former Lancashire town.

(Hunt, 2009:54). Preston was at the centre of the cotton industry, Lancashire's preeminent industry during the Industrial Revolution (Hunt, 2009:182; Timmins, 2021). Preston is the largest settlement in contemporary Lancashire and is also the administrative centre. It gained city status in 2002 and since the decline of the cotton industry in the 20th century has focussed development around education and services (Johnson, 2024:87).

Lancaster occupies an important place in English history. The Lancaster family were the eventual winners of the War of the Roses, a significant medieval conflict in England (Cook, 2014). Lancaster Castle is built on a former Roman fort, and is still a significant central landmark in the city (White & Constantine, 2001:57). In the 18th century, Lancaster expanded and significantly grew in wealth through trading and as an administrative centre (Dalziel, 1993:91). However, this period also includes the difficult history of being the UK's fourth largest slave-trading port (Elder, 1991:13). Similar to much of north-west England, Lancaster also expanded into producing cotton in the 19th century (Price, 1989), although the growth of the cotton industry here was relatively modest compared to further south in Lancashire (Winstanley, 1993:152). Today, Lancaster is a small city where the economy has diversified to services and education (Lancashire County Council, 2024).

Unlike Preston and Lancaster, Barrow had no significant settlement before the Industrial Revolution (Jepson, 2017:4). Iron ore was mined on a large scale through the 19th century which led to steel working, docks, and a railway in 1846 (Marshall, 1958). The town's population grew first to mine iron, and then to produce steel and eventually ships (Clark,

1971). In 1876, Barrow steelworks were the largest in the world (Arnold, 2012). The industrial growth experienced in Barrow and its dependence on manufacturing led to popular media accounts referring to the town as the 'Chicago of the North' or the 'New Liverpool' in its heyday (Arnold, 2012). This rapid industrial growth led to rapid population growth, much of it driven by immigration from Ireland, Scotland, Wales and the rest of England (Bainbridge, 1939; Marshall, 1958). We fully analyse this growth and its potential impact on accent in Section 3. Barrow is now especially known for manufacturing nuclear submarines (Murphy, 2022), developing from the shipbuilding industry which grew alongside the steel industry during the 19th century.

1.4 Summary and research questions

In summary, we test the social model of 19th century dialect evolution proposed in Kerswill (2018) to a case study of derhoticisation in three north Lancashire settlements which evolved differently during the Industrial Revolution. Our analyses aim to shed light on where new dialect formation is likely to occur, and where it does not.

We investigate three specific research questions:

1. How did derhoticisation spread across urban north Lancashire?
2. What linguistic and social factors predict derhoticisation?
3. Which social and linguistic conditions lead to new dialect formation, and which do not?

These questions are addressed in two analyses: Analysis 1 is a variationist analysis of rhoticity in the Elizabeth Roberts Working Class Oral History Archive (Section 2). Analysis

2 is a detailed demographic analysis of 1801–1931 i.e. during the later Industrial Revolution, and up to our participants acquiring accent (Section 3). We discuss the findings in Section 4. Data and code are available here: https://doi.org/10.17605/OSF.IO/R7ZPM.

2 Analysis 1: Rhoticity in North Lancashire

Our first analysis addresses research questions 1 and 2 about the factors contributing to derhoticisation across north Lancashire.

2.1 Methods

2.1.1 Data

We analysed interview data from the Elizabeth Roberts Working Class Oral History Archive (ERWCOHA).[2] The archive consists of recordings made in the 1970s and 1980s by Elizabeth Roberts and Lucinda McCray Beier in Preston, Lancaster, and Barrow with participants who identified as working class. The participants were born in the later 19th century and early 20th century. Interviews are 30–80 minutes long and were recorded with a tabletop microphone onto reel-to-reel tape. In total, the archive contains data from 260 participants and was digitised by the British Library in 2020–2021. We selected recordings from the earliest-born speakers (1890–1917), who were recorded individually, with limited background noise, and where participant metadata were available. Here, we analyse data from 27 speakers (Table 1). In each case, we analysed the first 33 minutes of each interview, corresponding to the first reel-to-reel tape. The interviews were recorded

[2] https://www.regional-heritage-centre.org

as part of a working class social history project (Roberts, 1984). This original data collection aimed to especially record the experiences of textile workers and shipyard workers. As such, there is a bias towards participants who worked in textiles in Preston and to a lesser extent in Lancaster. We further discuss the occupations of workers in Preston, Lancaster, and Barrow in detail in Section 4.1 and possible implications for accent.

Speaker[3]	Location	Year of birth	Main occupation after school	Gender
MissA3P	Preston	1899	Textile worker	Female
MissT4P	Preston	1912	Textile worker	Female
MrsB1P	Preston	1900	Textile worker	Female
MrsB5P	Preston	1899	Textile worker	Female
MrsC2P	Preston	1899	Textile worker	Female
MrsM3P	Preston	1898	Textile worker	Female
MrC1P	Preston	1884	Textile worker	Male
MrE1P	Preston	1895	Textile worker	Male
MrG1P	Preston	1903	Textile worker	Male
MissH4L	Lancaster	1883	Textile worker	Female
MrsA2L	Lancaster	1907	Confectioner	Female
MrsH2L	Lancaster	1889	Textile worker	Female
MrsM3L	Lancaster	1917	Domestic service	Female
MrsS4L	Lancaster	1896	Textile worker	Female
MrsW2L	Lancaster	1910	Shop worker	Female
MrG1L	Lancaster	1904	Shop worker	Male

[3] The speaker coding system was devised by Elizabeth Roberts for the initial data collection.

MrH3L	Lancaster	1904	Textile worker	Male
MrR3L	Lancaster	1890	Cabinet maker	Male
MrsA2B	Barrow	1904	Domestic service	Female
MrsA3B	Barrow	1892	Domestic service	Female
MrsC2B	Barrow	1887	Shop worker	Female
MrsD1B	Barrow	1899	Domestic service	Female
MrA2B	Barrow	1904	Joiner	Male
MrB1B	Barrow	1897	Baker	Male
MrH2B	Barrow	1888	Moulder	Male
MrM2B	Barrow	1898	Office boy, Mechanic	Male
MrP1B	Barrow	1900	Ship builder	Male

Table 1: Background information about the participants analysed in this study.

2.1.2 Data processing and analysis

We used the digitised versions of the interviews with guidance from the Regional Heritage Centre, based at Lancaster University. The recordings were digitised at 44.1kHz sampling rate. The interviewee's speech was transcribed by the authors or Research Assistants in ELAN (Max Planck Institute for Psycholinguistics, 2022). Each speaker's transcript was force-aligned using the Montreal Forced Aligner (McAuliffe et al., 2017) using the ARPA 2.0.0 model for American English so that potential rhoticity was captured (McAuliffe & Sonderegger, 2022). We then used Praat (Boersma & Weenik, 2025) and R (R Core Team, 2025) for analyses as described below.

Data were first auditorily coded for the presence or absence of rhoticity. Tokens of coda rhoticity were identified in Praat avoiding devoiced and very reduced examples. We did not include examples of pre-vocalic /r/, linking /r/, or /r/ which became pre-vocalic due to h-dropping e.g. dropped /h/ in 'forme**r h**ospital'. Each token was coded by two listeners including the authors and trained Research Assistants. In terms of auditory quality, our data are either non-rhotic, derhoticised with pharyngealisation, and occasional alveolar approximants. Coders were instructed to listen for presence of approximant rhotics and/or pharyngealisation and to exclude instances of schwa offglides with no pharyngealisation. Coders were in complete agreement on 65% of tokens (5626 out of 8834). We excluded all tokens where coders disagreed when the number of tokens was less than 10% of a speaker's total data (24 tokens). For the remaining potentially ambiguous tokens, we used the coding provided by the most experienced coder. 16 of the 27 speakers presented here were coded by the authors.

Acoustic analysis was conducted on the vowel+rhoticity interval. Boundaries were placed around this interval in Praat using the forced alignment as a starting point and adjusting where necessary. For formant estimation, files were first low pass filtered at 11,020Hz and downsampled to 22,050Hz. LPC formant estimation was carried out with a window length of 25ms, 30dB dynamic range, estimating 5 formants, with a maximum value of 5500Hz for female speakers and 5000Hz for male speakers.
Formants were extracted at 11 equidistant timepoints. We calculated the difference between F3 and F2 at each timepoint, where smaller values mean more rhoticity. We used this measure as the previous research on Lancashire rhoticity indicates the importance of F2 as well as F3 in rhoticity perception (Heselwood, 2009; Heselwood &

Plug, 2011). We did not further sociolinguistically normalise the data, since the ratio between formants already serves as a form of normalisation (Turton & Lennon, 2023). Our analysis reports on the minimum F3–F2 between 10% and 90% of the vowel+rhoticity interval. In order to remove extreme values possibly derived from formant estimation errors, we removed 5% of outlying values using the *find_outliers* function in the *joeyr* package (Stanley, 2021). Examples from our dataset are shown in Figure 2.

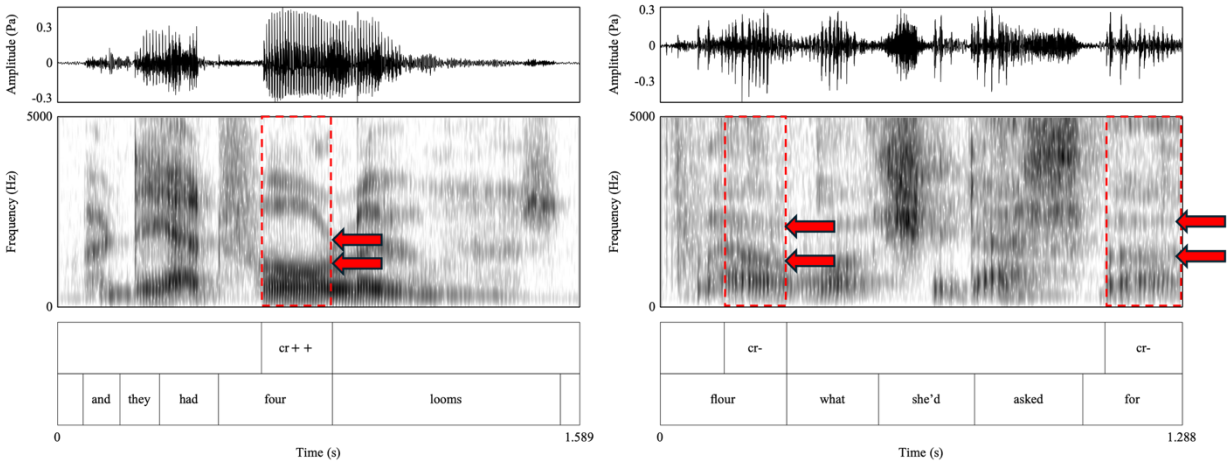

Figure 2: Examples of rhotic and non-rhotic tokens from the data. On the left: a male speaker from Preston produces substantial rhoticity, which can be seen in the substantial lowering of F3, and slight rising of F2. On the right, a male speaker from Barrow produces two tokens with no audible rhoticity. In 'flour' both F2 and F3 lower slightly through the coda, and in 'for' there is no perceptible movement in formants. The second and third formants are indicated by block arrows.

Preceding vowel context was extracted from the forced aligned transcripts in Praat and then vowel context recoded for British English in R. Words were coded as function or content words using the Part of Speech tagger in the *spacyr* package (Benoit & Matsuo, 2022). Tokens were coded in R as stressed or unstressed using the forced alignment codes. We excluded a small number of tokens (125) occurring in compound words which were classed as secondary stress e.g. 'woodw**or**k'. Data were coded for word position (internal vs. final) in R. We did not distinguish for syllable position e.g. 'pa**rt**' vs. 'pa**rt**y'

since previous work has found this to be non-significant or has not included this distinction (Blaxter et al., 2019; Ryan et al., 2022; Turton & Lennon, 2023). Vowel+rhoticity interval duration was extracted with the Praat script and log transformed (Turton & Lennon, 2023). The environment following vowel(+rhoticity) was extracted from the transcripts in Praat. We collapsed the following environment categories firstly into following pause, which has been found to favour rhoticity (e.g. Blaxter et al., 2019). We also distinguished between following voiced segment or following voiceless segment e.g. 'w**orl**d' vs. 'w**ork**'. Speaker gender and location were obtained from the ERWCOHA metadata. Data were checked and cleaned and the final dataset for analysis consists of 8018 tokens.

2.1.3 Statistical analysis

Auditory and acoustic datasets were analysed with mixed effects regression modelling. The auditory data were analysed with a logistic model, and the acoustic data with a linear model. In the auditory model, binary presence/absence of rhoticity was the dependent variable. In the acoustic model, standardised (*z*-scored) minimum F3–F2 was the dependent variable. We included the following social factors as fixed effects: location (Preston, Lancaster, Barrow; baseline Preston) and gender (baseline female). In terms of linguistic factors, we included word position (internal, final; baseline internal), word type (function, content; baseline content), vowel lexical set (CURE, letter, NEAR, NORTH/FORCE, NURSE, SQUARE, START; baseline CURE), following environment (pause, voiced segment, voiceless segment; baseline pause), log vowel+rhoticity duration. We also included two-way interactions between gender*location, and location*log duration. All discrete variables were sum-coded and the continuous predictor (log duration) was *z*-scored such

that the model intercepts represent the grand mean. Word and speaker were included as random intercepts. Significance testing was carried out by testing the full model against a model not including the predictor of interest by ANOVA (Winter, 2020). Where multi-level predictors were significant (vowel, location) post-hoc testing was carried out using the *emmeans* package (Lenth, 2021) and Tukey method.

2.2 Results

2.2.1 Auditory results

The results of the logistic regression modelling are shown in Table 2. Posthoc testing for Location, and Vowel set are shown in Table 3. Due to the large number of vowel comparisons, significant results only are displayed in Table 3 for clarity. The full set of results are in the Supplementary materials.

Full model intercept	$\widehat{\beta}$	**SE($\widehat{\beta}$)**	***z***	***p*(*z*)**
	-1.60	0.21	-7.50	<.001
Fixed effects		***df***	χ^2	***p*(χ^2)**
Location		6	78.6	<.001
Duration		3	458.4	<.001
Gender		3	10.27	.02
Gender*Location		2	2.76	.25
Duration*Location		2	43.44	<.001
Vowel set		6	57.73	<.001

Following environment	2	17.66	<.001
Stress	1	0.03	.86
Word position	1	3.50	.061
Word type	1	0.10	.75

Table 2: Full model intercept and fixed effects significance testing for the auditory logistic model.

Post-hoc tests for Location	$\widehat{\beta}$	**SE($\widehat{\beta}$)**	***z***	***p*(*z*)**
Preston – Lancaster	2.22	0.47	4.73	<.001
Preston – Barrow	3.43	0.47	7.28	<.001
Lancaster – Barrow	1.21	0.47	2.57	.003
Post-hoc tests for Following environment	$\widehat{\beta}$	**SE($\widehat{\beta}$)**	***z***	***p*(*z*)**
Pause – Voiced	0.10	0.12	0.87	.66
Pause – Voiceless	-0.28	0.13	-2.24	.07
Voiced – Voiceless	-0.39	0.09	-4.29	<.001
Post-hoc tests for Vowel set	$\widehat{\beta}$	**SE($\widehat{\beta}$)**	***z***	***p*(*z*)**
CURE – START	1.40	0.31	4.56	<.001
LettER – START	1.19	0.20	6.08	<.001
NORTH/FORCE – START	1.18	0.18	6.49	<.001
NURSE – SQUARE	0.70	0.23	3.02	.04

NURSE – START	1.19	0.18	6.67	<.001

Table 3: Posthoc testing for the auditory model Location, Following environment, and significant results for Vowel set.

The modelling shows that location significantly predicts audible rhoticity: Preston is significantly more rhotic than Lancaster, which is more rhotic than Barrow (Figure 3, left). Male speakers are more rhotic than female speakers. The interaction between gender and location was not significant, indicating that this pattern is true across all locations, however, the greatest magnitude of difference is in Lancaster. We have plotted the location*gender interaction to show the magnitude of the difference (Figure 3, right). There is an interaction between duration and location: longer coda duration significantly increases the probability of something being heard as rhotic, but more so in Preston compared to Lancaster and Barrow (Figure 4). Vowel set significantly predicts rhoticity: CURE, letter, NORTH/FORCE, and NURSE words are more likely to be rhotic than NEAR, SQUARE, and START words (Figure 5, left). For following environment, rhoticity is more likely preceding a voiceless sound compared to voiced (Figure 5, right).

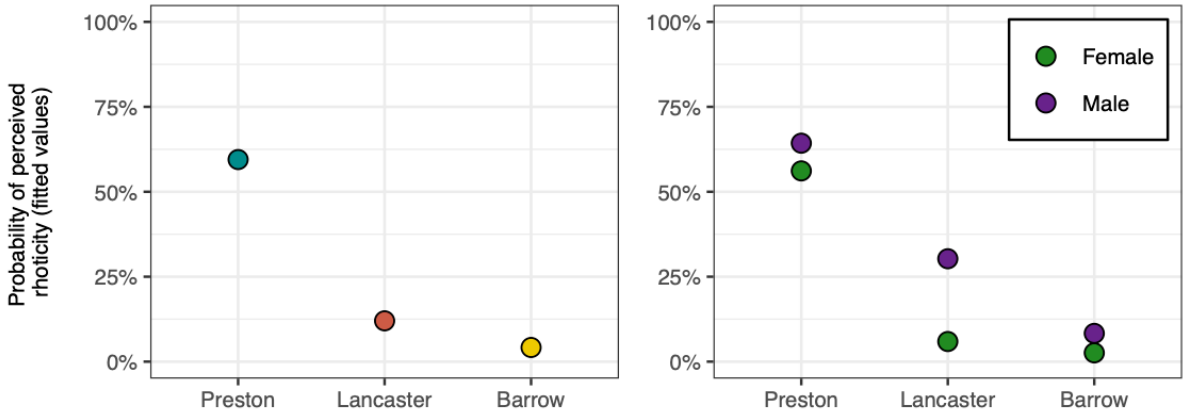

Figure 3: Model predictions for probability of coda rhoticity according to location (left), and in interaction with gender (right). Note the interaction with gender is not significant but is plotted to indicate the magnitude of differences in each location.

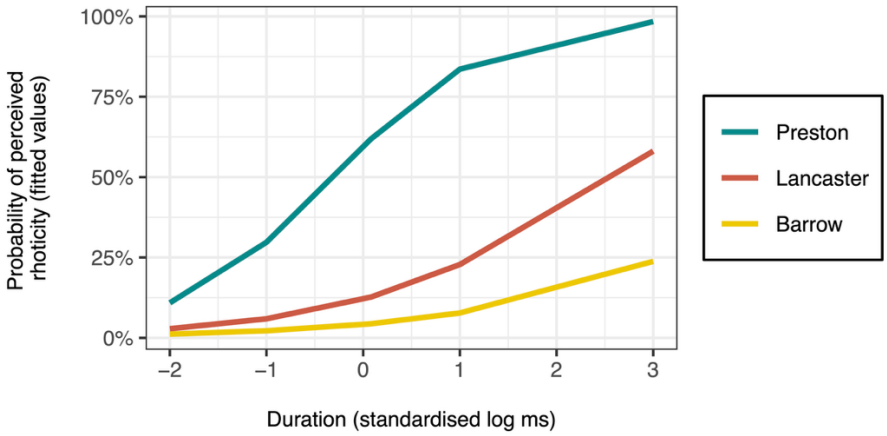

Figure 4: Interaction of vowel+rhoticity duration and location (fitted values).

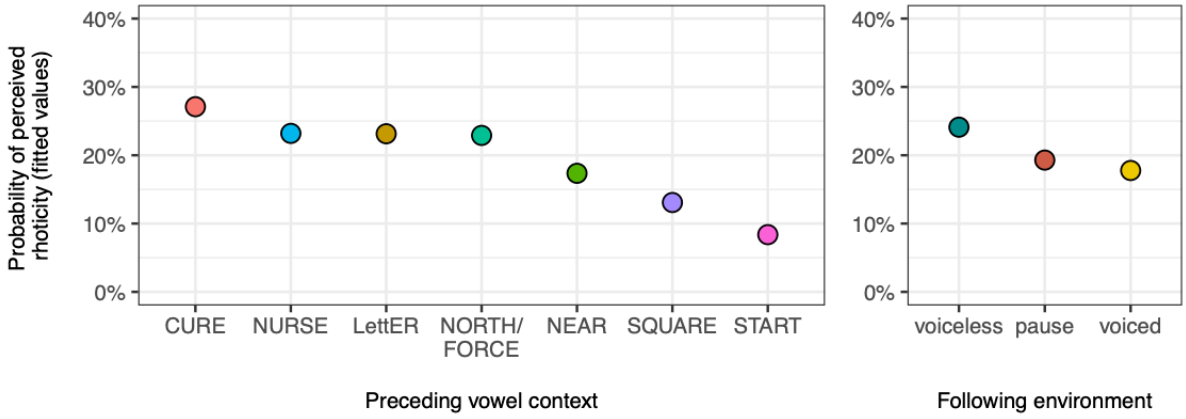

Figure 5: Model predictions for rhoticity in different preceding contexts (left), and following environments (right).

2.2.2 Acoustic results

The results of the linear regression modelling are shown in Table 4. Posthoc testing is shown in Table 5. As these results consider the difference between F3 and F2, it is unsurprising that there are a large number of differences between vowel lexical sets, and this does not reveal very much about presence/absence of rhoticity. As such, the posthoc tests for Vowel set do not reveal any useful answers to this study's research questions. For completeness, the full set of results are in the Supplementary materials.

Full model intercept	$\widehat{\beta}$	**SE($\widehat{\beta}$)**	***t***	***p*(*t*)**
	-0.09	0.06	-1.47	.15
Fixed effects		***df***	χ^2	***p*(χ^2)**
Location		6	68.43	<.001
Duration		3	394.97	<.001
Gender		3	5.76	.12
Gender*Location		2	5.45	.07
Duration*Location		2	44.78	<.001
Vowel set		6	368.44	<.001
Following environment		2	50.86	<.001
Stress		1	1.43	.23
Word position		1	5.35	.02
Word type		1	1.83	.18

Table 4: Full model intercept and fixed effects significance testing for the acoustic linear model.

Post-hoc tests for Location	$\widehat{\beta}$	**SE($\widehat{\beta}$)**	***z***	***p*(*t*)**
Preston – Lancaster	-0.32	0.12	-2.74	.02
Preston – Barrow	-0.60	0.12	-5.16	<.001
Lancaster – Barrow	-0.29	0.12	-2.39	.04
Post-hoc tests				

for Following environment	$\widehat{\beta}$	SE($\widehat{\beta}$)	*z*	*p*(*t*)
Pause – Voiced	-0.09	0.03	-2.92	.01
Pause – Voiceless	0.09	0.03	2.59	.03
Voiced – Voiceless	0.18	0.03	7.06	<.001

Table 5: Posthoc testing for the acoustic model Location.

Similar to the auditory results, there are significant differences for location, duration, and duration*location (though gender is not significant). Preston is significantly more rhotic than Lancaster, and Lancaster is significantly more rhotic than Barrow (Figure 6, left). These location results are mediated by duration. Figure 6 right panel shows the (non-significant) interaction between location and gender, plotted for comparison with the auditory results. Again, the magnitude of difference is greatest in Lancaster, where females behave similarly to participants from Barrow, and males behave similarly to participants from Preston. F3–F2 is lower as coda duration increases, but this effect is greater in Preston than in Lancaster and Barrow (Figure 7, left). Word-internal contexts are slightly more likely to be rhotic (Figure 7, right), though the difference is small. Vowel set is also significant (Figure 8, left), but as discussed above this is to be expected. Codas are more rhotic where the vowel(+rhoticity) interval precedes a voiceless segment, compared to a pause, and least likely preceding a voiced segment (Figure 8, right). This is the same as the auditory results.

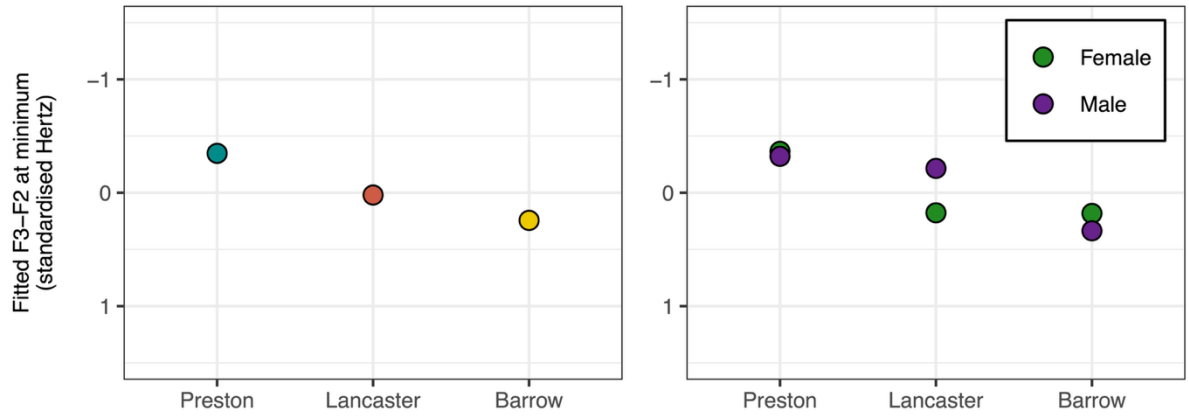

*Figure 6: F3–F2 at minimum (fitted values) by location (left panel) and location*gender (right panel). Note y axes scales have been reversed such that higher up = more rhotic. The location*gender interaction is not significant but is included to show the magnitude of the difference.*

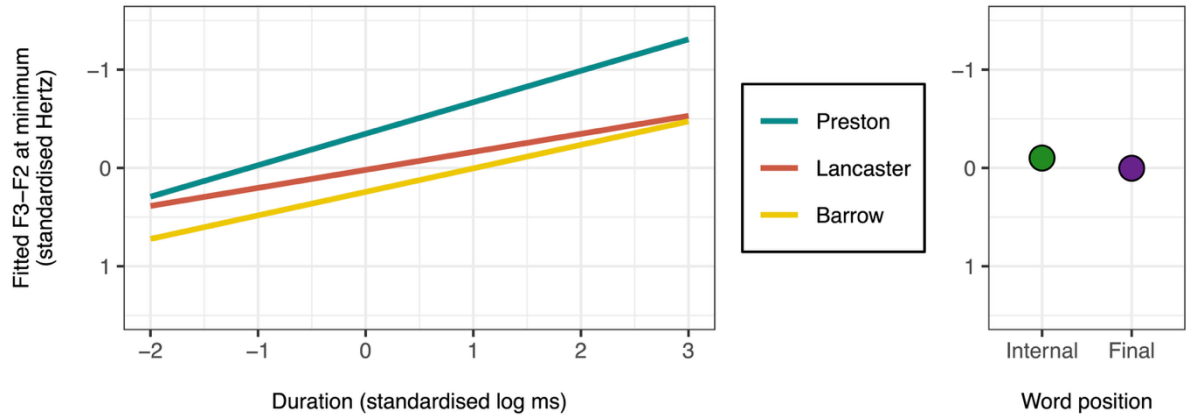

*Figure 7: Left panel: F3–F2 at minimum (fitted values) showing the duration*location interaction. Note y axis scale has been reversed such that higher up = more rhotic. Right panel: Fitted F3–F2 according to/r/ word position.*

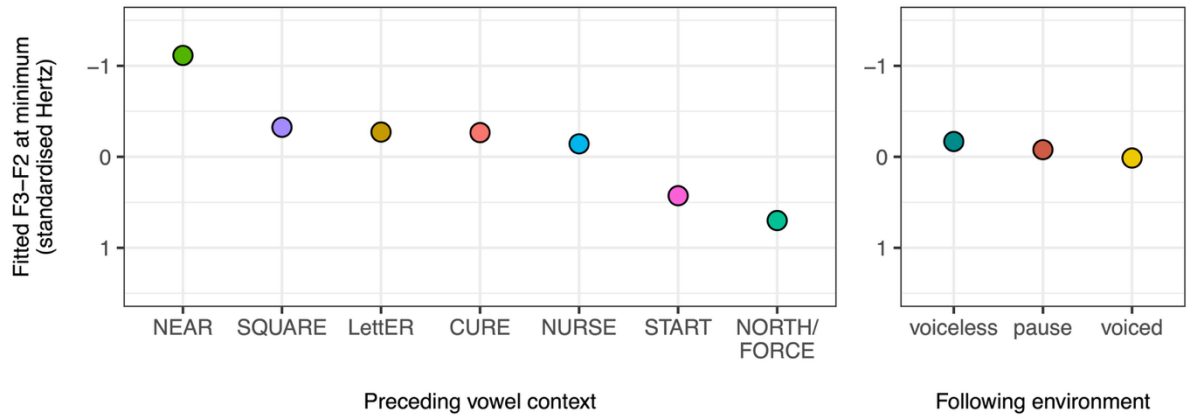

Figure 8: F3–F2 at minimum (fitted values) showing different preceding vowel sets (left), and different following environments (right). Note y axis scale has been reversed such that higher up = more rhotic.

2.3 Individual variation

The auditory and acoustic results show more rhoticity in Preston, especially in longer codas, followed by Lancaster, and then Barrow. In Lancaster, male speakers are much more rhotic than female speakers overall. However, these general results gloss over some of the differences between individual speakers, who are plotted in Figure 9. All the Preston speakers group together as more rhotic, all the Barrow speakers group together as less/non-rhotic. The Lancaster speakers are spread right across the continuum, though five out of the six Lancaster female speakers group with the Barrow speakers as mainly non-rhotic. We now analyse socio-demographic data in Section 3 to shed light on these results.

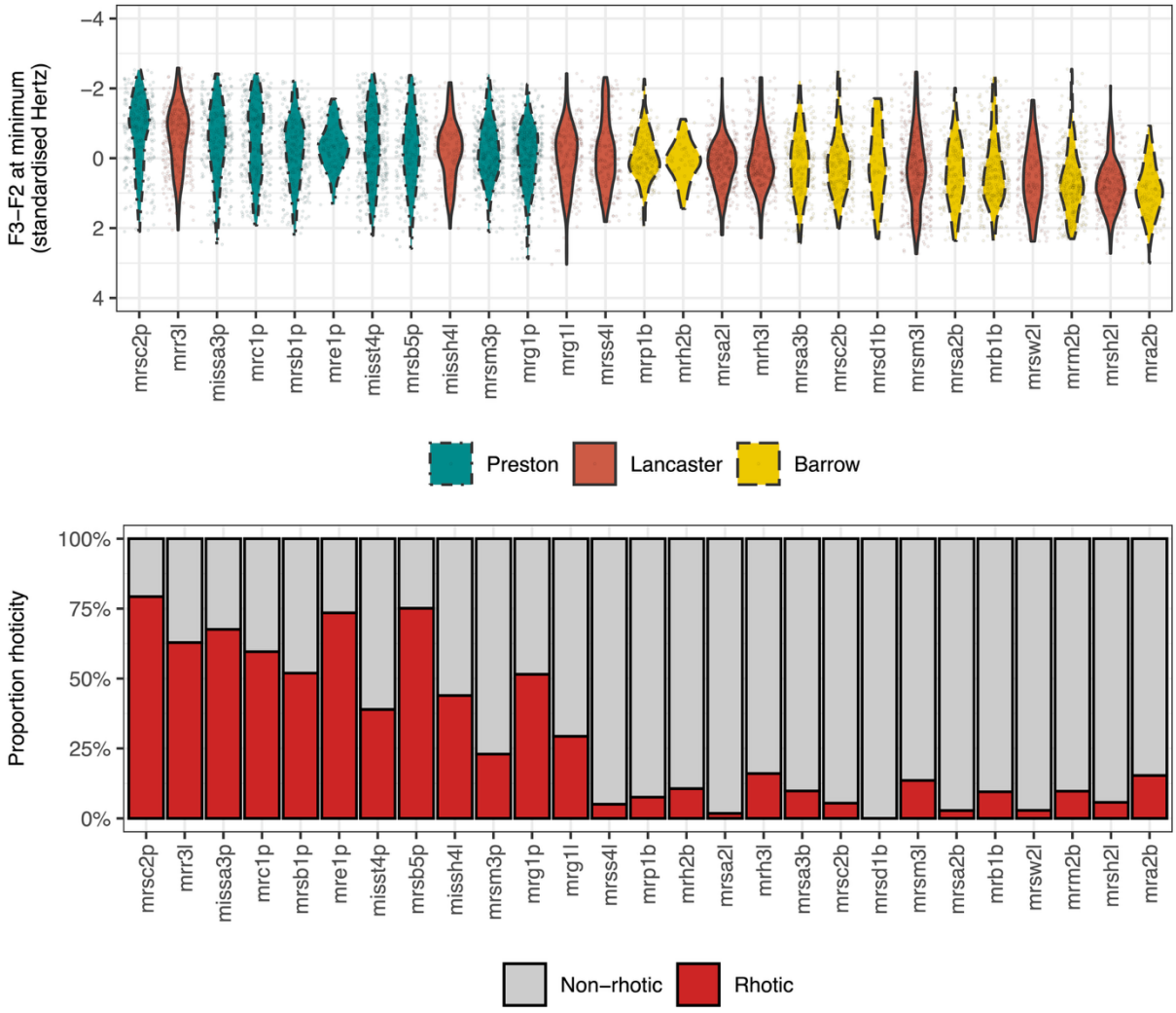

Figure 9: Acoustic (top) and auditory (bottom) results for individual speakers.

3 Analysis 2: Population dynamics

This section uses historical census data[4] to examine population and occupation in Preston, Lancaster, and Barrow[5] from the later Industrial Revolution up to 1931 and consider its impact on dialect evolution (RQ3). We chose 1931 as a relevant cut-off date as by this time the youngest of our speakers would be a young adult and would have a

[4] Census data were obtained from http://www.histpop.org.

[5] Barrow-in-Furness is not listed in the Census as a separate parish until 1871. For the first half of the 19th century we have used figures from Dalton-in-Furness, which included the (then) hamlet of Barrow (Bainbridge, 1939).

relatively stable accent. Population, and population growth, are plotted in Figure 10. It is clear that all three settlements experienced substantial population growth 1801–1931. However, Preston grew steadily in size with no very large increase between censuses. Lancaster also experienced steady growth except 1831–1841, which corresponds to the opening of new mills (Winstanley, 1993:152). The picture in Barrow is quite different with 30 years of very rapid growth 1851–1881.

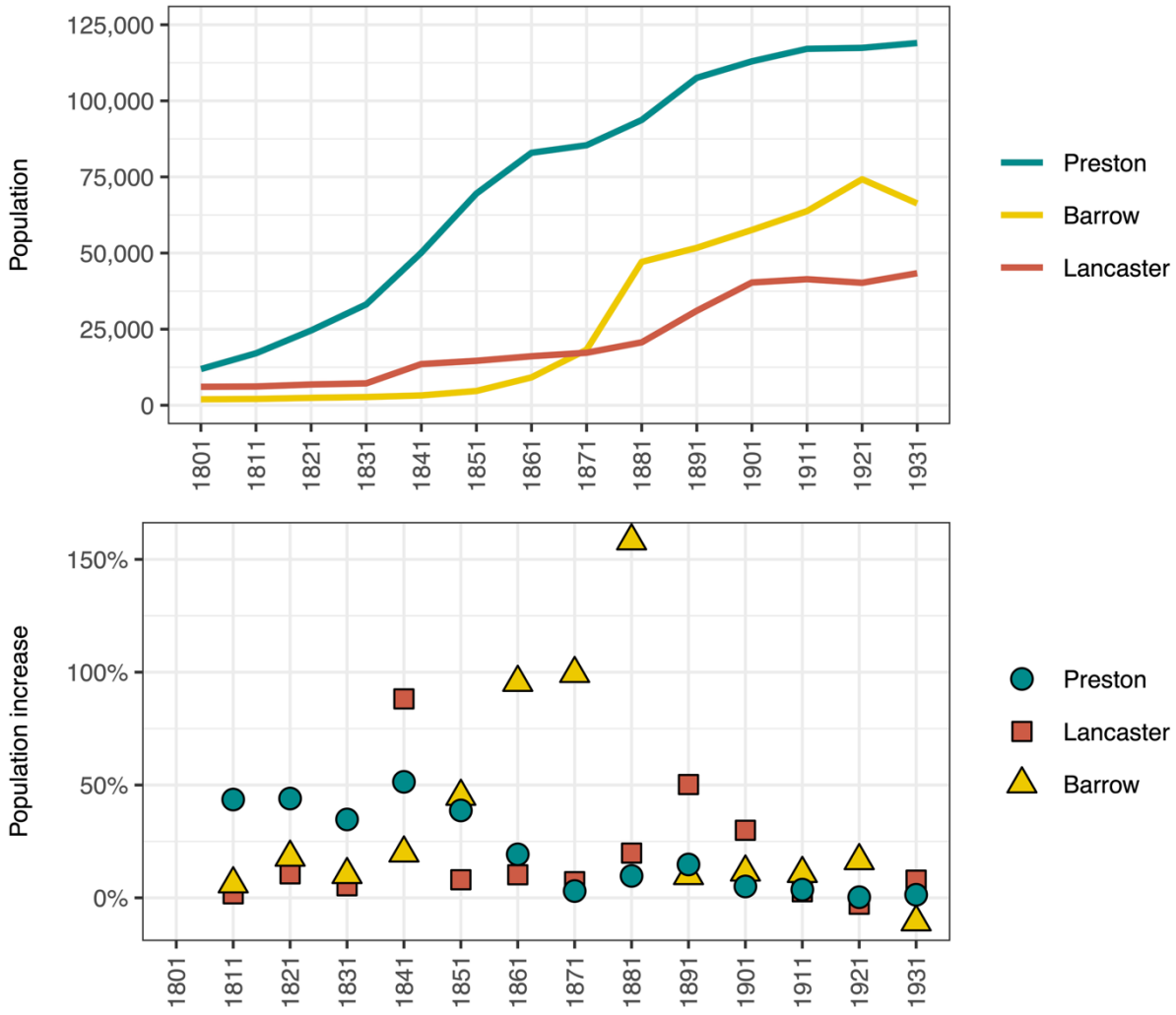

Figure 10: Population in Preston, Lancaster, and Barrow 1801–1931 (top panel). Population increase in Preston, Lancaster, and Barrow 1801–1931 (bottom panel).

To understand the nature of population change during the years of intense growth in Barrow, we focus on birthplace of adults in 1871 (Figure 11). 72% of adults in Preston

were born in Lancashire, compared to only 45% in Barrow. 7% of adults in Preston and Barrow were born in Ireland, but Barrow also has the highest proportion of adults born in English counties surrounding Lancashire, other English counties, Scotland, Wales, and other locations. Of interest to this analysis is that many of the migrants to Barrow presumably spoke rhotic varieties of English, for example from Scotland, Ireland or Cornwall. We return to this in Section 4.2.

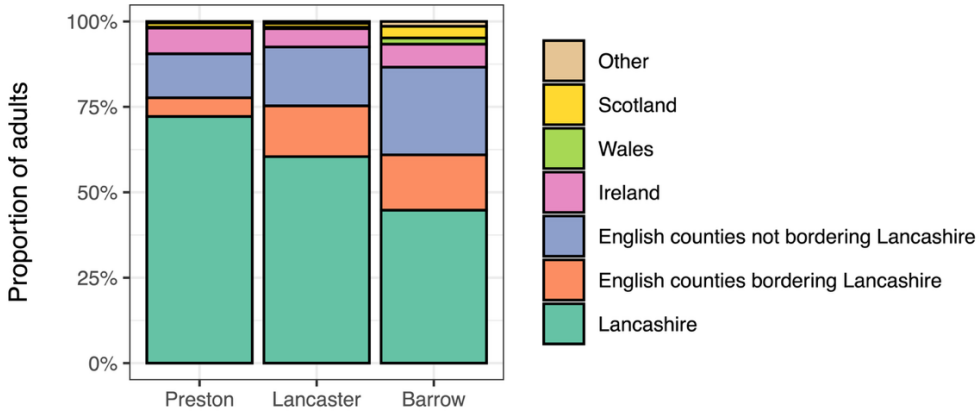

Figure 11: Birthplace of adults in Preston, Lancaster, and Barrow in 1871 from the England and Wales Census. English counties are divided into counties bordering Lancashire (Cheshire, Yorkshire, Westmorland, Cumberland) and English counties not bordering Lancashire. 'Other' category includes Islands in the British Sea, British Colonies, 'Foreign', Born at sea.

In order to estimate proportions of children and adults in the 19th century in our settlements, we assessed fertility rates. In Barrow in 1881 the fertility rate was 238, substantially higher than the England and Wales average of 165 (data for 1871 is not available).[6] The fertility rate in Barrow remained higher than the England and Wales average into the 20th century. In Lancaster and Preston in 1881, fertility rates were close to average: 178 and 157 respectively.

[6] Fertility rate is live births per thousand women aged 20–49 in a year. Data from https://www.visionofbritain.org.uk.

We also analysed occupation data from the UK Census at two snapshots in time: 1871 (to parallel the analysis in Figure 11) and 1911 (to gain a picture of when most of our speakers were young adults before the First World War). This analysis indicates that 84% of working women in Preston in 1871 worked in textiles, specifically cotton (42% of working men). This figure was 71% in 1911 (26% of working men). In Lancaster, occupations were more mixed in 1871: 46% of women worked in textiles and 38% in hospitality or in-service. Male occupations in 1871 are mainly split between skilled trades such as furniture making (31%), textiles, and mining. This level of occupation data was not recorded for Lancaster in 1911. In Barrow, the greatest employer for women in 1871 was hospitality and service (54% of working women) and 28% worked in textiles. Men in Barrow in 1871 worked mainly in mining and metalwork (34%) or skilled trades (31%). In 1911, hospitality/service was still the largest employer for women in Barrow (34%), and mining and metalwork became the dominant industry for men (59%). Full analysis of the census data for occupation is in Supplementary Materials. The occupations of our participants (Table 1) reflect this uneven distribution of trades across locations and the dominance of the cotton industry in Preston.

4 Discussion

4.1 Derhoticisation across the industrial North-West

Our first two research questions relate to the spread of derhoticisation across north Lancashire, and linguistic predictors of rhoticity. The quantitative analysis presented in Section 2 indicates more rhoticity in Preston, followed by Lancaster, and then Barrow, where speakers are almost entirely non-rhotic (RQ1). The auditory analysis shows that

male speakers are more rhotic, and the greatest magnitude of difference between males and females is in Lancaster. There are, however, substantial individual differences (Figure 9), especially for speakers from Lancaster.

Linguistic environment significantly predicts rhoticity (RQ2). There is a greater probability of audible rhoticity, and lower F3–F2, where there is a longer vowel(+rhoticity). This effect is greatest in the most rhotic place, Preston. It is possible that the change to audible non-rhoticity is mediated by speech rate: when speech rate is greater (leading to a shorter coda duration) the rhotic gesture is either produced late, after the end of the word (Lawson et al., 2014:74), or is much lesser in magnitude. We therefore suggest that derhoticisation could originate in a fast speech lenition process, leading to gestural reduction and loss of audibility (also argued in McMahon, 2000:273).

Our auditory analysis indicates that CURE, letter, NORTH/FORCE, and NURSE words are more likely to be rhotic than SQUARE, NEAR, and START. These results partially agree with recent auditory analysis of historic south Lancashire data in Ryan et al. (2022). It is common for NURSE contexts to favour rhoticity in England (Blaxter et al., 2019; Piercy, 2012). In East Lancashire, it seems that NORTH/FORCE is also a favouring context (Nance et al., 2023), and NORTH/FORCE is merged with CURE for many of our speakers. Letter contexts are less often cited as favouring rhoticity, though Blaxter et al.'s review notes that there is considerable variability in vowel contexts across studies (2019:99). Our analysis finds that pre-pausal and pre-voiceless environments favour rhoticity (Barras, 2010; Piercy, 2012; Ryan et al., 2022). We also found that word-internal contexts were more rhotic than word-final in the acoustic analysis only. This is similar to the findings in Turton & Lennon

(2023) (e.g. 'b**ir**d' more likely to be rhotic than 'c**ar** boot' see p.17), though their result was not significant.

4.2 Dialect evolution in 19th century Britain

Our main aim in this study and RQ3 was to assess which conditions led to new dialect in 19th century Britain, and which did not. We now consider the balance of social factors through Kerswill's (2018) framework applied to our linguistic data. Essentially, we will argue that rapid immigration and population mixing led to new-dialect formation in Barrow between 1861–1891, but not in Lancaster or Preston. Kerswill's model includes three elements: proportions of incomers speaking different varieties (Trudgill, 1986), social networks and community attitudes (Andersen, 1988; Kerswill & Williams, 2000), and rate of immigration relating to the Founder Principle (Mufwene, 2001). We first discuss proportions of incomers and rate of immigration together, and then social networks and community attitudes.

4.2.1 Population dynamics

In 1871, only 45% of the adults in Barrow were born in Lancashire (Figure 11). This includes Barrow, but also includes immigrants from Manchester, Liverpool, Preston, and other Lancashire[7] locations with varying accents and rates of rhoticity. It is highly likely therefore that the Barrow-born population was well below 50% of the people in Barrow at this time. Kerswill (2018:20) suggests that for new-dialect formation to take place, 50% of the population should be born outwith the settlement within a 10-year period. In 1871, only 60% of the people in Lancaster were born in Lancashire, indicating that this

[7] As noted above, Lancashire was larger at this time than the current ceremonial county (see Figure 1).

community could also potentially have been quite mixed. However, Lancaster represents a different context to Barrow since it had a greater proportion of people born locally, a longer history of settlement as a distinct city with an established culture and presumably dialect (Section 1.3), and a greater proportion of people employed in traditional industries such as cotton and agriculture (Section 3). The analysis here relates to population mixing and growth in Barrow in the 19th century, but this continued into the lives of our participants. Barrow experienced the highest population growth of our three settlements at a time when our speakers were young adults in 1911 and 1921. Much of this was driven by recruiting workers for the steel, ship-building, and armament industries (Schofield, 2017). Schofield cites a Yorkshire Evening Post article from 1915 describing Barrow as a 'Tower of Babel for dialect' due to workers arriving from across the UK and Ireland (Schofield, 2017:36).

Our analysis of population dynamics indicates three ten-year periods of near 100% population growth in Barrow 1851–1881 (Figure 1). In this respect, Barrow is similar to the context of Middlesbrough (Llamas, 2015). Although some of the population growth in Barrow will be 'natural' growth (i.e. more births than deaths), several accounts refer to the big demographic change and substantial immigration to Barrow and areas in nearby west Cumberland at this time (Bainbridge, 1946; Marshall, 1958). For example, Jepson (2017:21) states that it is a 'well-known fact that few Barrovians are able to trace their ancestry in the area before 1850'. Other than one 10-year period in Lancaster, there is no comparable period of growth in Lancaster or Preston indicating that the incoming population in Barrow were substantially more likely to overcome the effects of the Founder Principle and form a new dialect (Mufwene, 2001).

Linguistic factors could also interact with the sociodemographic aspects to new dialect formation in Barrow. We do not know of any work which has directly compared the quality of, for example, Cornish and Scottish rhoticity, but auditorily our impression is that codas sound quite different in these locations. In addition, rhotic codas have substantially different vowel phonology. For example, Scots traditionally has three different vowels in fir /i/, fur /ʌ/, fern /ɛ/, where English has /ɜ:/ (Abercrombie, 1979:72). Potentially, these rhotics and vowel systems were so perceptually different that listeners categorised them as completely separate, minority varieties, and non-rhotic productions were the largest proportional variant across the community. In terms of the traditional dialect of areas closest to Barrow, the SED data indicate that the closest rural varieties were still largely rhotic (Cartmel and Coniston), although there is no data from the area immediately surrounding Barrow. However, SED data indicates areas of lower rhoticity in central Cumberland and Westmorland (Supplementary Materials Figure A1). Speakers migrating from these regions potentially contributed lower rates of rhoticity to the mix. This would mean that non-rhoticity was selected in the new variety emerging in Barrow due to weight of numbers (Trudgill, 1986, 2004). It is possible that a process of 'drift' also took place in parallel, where the new dialect accelerates changes already in progress in the speech of newcomers, in this case derhoticisation in inputting English dialects (Gordon et al., 2004:81).

We suggest that ongoing change towards derhoticisation continued slowly in Preston as part of the Lancashire dialect continuum. In this respect, Preston is similar to many industrial contexts in England, where large population growth in the 19th century was

mainly local (Figure 11) and therefore did not significantly restructure varieties (Kerswill, 2018:25). At the same time, Preston is located in the area of central and east Lancashire, where the SED data indicate greatest retention of rhoticity in traditional rural varieties (Section 1.2). Lancaster is another formerly industrial city where population growth seems to have been largely driven by (relatively) local immigration as well as 'natural' growth. We argue that the social makeup of Lancaster in comparison to, for example Preston, has implications supporting dialect restructuring in addition to Lancaster being a little north of the rhotic heartlands of Lancashire. We now explore these social factors in more detail.

4.2.2 Social networks and attitudes

Here, we turn to the role of social networks and Andersen's (1988) distinction between 'closed'/'open' communities and 'endo-'/'exo-centric' to especially explain differences between Lancaster and Preston. Both Lancaster and Preston are relatively 'open' on this scale and would have been during the 18th–19th centuries due to being port cities and communications hubs. However, in Preston the economy, and inhabitants' occupations, were largely dominated by the cotton industry across the time period relevant to this study. We suggest that the more mixed economy and mix of occupations might have led to more opportunity for inter-class mixing in Lancaster and a more 'open' community, potentially explaining the large individual differences in rhoticity in Lancaster (Figure 9). In addition, the census data also reveal a 10-year period with very rapid population growth in Lancaster 1831–1841 when new mills were opened (Figure 11). This could have led to greater proportion of migrants Lancaster compared to Preston (albeit nowhere near the scale of population change experienced in 'open' Barrow).

In Preston, one industry employed almost all working women, and was the largest employer for working men through the late 19th and early 20th century. Dann et al. (2022) note the links between the traditional occupation of cotton weaving, community solidarity, and retention of rhoticity in Oldham, (then) south Lancashire. We build on this to also argue that Preston could also be more 'endocentric' in its attitude than Lancaster and Barrow due to the heavy dominance of this traditional industrial occupation across the economy in a way which was not the case in Lancaster. In addition, Preston has been nicknamed 'Proud Preston' since at least the early 18th century, as reported by Daniel Defoe on a visit to the city due to its role in the Jacobite rebellions, strong retention of Catholicism during the Reformation, and distinct local identity (Hunt, 2009:138). This nickname is widely used today, for example there is a local news blog named 'Proud Preston'[8] and the city was named the UK's 'proudest' in 2022 (Musgrove, 2022). These differences in the contact and economic history, as well as the culture of the settlements, could be one contributing factor to the differences we find in speakers from Lancaster and Preston in addition to prevailing dialect trends (Section 1.2).

As well as location differences between Lancaster and Preston, gender significantly predicts derhoticisation in the auditory analysis. Women are leading the change to derhoticisation, especially in Lancaster, while Barrow is essentially non-rhotic. This is in line with sound changes across western societies due to expectations about gender performance, traditional roles in the workplace, and gendered aims for socioeconomic advancement (Eckert & McConnell-Ginet, 2003:300; Labov, 2001:516). But where

[8] https://www.blogpreston.co.uk/category/preston-proud/

perhaps we expected to find a gender difference in Preston, there was none. We suggest that the links between rhoticity and traditional occupations such as cotton weaving (Dann et al., 2022), and the hugely important role of women in this industry (Roberts, 1984), have led to high retention of rhoticity in female Preston speakers.

Where a link with traditional industries in Preston facilitated retention of rhoticity, it is possible that the opposite effect took place in Barrow. In contemporary England, rhoticity is stigmatised and associated with old-fashioned rurality (Turton & Lennon, 2023:2). It is difficult to know for certain how rhoticity was perceived at the time period relevant to our study due to differing access to social meanings, but it is possible that a move away from rhoticity would be associated with modernity and the development of a forward-thinking new town such as Barrow (the 'Chicago of the North' (Arnold, 2012)). Finally, we also note the possibility of lifespan change towards derhoticisation (Sankoff & Blondeau, 2007). It is possible that our speakers became less rhotic during their lives before they were recorded. It is also possible that their parents became less rhotic when they moved to Barrow. A limitation of our sample is that we are not able to fully investigate the role of lifespan change within our speakers.

A final factor in the formation of a new dialect or not is the ratio of adults to children, and density of child networks (Kerswill & Williams, 2000:84). As discussed in Section 3, the fertility rate in Barrow was well above average for England, whereas in Lancaster and Preston it was near the average. From 1880 children in England were required to attend school, creating the denser child social networks which were not present in the seventeenth century Fens (Britain, 1997). This higher ratio of children to adults in Barrow,

and dense child social networks, might have also contributed to the rapid focussing of the new dialect and near-complete loss of rhoticity.

5 Conclusions

Our analysis tests the social model of 19th century dialect evolution presented in Kerswill (2018). Specifically, we applied the model to sociophonetic analysis of derhoticisation in north Lancashire and demographic analysis of 19th century population trends in order to assess where new dialect formation occurred and where it did not. Our analysis indicates a role for proportions of input varieties and ongoing sound changes, but also social networks and speaker attitudes in determining the outcome of historical dialect evolution.

In Barrow, 19th century population growth and immigration resulted in the development of a 'strange and quite unique' accent (Jepson, 2017:21). Barrow speakers were almost entirely non-rhotic. Data from the censuses show a huge population increase in 19th century Barrow, driven by immigration as well as high fertility rates. We argue that new-dialect formation took place between 1861–1891 in Barrow leading to a rapid acceleration of the ongoing derhoticisation. On the other hand Preston, '*the* classic mill town' (Hunt 2009:182), retains rhoticity in over 50% of possible contexts. In Lancaster, there is less rhoticity overall, and very substantial individual variation between speakers. We argue that the change towards derhoticisation in Lancaster is more advanced than in Preston due to restructuring of Lancaster's dialect through greater inter-class contact, less endocentric sense of local identity, and also prevailing traditional dialect trends. The

findings interact with vowel(+rhoticity) duration suggesting that derhoticisation originated in a fast speech lenition process (Lawson et al., 2014; McMahon, 2000).

We were able to apply Kerswill's (2018) proposed social model of 19th century dialect change to linguistic analysis and demonstrate that new-dialect formation took place in Barrow during the Industrial Revolution, but not in Lancaster or Preston. In doing so, we have been able to provide a quantitative analysis of historical derhoticisation in England, the 'most fundamental division in English dialects' (Lawson & Stuart-Smith, 2021:1).

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