Title page

Full title: Each p[ɚ]son does it th[ɛː] way: Rhoticity variation and the community grammar

Short title: Rhoticity variation and the community grammar

Authors:

* Tam Blaxter, University of Cambridge
* Kate Beeching, Bristol Centre for Linguistics, University of the West of England
* Richard Coates, Bristol Centre for Linguistics, University of the West of England
* James Murphy, Bristol Centre for Linguistics, University of the West of England
* Emily Robinson, Bristol Centre for Linguistics, University of the West of England

Contact details of lead author:

Tam Blaxter, Gonville & Caius College, Trinity St., Cambridge CB2 1TA, UK

[ttb26@cam.ac.uk](mailto:ttb26@cam.ac.uk) (please also cc [kate.beeching@uwe.ac.uk](mailto:kate.beeching@uwe.ac.uk))

(+44) (0)7588846600

Full title: Each p[ɚ]son does it th[ɛː] way: Rhoticity variation and the community grammar

Abstract:

This paper examines individual differences in constraints on linguistic variation. Problems are identified with the standard variationist methodology of pooling data from multiple speakers for analysis. It is proposed that these problems, in light of Labov’s (2007) proposal that adult change (diffusion) disrupts systems of constraints and Tamminga, MacKenzie & Embick’s (2016) work on the typology of constraints, may lead variationist sociolinguists to miss some of the complexity involved in structured variation in some communities. In order to investigate these claims, data on rhoticity from speakers of Bristol English are compared to 34 previous studies of rhoticity in varieties of English around the world. Constraints found to be consistent across varieties are also found to be consistent across speakers of Bristol English, whereas those that differ between varieties also differ between individuals, implying that only those which differ are truly part of the grammar and that these are indeed disrupted by diffusion.

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# Each p[ɚ]son does it th[ɛː] way: Rhoticity variation and the community grammar

# Introduction

This paper will use data from rhoticity variation in Bristol English to investigate the nature of constraints on sociolinguistic variables and the relationship between the grammars of individuals and the community grammar. It will be argued that these data call into question the stable, simple relationship between community grammar and individual grammar normally assumed in variationist sociolinguistics, with both methodological and theoretical implications.

In a typical variationist sociolinguistic study:

1. the grammar of a speech community (‘community grammar’) is the object of study;
2. data is pooled from multiple speakers who are taken to constitute a random sample from the speech community;
3. statistical effects on the dependent variable are identified in this dataset;
4. constraints within the grammar are directly (and more or less explicitly) inferred from these effects.

Epistemological and methodological problems arise from (1), (2) and (4) that deserve further investigation.

## The community grammar and individual grammars

The identification of the community grammar as the object of study and the relationship between community grammar and individual grammars allow a number of interpretations. Firstly, we might *define* the speech community as a community of individuals who share the same variable grammar (i.e. system of constraints) and evaluative norms. This is probably the most common understanding of (1) (Tamminga, MacKenzie & Embick 2016:307) and is exemplified already in Labov (1966). Under this understanding, studying the grammar of the speech community is definitionally equivalent to studying the grammars of individuals within it.

Secondly, we might define the speech community independently (by shared location, overlapping social networks, other shared cultural practices, etc.) but *assume* that all individuals within it share the same grammar. In this case, studying the grammar of the speech community is assumed to be a good proxy for studying the grammar of individuals. This is implicit, for example, in work which attempts to determine a formal representation for variation in historical data reflecting multiple speakers (e.g. Santorini (1992; 1994), Abramowicz (2008), Nevins & Parrott (2010)).

Thirdly, we could avoid the question by asserting that the grammars of individuals are entirely outside the scope of study, as Labov does when he writes that “the individual does not exist as a unit of linguistic analysis” (2014:18). Under this conception, individual grammars are presumably epiphenomenal on the community grammar. They could be largely uniform and identical to the community grammar (as is Labov’s position: “The end result [of native acquisition] is a high degree of uniformity in both the categorical and variable aspects of language production, where individual variation is reduced below the level of linguistic significance” (Labov 2014:17)) or could vary substantially and arbitrarily relative to it.

Unless we assume this third position, the (near, typical) identity of community grammar and individual grammars is central to variationist sociolinguistics. Both of the first two positions build into their research methodology the assumption that groups of individuals in a given location whose social networks overlap share near-identical grammars: in the first case, this allows such a group of individuals to be defined as a speech community; in both cases, it enables the methodological convenience of pooling data from multiple speakers (step (2) above). This assumption has been tested in studies. Guy (1980) investigated t/d deletion in Philadelphia and New York speakers, concluding that individual deviations from the overall constraint hierarchy merely reflected statistical noise with two exceptions to prove the rule: the effect of a following pause, which differed systematically between New York and Philadelphia speakers, demonstrating that these represented different speech communities, and a morphological condition that differed between middle-class adults and others. Meyerhoff & Walker (2007:353–359), investigating variable zero copula in Caribbean English, find no differences between the community grammar and the grammars of speakers who had spent a significant time away from the community as adults.

However, there are also contrary findings. Horvath & Horvath (2003), in a study of l-vocalisation in a series of New Zealand and Australian English datasets, find individual deviations in sizes, relative orders and even directions of effects, although they point out that “the percentage of individuals was quite small and statistical fluctuation cannot be ruled out” (Horvath & Horvath 2003:167). Forrest (2015), investigating (ing) in the English of Raleigh, North Carolina, finds substantial variation in individual effect sizes and orderings that does not seem attributable to statistical noise. With the caveat that “a reorganization of the hierarchy of internal constraints never truly occurs” (2015:400), Forrest goes so far as to say that “it would be overstating the case to say that an aggregate representation of constraint weight values accurately represents all members of the community; rather, they seem to represent a central tendency of speakers, given enough speakers in a corpus.” (2015:401)

In addition to these empirical reasons to be worried about the relationship between individual grammars and the community grammar and the practice of pooling data from multiple speakers, there is a particular conceptual problem with features undergoing change due to contact. The transmission-diffusion distinction (Labov 2007) suggests that, due to the degraded language-learning ability of adults, when features are transferred among adult speakers (diffusion) rather than from adults to children (transmission), the grammatical detail of those features is disrupted and their complexity reduced. This underlies a proposed distinction between features which have spread into communities from outside, and therefore show the disrupted signature of diffusion, and those which have a long history within the community. The argument is that the agents of transfer between communities must be mobile adults and so the mechanism must be diffusion, in contrast to community-internal transfer which is by transmission. The process by which this inter-community transfer takes place is complex: contact will often involve many independent agents travelling in both directions and be spread over a longer time; such agents will undergo different degrees of contact-induced adult change (diffusion) at different times. Thus we must assume that both undisrupted grammars and many grammars with differently disrupted systems of constraints enter such speech communities.

Additionally, longitudinal studies of various ongoing changes have found that a subset of speakers participate in changes during their adulthoods (lifespan change): for example, Buchstaller (2006) finds this for the spread of quotative *be like*; Sankoff & Blondeau (2007) demonstrate this dramatically for the change from apical to dorsal realisation of /r/ in Montreal French; Raumolin-Brunberg (2009) demonstrates it for several morphosyntactic features in Early Modern English. Some studies (such as Bowie 2005; Blondeau 2006; Sankoff & Wagner 2006; Wagner & Sankoff 2011) find retrograde lifespan change (perhaps a sign of advanced changes of which speakers are highly conscious (Sankoff 2013:10)). Far more examples can be found in Sankoff’s (2013) review. The point here is adults do participate in change, including changing their underlying vernacular grammar (Sankoff & Blondeau 2010:15–17; Sankoff & Blondeau 2013; contra Meyerhoff & Walker 2007). This, too, must be understood in at least some cases as diffusion and so we should expect those adults who have undertaken large enough lifespan change to exhibit disrupted grammars for their newly acquired features.

The question then is: if we have a change spreading into a speech community from outside (diffusion) in which some adults are participating (lifespan change), is the end result still somehow a variable grammar that is consistent across individuals? Do learners manage to settle on a common core of constraints which they then reproduce faithfully (koinéisation?), or is input variation from the diffusers so great that our transmitters, too, end up with disagreeing grammars?

## Mechanisms behind statistical effects

In spite of the general practice of inferring directly from statistical findings to grammatical constraints, there is good reason to think that not all effects on variable linguistic phenomena reflect constraints in the grammar. Guy (1997) distinguishes between articulatory universals, which reflect physiological properties of the articulators, functional universals, and the truly linguistic, variety-specific constraints that can evolve from these two types. Horvath & Horvath (2003), investigating l-vocalisation, aim to discover which effects are constant across varieties (‘scale-independent’, in their vocabulary) and which are variety-specific (‘scale-dependent’) on the assumption that effects which are constant may reflect universal phonetic processes whereas those which are specific must be “open to social intervention” (Horvath & Horvath 2003:148) (i.e. part of the grammar and so potentially subject to sociolinguistic variation). Nagy & Irwin (2010) compare constraints from past studies of rhoticity to identify which can and cannot vary between varieties, suggesting that only those which can vary should be used as metrics for relatedness. In a lucid and thorough exploration of the issue, Tamminga, MacKenzie & Embick (2016) distinguish three types of effects:

1. ‘s-conditioning’ = sociostylistic factors
2. ‘i-conditioning’ = internal linguistic factors
3. ‘p-conditioning’ = physical and cognitive factors

These types differ in their relationship to the grammar: i-conditioning is clearly part of the grammar; s-conditioning might fall inside or outside the grammar, depending on your theoretical orientation and whether we’re talking about the community grammar or the individual grammar; p-conditioning is clearly outside the grammar. A necessary caveat here is that over time, p-conditioning can give rise to s- and i-conditioning; for this point, see also Janda & Joseph (2003). They also differ in their universality: p-conditioning is universal (even if certain p-conditioning factors, such as short-term memory capacity, vary between speakers, they don’t vary between populations) whereas i-conditioning and s-conditioning are variety- and/or community-specific. There are potential exceptions to this. It is perfectly conceivable that a variable i- or s-conditioning factor might counteract an invariant p-conditioning factor, giving the appearance of an inconsistent p-conditioning factor. Likewise it is perfectly conceivable that within a given set of varieties an s- or i-conditioning factor might happen to be universal, especially if the varieties in question are related. Nevertheless, we can expect these broad tendencies to hold. Note also that they seem to hold at the level of individuals as well as communities: in Horvath & Horvath’s study (2003:160–161) it appeared that an effect which was more consistent across communities was also more consistent across individuals within a community.

## The problem

If we put these two sets of observations together, we find the problem. If, particularly in the case of features undergoing diffusion, there is considerable inter-individual disagreement in variable grammars (constraint hierarchy variation), then effects which have conflicting directions for different speakers will tend to cancel each other out in pooled data. With pooled data, we will most consistently be able to identify effects which reflect universal physical and cognitive factors (i.e. p-conditioning) since these will usually be invariable across individuals: but these effects are precisely those which are not part of the grammar. Effects which are part of the grammar (i-conditioning) will only emerge from analyses of pooled data if they are shared by most speakers or are very strong for the subset of speakers to whom they apply, which may happen to be true for some such effects but need not be true for all of them. What is more, the exact composition of the sample from the speech community may have a decisive effect on what effects we find.

This problem is most acute for studies which compare constraint hierarchies identified from different populations of speakers to make arguments about community identities and histories. One set of examples are studies that compare constraint hierarchies for variable phenomena in AAVE to the grammars of English-lexifier creoles to interrogate the possibility that AAVE is the descendent of such a creole (e.g. Poplack & Sankoff 1987; Poplack & Tagliamonte 1989; Poplack & Tagliamonte 1991; Cukor-Avila 1999; Tagliamonte 2013). Other examples include studies that use shared constraint hierarchies in different ethnic groups (e.g. Hoffman & Walker 2010; Becker 2014) or generations (e.g. Blondeau 2006) to demonstrate membership of a larger speech community or, indeed, studies which use differences in constraint hierarchies to argue for a history of diffusion (Labov 2007; Buchstaller & D’Arcy 2009). All of these approaches assume that findings of effects in pooled data are findings of constraints in grammars; they are weakened if their methodology is most effective at discovering those effects which are *not* parts of grammars. They also rely on the assumption that individuals share the grammar of their group. Should we assume that ethnic minority individuals whose constraints differ to their group are not members of their speech community? What if *most* such individuals differ along some axis? Or, even less coherent, do we assume that speakers of AAVE with certain constraints speak a variety descended from a creole and others with different constraints do not?

# Background on rhoticity

## Rhoticity in Bristol English

Loss of rhoticity in Bristol English offers us an excellent case study to explore these issues. Rhoticity, the realisation of non-prevocalic /r/, is undergoing change in many English varieties: rhoticity is declining in many previously rhotic British English varieties, but being gained in traditionally non-rhotic varieties in North America. The loss of rhoticity in West Country Englishes like Bristol English is change triggered by an external norm in which there is good reason to think adults participate: Standard Southern British English (SSBE) has categorical non-rhoticity in nonprevocalic contexts. Rhoticity is an extremely well-studied variable: as such, we can compare many past studies to identify likely universal and variable effects. Effects found to be universal across previous studies are potential candidates for p-conditioning, whereas variable effects are more likely to reflect i- or s-conditioning. If the above discussion is on the mark, we will find that older speakers (who were agents of diffusion and/or participated in community-internal lifespan change) vary in the effects of such i- and s-conditioning factors. For younger speakers, we might find that a consistent consensus system has emerged, or we might find yet more constraint hierarchy variation, the result of acquiring the variable from a mixed input. Since the external standard has categorical non-rhoticity, there should be no external standard constraint hierarchy which could play a role.

This study is based on data on the use of rhoticity by 30 speakers of Bristol English in unstructured sociolinguistic interviews. The sample population was made up of 15 speakers born between 1920 and 1947, 4 speakers born between 1983 and 1989, and 11 speakers born between 2000 and 2003. A minimum of 20 tokens were collected per speaker for each preceding vowel context except where fewer than 20 such tokens occurred in the interview; there were insufficient tokens following certain vowels (exemplified by the lexical sets CURE, FIRE and HOUR) and so these were excluded. Tokens were judged by ear as rhotic or non-rhotic and the spectrogram for each token examined; where tokens were perceptually indeterminate, they were classified as rhotic if the spectrogram showed a discernible drop in f3 across the vowel segment. These judgements were made by a single coder, Blaxter. Speakers with (near-)categorical non-rhoticity (b1, b2, 9, 11) were excluded from the analysis (although they are included in Table and Figure). In total, the remaining dataset consists of 5817 tokens.

These data are reported on more fully in Blaxter et al. (forthcoming). Here, suffice it to say that there is ongoing change, with traditional rhoticity declining under the influence of the non-rhotic standard.[[1]](#footnote-2) This is visible in these data as change in apparent time: Table and Figure show the number of observations and proportion of rhoticity per speaker against speaker age (the blue line is the linear trend line; points for female speakers are coloured blue and male speakers red)[[2]](#footnote-3). As is also clear from this figure, there is a high degree of within-group variability: there are speakers with less than 30% rhoticity born before 1950 and speakers with greater than 70% rhoticity born after 2000. The evidence of the Survey of English Dialects suggests that the traditional variety spoken in the region when these oldest speakers were children was fully rhotic: although speakers would have had some exposure to non-rhotic RP, there was probably little variation in rhoticity in the variety spoken by the community itself. Instructively, Piercy (2012: 79) finds that 97% of tokens produced by five SED speakers in Dorset were rhotic, a figure similar to the most conservative speakers in this study (b5, b7 and b8 all have over 95% rhoticity). Taken together, these observations suggest that much of the change away from rhoticity has taken place over the course of these speakers’ liftetimes. We might guess, then, that the older speakers in this study with the highest rates of rhoticity reflect community usage at the time of their childhoods, whereas the adults who exhibit low rates of rhoticity (such as speakers 26, 28, 20 and 22) have undergone substantial lifespan change.

| **speaker** | **year of birth** | **gender** | **observations** | **overall % rhoticty** |
| --- | --- | --- | --- | --- |
| 24 | 1920 | F | 102 | 63.73% |
| 25 | 1924 | F | 91 | 60.44% |
| 26 | 1925 | F | 128 | 52.34% |
| b5 | 1927 | F | 877 | 95.67% |
| 23 | 1932 | F | 113 | 64.60% |
| b6 | 1932 | F | 375 | 89.60% |
| 27 | 1934 | M | 132 | 78.03% |
| 28 | 1935 | F | 140 | 12.14% |
| 29 | 1935 | M | 113 | 1.77% |
| b7 | 1939 | M | 453 | 96.47% |
| b3 | 1940 | F | 388 | 83.76% |
| 19 | 1941 | M | 122 | 74.59% |
| b8 | 1942 | M | 595 | 96.47% |
| 20 | 1946 | F | 143 | 20.28% |
| 22 | 1947 | F | 143 | 20.98% |
| 21 | 1947 | M | 120 | 92.50% |
| b1 | 1983 | F | 558 | 0.00% |
| b2 | 1984 | M | 427 | 1.41% |
| b13 | 1986 | M | 646 | 60.37% |
| b12 | 1989 | F | 559 | 85.69% |
| 11 | 2000 | F | 136 | 0.74% |
| 3 | 2000 | M | 108 | 69.44% |
| 7 | 2000 | M | 99 | 16.16% |
| 4 | 2001 | F | 131 | 11.45% |
| 8 | 2001 | F | 130 | 32.31% |
| 6 | 2001 | M | 104 | 11.54% |
| 10 | 2001 | M | 130 | 38.46% |
| 1 | 2002 | F | 261 | 22.61% |
| 5 | 2002 | F | 125 | 62.40% |
| 2 | 2003 | F | 125 | 60.80% |
| 9 | 2003 | M | 109 | 0.92% |

Table 1: Observations and rhoticity rates per speaker

  
Figure 1: Rates of rhoticity by speaker for the sample population

## Independent variables

In order to identify the relevant independent variables to investigate, 34 previous studies of variation in rhoticity in varieties of English were surveyed. These include seven studies of other West Country varieties (Sullivan 1992; Jones 1998; Dudman 2000; Piercy 2006; Piercy 2007; Piercy 2012; Hollitzer 2013), seven studies of varieties elsewhere in the UK (French 1988; Williams 1991; Simpson 1996; Vivian 2000; Barras 2010; Schützler 2010; Watt, Llamas & Johnson 2014), 15 studies of North American English varieties (Parslow 1967; Parslow 1971; Labov 1972; Myhill 1988; Feagin 1990; Pollock & Bernie 1997; Miller 1998; Hinton & Pollock 2000; Elliott 2000; Ellis, Groff & Mead 2006; Irwin & Nagy 2007; Baxter 2008; Villard 2009; Nagy & Irwin 2010; Becker 2014) and four studies of English varieties elsewhere (Sudbury & Hay 2002; Trudgill & Gordon 2006; Sharbawi & Deterding 2010; Hartmann & Zerbian 2010). Table summaries of the findings of this survey, showing what independent variables were examined in each study and what effects they had, are given in the appendix. Here, we will concentrate on what generalisations can be made across studies. Since the sophistication of statistical tools used varies between studies—and even where studies report coefficients from similarly designed regression models, such coefficients are not strictly comparable—the findings have been simplified to whether a variable was found to favour, disfavour or be neutral for rhoticity. All linguistic variables except preceding vowel are reported in Appendix Table Appendixtable. In the case of preceding vowel, hierarchies of favouring → disfavouring have been compared; these are reported in Appendix Table Appendixtable.

One of the most striking findings of this review is the high degree of inter-variety agreement. Especially if we do not consider findings of no effect as strong evidence, most factors consistently disfavour rhoticity:

* higher word frequency (disfavouring in 3/3 studies),
* another /r/ in the word (disfavouring in 3/4 studies, no effect in 1),
* function words (disfavouring in 2/3 studies, no effect in 1)

or consistently favour it:

* stress (favouring in 10/10 studies),
* a following tautosyllabic consonant (favouring in 7/10 studies, no effect in 2, mixed in 1).

Thus the only factors for which we find substantial inter-variety disagreement are:

* word-final position (disfavouring in 8/12 studies, favouring in 3 and no effect in 1),
* prepausal position (favouring in 6/7 studies, disfavouring in 1),
* and morpheme-final (word-internal) position (disfavouring in 3/5 studies, no effect in 1, mixed in 1).

There is some slight evidence that direction of change (or perhaps dialect family) determines the effect of word-final position: all three studies which found word-final position favoured rhoticity were studies of North American varieties with increasing rhoticity.

The effects of preceding vowel are more heterogenous. Where studies have simply compared back and front vowels, they have usually found that back vowels favour rhoticity compared with front vowels (Labov 1972; Sudbury & Hay 2002; Baxter 2008; Barras 2010), although there are contradictory findings (Pollock & Bernie 1997). Where studies have divided this context into vowel phonemes (generally denoted by lexical sets), we find considerable variation. All of this information has been summarised in Table: this table shows the proportion of studies in which the vowel in the row was found to favour rhoticity compared with the vowel in the column, excluding those in which the vowel was not included or the two were found to have equal effect. Studies which grouped vowels have been coded as finding an identical effect for all of them. On the one hand, certain vowels stand out as having consistent effects: preceding NURSE is almost always one of the most favourable contexts (an exception is Nagy & Irwin’s (2010) findings for younger speakers); preceding lettER, NORTH and FORCE are usually among the most disfavouring contexts (exceptions include Asprey (2007) and Trudgill & Gordon (2006)). On the other, there is no pair of vowels with totally consistent relative effects across previous studies.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | NURSE | START | CURE | NEAR | SQUARE | FORCE | NORTH | lettER |
| NURSE |  | 80% | 83% | 95% | 95% | 84% | 90% | 95% |
| START |  |  | 67% | 47% | 73% | 86% | 87% | 83% |
| CURE |  |  |  | 71% | 71% | 83% | 83% | 73% |
| NEAR |  |  |  |  | 50% | 64% | 67% | 82% |
| SQUARE |  |  |  |  |  | 71% | 73% | 71% |
| FORCE |  |  |  |  |  |  | 67% | 87% |
| NORTH |  |  |  |  |  |  |  | 75% |
| lettER |  |  |  |  |  |  |  |  |

Table 2: Proportion of previous studies finding that the vowel in the row favoured rhoticity compared with the vowel in the column

These findings offer us some evidence for the classification of these factors in terms of the typology proposed by Tamminga, MacKenzie & Embick (2016). Since, barring interactions with other factors, p-conditioning will be universal whereas i-conditioning need not be, factors with a consistent effect across previous studies are more likely to reflect p-conditioning and inconsistent factors i-conditioning. This classification can be further informed by other properties of the factors in question: factors which are cross-linguistically observed never to have categorical effects (such as lexical frequency) must be p-conditioning; in any case, we should be able to posit a plausible mechanism of effect in the relevant domain. Suggested classifications are summarised in Table.

|  |  |  |
| --- | --- | --- |
| **Effect(s)** | **Class** | **Comments** |
| word length | p-conditioning | never involved in categorical alternations cross-linguistically |
| word-frequency |
| emphasis, stress, lettER, function word | p-conditioning | these four effects probably reduce to the effect of stress, with r-lessness as a form of lenition in unstressed contexts |
| another /r/ in the same word | p-conditioning | we can see this as an example of dissimilation at a distance, the result of overlapping perceptual cues to rhoticity (cf. Ohala 1981: 188–196) |
| following tautosyllabic consonant | p-conditioning | the effect across previous studies is extremely consistent and in terms of mechanism we might suggest that segments in syllable-final position are more susceptible to lenition processes; nevertheless, this is not a strongly evidenced classification |
| prepausal | p-conditioning / i-conditioning | there is a coherent mechanism for prepausal position as yet another indirect effect of stress (phrase-final lengthening), but since the effect varies among past studies this suggests it might instead (sometimes) reflect i-conditioning |
| morpheme-final position | p-conditioning / i-conditioning | appears to have a consistent effect across previous studies, but there is no especially obvious mechanism for p-conditioning |
| preceding NURSE | p-conditiong / i-conditioning |
| word-final position | i-conditioning |  |
| preceding START, CURE, NEAR, SQUARE, NORTH/FORCE | i-conditioning |  |

Table 3: Classification of internal effects on rhoticity

This typology guides variable selection for this study. We want to include all potential i-conditioning effects (which are of most interest for our research questions), as well as some of the strongest and best-studied p-conditioning effects. The independent variables included are:

* preceding vowel,
* morphological position (morpheme-internal vs. word-internal morpheme-final vs. word-final),
* prepausal position,
* function word vs. content word,
* frequency (on the basis of the spoken BNC (Leech, Rayson & Wilson 2001))
* and time during the interview measured in seconds (which gives a very crude measure of shifting style).

Finally, note that past studies also identified external effects on rhoticity, which are summarised in Appendix Table Appendixtable; we can assume that all of these reflect static s-conditioning.

# Methodological issues with studying individuals

Investigating variation between individuals in conditioning systems is methodologically tricky. The standard tool of variationist sociolinguistics is multiple regression analysis. We can fit a separate regression model to the data from each speaker and compare them. This was the method used by Guy (1980). However, there are two problems with this. Firstly, from a purely practical standpoint, we normally do not have enough data per speaker. Small datasets make it less likely we will be able to identify real but weak effects and are more likely to suffer from problems such as perfect or quasi-perfect separation. Secondly, although we can identify differences in the strengths, directions and relative orders of coefficients by comparing our models, we do not have a measure of whether those differences were significant. All of these problems affected Guy’s analysis: in order to reach his conclusion that individuals agree with the community grammar he has to write off a number of disagreeing individuals as the results of statistical noise in small samples, and he notes that at least one effect he reports is from a model which did not converge (Guy 1980:22).

Judging their datasets too small for regression analysis, both Meyerhoff & Walker (2007) and Horvath & Horvath (2003) instead simply compare raw rates in different contexts when they get down to the level of examining individual speakers; Poplack & Sankoff (1987) make the same decision faced with the related problem of breaking their data down into communities, as does Tagliamonte (2013:137–142) for *was/were* variation. This creates some of the same problems as using regression analysis (we don’t know whether differences in constraints between different individuals are significant) without the benefits (so that we also don’t know whether apparent effects are secondary). Tagliamonte (2013:148–149) also uses conditional inference trees to compare speakers, but again this offers us no way of deciding whether differences are significant or just the result of small sample sizes.

Returning to regression analysis, we can fit a single model to the whole dataset but try to identify individual deviations from the community constraint hierarchy by adding fixed interaction terms between speaker and each of our internal predictors or by examining random slopes for speaker/predictor combinations in a mixed effects model. This latter approach was undertaken successfully by Forrest (2015). This gives us a test of whether *at least one* speaker differs from the baseline model for a given predictor (is the model significantly improved by adding the interaction or by adding random slopes) but does not give us a significance test per speaker/predictor combination or any other way to undertake feature-selection on a per speaker/predictor combination basis. It still potentially suffers from the problems of small data.

Another alternative is elastic net regression (Zou & Hastie 2005), a method that combines ridge regression with lasso regression and has several features that make it an attractive tool for this case. Conceptually, these are methods of fitting regression models which ‘penalise’ large coefficients in order to avoid overfitting. Like ridge regression, elastic net regression is robust when predictors are highly or even perfectly correlated (as is likely when dealing with a large number of predictors) and shrinks highly inflated coefficients (which sometimes arise when dealing with small datasets). Like lasso regression, it can deal with large numbers of predictors (even where *p > n*) and incorporates a form of automatic feature selection, tending to reduce small coefficients to zero and thus effectively removing them from the model. Thus an elastic net regression model including interaction terms between speaker and all internal predictors offers us a solution to the problems laid out above:

* the method achieves a parsimonius model by reducing as many coefficients as possible to zero;
* although we have no measure of significance per sefor elastic net regression, since it automatically performs variable selection on a per-coefficient basis we can confidently interpret the results for each coefficient that remains in the model;
* the model offers interpretable results with small per-speaker datasets and can converge under perfect separation;
* it is able to deal with highly correlated predictors, which are often a problem with linguistic data.

A full explanation of this and related methods is given in the appendix; for further detail on elastic net regression the reader is referred to Zou & Hastie (2005). Here, the implementation of penalised logistic regression from the R package ‘penalized’ (Goeman 2009; Goeman et al. 2017) was used to fit a single model for the whole dataset. The model included all of linguistic variables listed at the end of 2.2, plus interaction terms between speaker and each of these predictors. The coefficients for non-interaction terms will be described as the ‘baseline model’: these represent the average constraint ranking for the whole community. The sums of non-interaction and interaction coefficients then give us our models for each speaker (these are given rather than giving the interaction coefficients directly so as to be able to give a constraint ranking for each speaker). The optimal values for the penalty terms were set using a combination of grid- and random-search to minimise the Aikaike information criterion (AIC): λ1 was set at 0.62497 and λ2 at 0.00101. Of 378 possible coefficients, 242 were non-zero; the coefficients reduced to zero are effectively removed from the model. The (near-)categorical speakers b1, b2, 9 and 11 were not included in the model. Categorical predictors (morphological position, preceding vowel) were sum-coded. Word frequency and time in the interview were scaled and centred such that they had mean 0 and standard deviation 1.[[3]](#footnote-4)

# Results

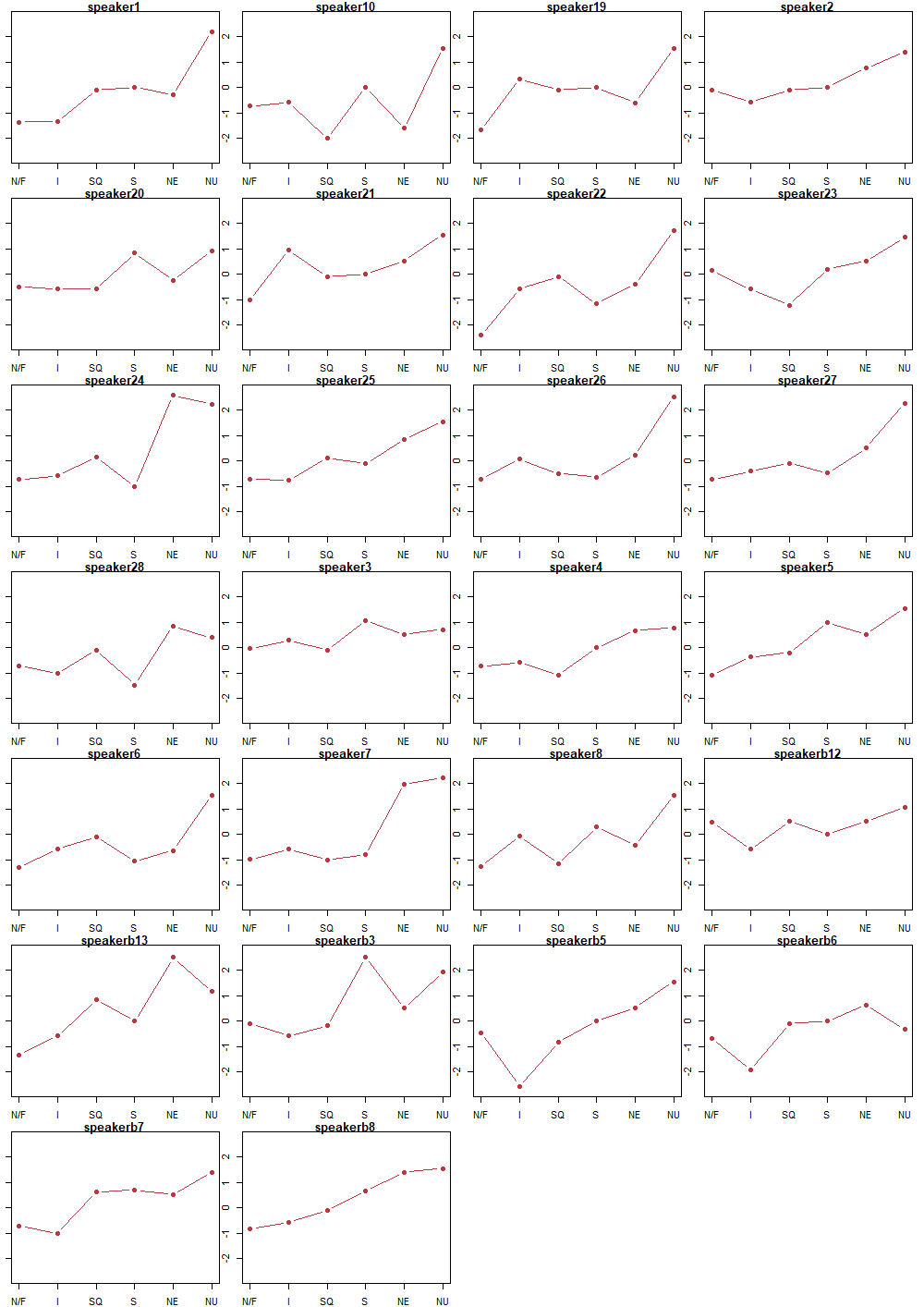
Figure gives the model coefficients[[4]](#footnote-5) for different preceding vowels and Figure for all other predictors (raw cell values on which all coefficients are based are reported in section 7). These figures show roughly the expected picture: preceding vowels favour rhoticity in a hierarchy NURSE > NEAR > START > SQUARE > lettER > NORTH/FORCE. Among other predictors, the largest effects are the favouring effect of prepausal position and the disfavouring effect of being a function word. The magnitudes of other effects are relatively small. All effects except word frequency are in the same directions as identified in the majority of previous studies.

  
Figure 2: Coefficients for preceding vowels (baseline model)

  
Figure 3: Coefficients for other predictors (baseline model)

The interesting results, however, are in individual speaker deviations from this baseline model. Of the 338 possible interactions in the model, 212 had non-zero coefficients. Figure shows the sums of the coefficients of the interaction terms between speaker and preceding vowels and the coefficients of preceding vowels in the baseline model, and Figure shows the same for other predictors; the orders of predictors are the same as in Figure and Figure.

At one end of the spectrum, we find speakers whose systems are basically in complete agreement with the community system, cf. the preceding vowel coefficients for speaker b8 ( Figure[[5]](#footnote-6)) or the coefficients for other predictors for speaker 1 ( Figure). Most speakers, however, have at least some significant deviations from the common system. At the other extreme, we find highly divergent systems, such as the preceding vowel system of speaker b12 in which NORTH/FORCE and SQUARE slightly favour rhoticity ( Figure) or the system of other predictors for speaker 24 where prepausal position slightly disfavours rhoticity and most influence comes from morphological position and time ( Figure).

  
Figure 4: Coefficients for interactions between speaker and preceding vowel (ordered by speaker number)

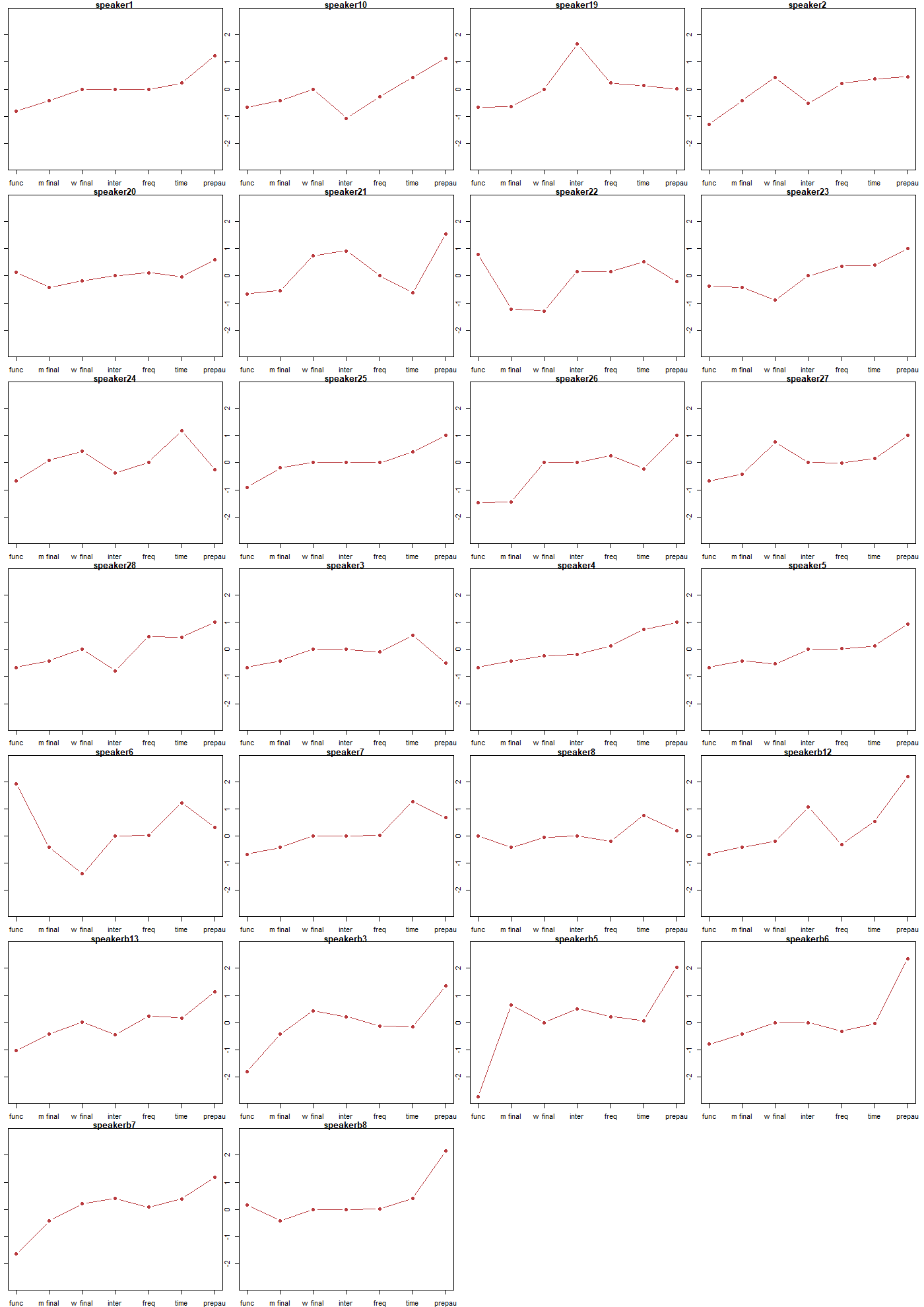
  
Figure 5: Coefficients for interactions between speaker and word class, morphological position, frequency, time and prepausal position (ordered by speaker number)

  
Figure 6: Coefficients for preceding vowels (speaker b8)

  
Figure 7: Coefficients for other predictors (speaker 1)

  
Figure 8: Coefficients for preceding vowels (speaker b12)

  
Figure 9: Coefficients for other predictors (speaker 24)

One way of measuring speakers’ levels of agreement with the community norms is to look at rank correlations between the coefficients of the baseline model and coefficients from individual speaker models (i.e. sums of baseline coefficients and interaction coefficients): a perfect rank correlation would imply that, even if a speaker’s system differs from the community norm in details, the overall constraint hierarchy is the same; a correlation coefficient of zero would imply that a speaker’s system bore no relation to the community norm. Figure visualises these rank correlation coefficients for vowels and for other predictors. There are no obvious patterns by age or gender: highly agreeing and highly disagreeing speakers are found in the young and old, male and female groups. Note too that there is no significant correlation between these two measures: having a vowel system that deviates from the community norm is not a good predictor of having other effects which deviate from the community norm, and vice versa.

  
Figure 10: Rank correlation coefficients between speaker coefficients and global coefficients

Turning from speakers to variables, we find some highly consistent predictors. The strongest example is preceding vowel NURSE, which is the most favouring vowel for all but six speakers (and five of those it is the second most favouring). However, we also find some highly variable predictors such as word final position, which varies from being one of the most favouring contexts for rhoticity (speakers 2, 3, 24, 27 and b8) to the most disfavouring (speaker 6, 22 and 23).

Figure visualises the ranges of coefficients across speakers. In summary, we can say that the following relatively consistently favour rhoticity:

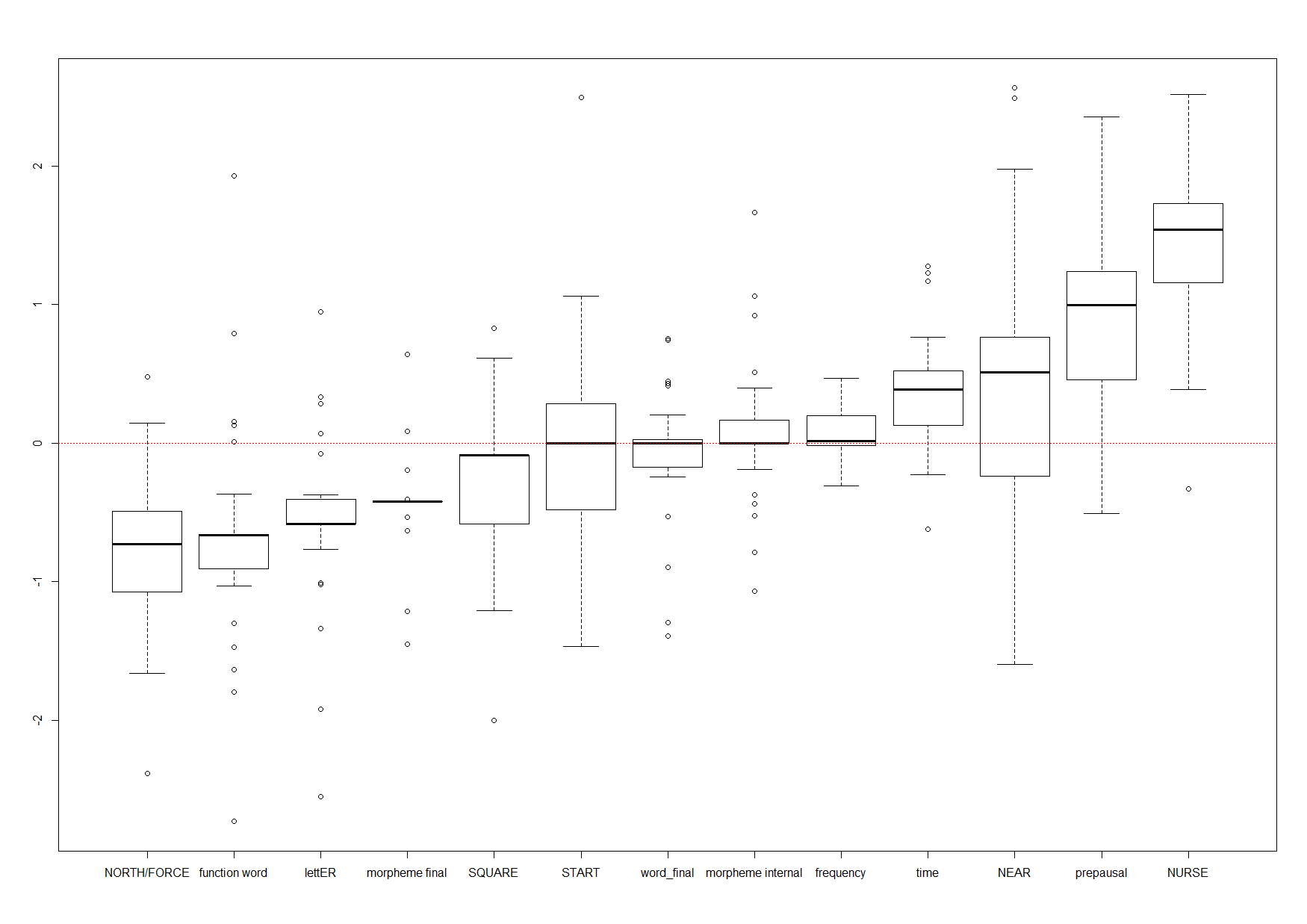
* preceding NURSE (weak reversed effect for speaker 6),
* prepausal position (reversed effect for speakers 3, 22 and 24),
* time in the interview (reversed effect for speakers 21, 26, b3 and b6);

the following relatively consistently disfavour rhoticity:

* function words (with a clearly reversed effect for speakers 6 and 22, and very weakly reversed effects for speakers 8, 20 and b8),
* preceding NORTH/FORCE (reversed effect for speakers 23 and b12),
* preceding lettER (reversed effect for speakers 3, 19, 21 and 26),
* morpheme-final position (reversed effect for speakers b5 and 24);

and the following have inconsistent effects:

* preceding NEAR (favours for 19 speakers but disfavours for speakers 1, 6, 8, 10, 19, 20 and 22),
* word frequency (disfavours for 9 speakers, favours for 18 speakers of which 6 only very weakly),
* morpheme-internal position (disfavours for 6 speakers, neutral for 13 speakers, favours for 7 speakers),
* preceding START (disfavours for 8 speakers, neutral for 10 speakers and favours for 8 speakers),
* word-final position (disfavours for 8 speakers, neutral for 11 speakers and favours for 7 speakers),
* and preceding SQUARE (disfavours for 21 speakers of which 11 only very weakly, favours for speakers 24, 25, b7, b12 and b13).

  
Figure 11: Ranges of coefficients across speakers

# Discussion

In sections 1 and 2 we sketched the following scenario:

* following Tamminga, MacKenzie & Embick (2016), influences on the occurrence of rhoticity fall into three categories, i-conditioning, p-conditioning and s-conditioning;
* p-conditioning reflects universal physical and psychological factors: excepting interactions with other factors, it should be found to be consistent across studies of different speech communities and (for direction if not necessarily for degree) across individuals within speech communities;
* s- and i-conditioning should be community-specific: they should vary across studies of different communities;
* in speech communities undergoing external change (diffusion), s- and i-conditioning should be disrupted and so vary across individuals.

On the basis of these observations, and given that Bristol English is a variety undergoing just such external change, we predicted that:

1. variation across individuals in this study should be substantial, with true reorganisations of systems of constraints;
2. there might be greater consistency for younger speakers, who have koinéised the mixed community input to settle on a common system of constraints;
3. within this variation, certain factors should recur across all studies and all individuals within this study; these should otherwise fit the profile of p-conditioning factors (having a plausible physical or cognitive mechanism, potentially never occurring as categorical grammatical factors);
4. whereas factors which differ across past studies and between individuals in this study should have plausible s- and i-conditioning mechanisms.

Considering the first of these predictions, we find that this is clearly borne out by the data. There are three highly consistent findings across all speakers: preceding NURSE is almost always one of the strongest favouring contexts for rhoticity (the only real exceptions is speaker b6); preceding NORTH/FORCE always has a disfavouring effect; word frequency is always one of the weakest effects. In every other respect, we find variation across speakers. Comparing the magnitude of coefficients, we find speakers (6, b5, b7) for whom function word status has the largest effect, speakers (21, b6, b8, b12) for whom prepausal position has the largest effect, and many speakers for whom the largest effect is from preceding vowel. There are speakers (7 and 24) for whom the predictor with the third largest magnitude is the time in the interview, suggesting that these speakers showed a particularly high degree of style shifting over the course of the interview[[6]](#footnote-7). Among preceding vowels, there is substantial variation: preceding START ranges from most favouring to least favouring context; preceding NEAR ranges from the most favouring to second most disfavouring; preceding SQUARE and lettER from the second most favouring to most disfavouring. All in all, we find such substantial differences between systems exhibited by different speakers that we cannot describe these as merely minor variations in strengths or reorderings of already-similar effects: it is only reasonable to describe these as true reorganisations of systems of constraints.

Our second prediction fares much more poorly. There are younger speakers (such as speaker 5) whose systems agree relatively well with the global model, but there are also younger speakers with highly divergent systems (such as speaker 6, whose function word constraint is reversed); the same is true of older speakers. Overall, there is no evidence that inter-individual variation is lessening with successive generations of speakers.

Turning to the third prediction, we do find some convincing examples. Function words consistently disfavour rhoticity across past studies and across all but two speakers in this study. An obvious mechanism for this effect is that function words are chronically understressed and so more subject to lenition and fast-speech processes: this is a mechanical consequence of the nature of function words and so qualifies as p-conditioning; there is no reason to think this constraint is part of competence for these speakers (although hypothetically it could easily give rise to a truly linguistic constraint, such as by developing into a lexical split where function words lose underlying rhoticity but content words do not).

Likewise the preceding vowel lettER seems a good candidate for p-conditioning. This disfavours rhoticity across a large majority of previous studies, and it disfavours rhoticity for a large majority of speakers in this study. Again, the mechanism here would be to do with stress: lettER is the only fully unstressed rhotic vowel.

The evidence of this study suggests that the influence of prepausal position on rhoticity may also reflects p-conditioning: it favours rhoticity for all but three speakers in this study, and favours rhoticity in all but one previous study. Here, the mechanism is presumably derived from phrase-final lengthening, with rhoticity more likely to be preserved in lengthened syllables and words; since this phrase-final lengthening is a common phenomenon across languages, there is no reason to imagine this effect would be part of learnt competence. The varying size of this effect across speakers in this study might reflect individual differences in speech-rate or propensity for phrase-final lengthening.

Turning to our fourth prediction, we find several effects which fit well into our account. The inclusion of time in the model can give us a (very crude) measure of style shifting—dynamic s-conditioning in the terms of Tamminga et al. (2016)—and as expected for s-conditioning, we see variation across individuals, with some speakers (such as 7 or 24) substantially increasing their rate of rhoticity over the course of the interview whilst others (such as speaker 20 or b5) show close to no change and a few (21, 26 and b3) *de*crease their rate of rhoticity over the course of the interview.

In terms of i-conditioning, the preceding vowels SQUARE, START and NEAR clearly behave as predicted for i-conditioning factors: the effects of these contexts varies both between past studies and between individuals in this study, implying that they are learnt effects which can be disrupted by diffusion. Likewise the effects of morphological context (a following word boundary vs. a following word-internal morpheme boundary vs. neither) are inconsistent across previous studies and inconsistent across Bristol English speakers, suggesting that these are arbitrary, learnt effects that are part of the grammar and can be disrupted by diffusion.

Three effects are a problem for our account and deserve closer comment. The favouring effect of preceding vowel NURSE on rhoticity is very consistent across speakers in this study and one of the most consistent across past studies, suggesting that it might reflect p-conditioning, yet there is no immediately obvious universal mechanical or psychological mechanism to account for it. Similarly, the disfavouring effect of preceding NORTH/FORCE on rhoticity is quite consistent across previous studies and very consistent across speakers in this study. It is, of course, possible that these reflect i-conditioning factors that simply happen to be consistent across all varieties of English studied. If this were the case, we might hypothesise that they would be less liable to disruption by diffusion, since they would be a constant across all varieties a potential diffuser was exposed to, explaining their inter-speaker consistency in this study. Nevertheless, it is worth exploring whether any plausible universal cognitive or physical mechanism can be proposed for these effects.

One possibility is that these are explained by structural phonological factors shared by all varieties of English studied. Considering the loss of rhoticity, we could classify words by whether the change is a merger—i.e. the phonological transfer of words from one class into another existing class—or involves the creation a new vowel phoneme. By this classification, NORTH/FORCE words are at one end of the spectrum (the THOUGHT vowel and for some speakers the CLOTH vowel are large, well-established lexical sets into which NORTH/FORCE words are transferred) whereas NURSE words are at the other (there is no other source of /ɜː/). Other lexical sets fall between these extremes, with the loss of rhoticity involving transfer into marginal existing sets (IDEA for NEAR, YEAH for SQUARE) or sets which only exist in certain varieties (BATH for START only in varieties with the TRAP/BATH split, a phenomenon discussed more extensively in Blaxter & Coates (forthcoming)). The one other preceding vowel for which loss of rhoticity involves merger into a large, well-established lexical set is lettER, which merges with commA, and this vowel, like NORTH/FORCE, consistently disfavours rhoticity across speakers and past studies. This implies that there may be a universal psychological mechanism at work here: that it is easier to transfer a word into an existing phonemic class than it is to create a new phoneme.

Finally, word frequency fails to fit our predicted picture: more frequent words consistently disfavoured rhoticity in (admittedly only three) past studies, but had a small and inconsistent *positive* influence on rhoticity for Bristol English speakers. Here, we have two possibilities. Firstly, it is possible that this reflects i-conditioning and that the sample of previous studies is simply too small to have identified the fact that the direction of this effect can differ between varieties. However, the problem would then be that it seems very unlikely *a priori* that word frequency is a variable that can be involved in i-conditioning, since it is not a variable that can be involved in categorical grammatical rules (no language, for example, has one allomorph which is used on stems above a certain threshold frequency in connected discourse and a different allomorph for other stems). We must turn, then, to the second possibility, which is that there is some methodological problem in the approach to frequency in this study or in past studies: either the source of frequency data used here (the spoken component of the British National Corpus) is not a good measure of frequency for these speakers, the effect is too small to capture accurately in the datasets used, or an interaction with other predictors interferes with the effect. There is, in fact, good evidence for this last conclusion: the three studies which found that higher word frequency disfavoured rhoticity did not investigate the effect of function vs. content word status, and the one past study which investigated both found no effect of frequency. As the most frequent words are typically function words, it is likely that past findings that frequency favours rhoticity are due to the status of function words, explaining the disagreement with the findings of this study.

|  |  |  |
| --- | --- | --- |
| **Variable** | **Previous studies** | **Bristol speakers** |
| preceding NORTH/FORCE | consistently disfavour | consistently disfavour |
| preceding lettER | consistently disfavour | consistently disfavour |
| preceding SQUARE | inconsistent | inconsistent |
| preceding START | inconsistent | inconsistent |
| preceding NEAR | inconsistent | inconsistent |
| preceding NURSE | consistently favour | consistently favour |
| function word | consistently disfavour | consistently disfavour |
| morpheme final | inconsistent | inconsistently disfavour |
| word final | inconsistent | inconsistent |
| word frequency | consistently disfavour | inconsistent |
| morpheme internal |  | inconsistent |
| time |  | inconsistently favour |
| prepausal | consistently favour | consistently favour |

Table 4: Comparison of effects across previous studies and across Bristol English speakers

# Conclusions

This study has proposed that, in light of Labov’s (2007) transmission-diffusion distinction and the work of Tamminga, MacKenzie & Embick (2016) on the nature of constraints on variation, more attention must be paid to individual differences in conditioning of variables within speech communities. What is more, it has proposed that the standard variationist methodology of pooling data from multiple speakers in order to investigate variable conditioning may be flawed in some cases: if there is substantial individual variation in conditioning systems, which may be typical of cases of ongoing diffusion, the pooling method may miss this variation; in such cases it may also be less effective at identifying precisely those effects in which variationists are usually most interested, effects which are part of the grammar (i-conditioning). In order to investigate these claims, data on rhoticity variation from speakers of Bristol English were compared to 34 previous studies of rhoticity in varieties of English around the world.

In keeping with predictions, it was observed that certain factors (function word status, prepausal position, preceding vowel NURSE/NORTH/FORCE/lettER) have highly consistent effects across different varieties studied and across speakers in Bristol English. This is taken as suggestive that these effects reflect universal physical (in the case of function word, prepausal position and preceding lettER) or structural-psychological (in the case of NURSE/NORTH/FORCE) factors; this suggests that these effects may not be learnt and encoded in the grammar. Other factors had variable effects both across past studies and across speakers in this study, offering evidence that they are part of the grammar and so subject to disruption through imperfect learning when undergoing external change.

Contrary to predictions, there was no indication that younger speakers had more consistent variable grammars than older speakers. This implies that no process of koinéisation, in which new generations of speakers systematise and simplify unstructured variation in the input generated by contact and diffusion, has taken place. This is perhaps unsurprising in light of the fact that the external pressure to change (knowledge of prestigious SSBE/RP) has remained a constant for the entire trajectory of the change. There was no defined period of contact and diffusion after which disrupted grammars could be transmitted and koinéised: rather, contact, adult change and accordingly new disruption have presumably continued to take place throughout.

These findings problematise both the notion of the community grammar and the method of pooling data from multiple speakers when studying certain communities. From a conceptual standpoint, it is not clear that a notion of speech community as defined by shared grammar is tenable for data like those presented here (although definition by shared evaluative norms might still be). If the idea that individuals in the speech community share underlying production norms is understood as an assumption rather than as definitional, these data suggest that it should instead be seen as a hypothesis that must be confirmed for any given dataset. Either way, the rich individual variation in these data suggest that we should be wary of investigating variable conditioning in data pooled from multiple speakers without first investigating how much those speakers’ grammars differ from one another. Not only does this give us a better chance of identifying real grammatical constraints that can vary between speakers, it also provides us with evidence for the nature and interpretation of the effects we find.

# Appendix 1: cell values and summaries of previous studies

| **speaker** | **lettER** | **NEAR** | **NORTH/FORCE** | **NURSE** | **SQUARE** | **START** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 2/20 (10%) | 2/15 (13.33%) | 1/20 (5%) | 16/20 (80%) | 4/20 (20%) | 6/20 (30%) |
| 10 | 10/20 (50%) | 2/10 (20%) | 6/20 (30%) | 16/20 (80%) | 2/20 (10%) | 9/20 (45%) |
| 19 | 15/20 (75%) | 7/15 (46.67%) | 9/20 (45%) | 20/20 (100%) | 13/20 (65%) | 18/20 (90%) |
| 2 | 10/20 (50%) | 14/17 (82.35%) | 11/20 (55%) | 16/20 (80%) | 9/20 (45%) | 12/20 (60%) |
| 20 | 2/20 (10%) | 2/20 (10%) | 3/20 (15%) | 6/20 (30%) | 2/20 (10%) | 7/20 (35%) |
| 21 | 20/20 (100%) | 12/13 (92.31%) | 15/20 (75%) | 20/20 (100%) | 19/20 (95%) | 19/20 (95%) |
| 22 | 2/20 (10%) | 1/20 (5%) | 0/20 (0%) | 14/20 (70%) | 4/20 (20%) | 2/20 (10%) |
| 23 | 8/20 (40%) | 8/12 (66.67%) | 15/20 (75%) | 17/20 (85%) | 8/20 (40%) | 13/16 (81.25%) |
| 24 | 10/20 (50%) | 14/14 (100%) | 8/20 (40%) | 19/20 (95%) | 8/11 (72.73%) | 5/16 (31.25%) |
| 25 | 9/20 (45%) | 8/10 (80%) | 8/20 (40%) | 17/19 (89.47%) | 9/14 (64.29%) | 4/8 (50%) |
| 26 | 13/20 (65%) | 7/20 (35%) | 8/20 (40%) | 19/20 (95%) | 5/20 (25%) | 9/20 (45%) |
| 27 | 16/20 (80%) | 15/17 (88.24%) | 12/20 (60%) | 20/20 (100%) | 14/20 (70%) | 13/20 (65%) |
| 28 | 0/20 (0%) | 6/20 (30%) | 1/20 (5%) | 1/20 (5%) | 4/20 (20%) | 0/20 (0%) |
| 3 | 14/20 (70%) | 15/20 (75%) | 13/20 (65%) | 16/20 (80%) | 6/13 (46.15%) | 11/12 (91.67%) |
| 4 | 1/19 (5.26%) | 5/20 (25%) | 1/20 (5%) | 4/20 (20%) | 0/20 (0%) | 3/20 (15%) |
| 5 | 11/20 (55%) | 11/16 (68.75%) | 6/20 (30%) | 18/20 (90%) | 8/20 (40%) | 18/20 (90%) |
| 6 | 1/20 (5%) | 0/9 (0%) | 0/20 (0%) | 7/20 (35%) | 3/20 (15%) | 0/12 (0%) |
| 7 | 1/20 (5%) | 3/6 (50%) | 0/20 (0%) | 11/20 (55%) | 0/17 (0%) | 0/12 (0%) |
| 8 | 7/20 (35%) | 3/15 (20%) | 2/20 (10%) | 14/20 (70%) | 2/20 (10%) | 9/20 (45%) |
| b12 | 91/118 (77.12%) | 23/26 (88.46%) | 108/128 (84.38%) | 135/141 (95.74%) | 76/92 (82.61%) | 50/61 (81.97%) |
| b13 | 77/143 (53.85%) | 41/42 (97.62%) | 51/170 (30%) | 112/135 (82.96%) | 70/91 (76.92%) | 34/53 (64.15%) |
| b3 | 98/118 (83.05%) | 33/37 (89.19%) | 49/65 (75.38%) | 72/74 (97.3%) | 33/51 (64.71%) | 27/27 (100%) |
| b5 | 184/213 (86.38%) | 43/43 (100%) | 166/171 (97.08%) | 133/133 (100%) | 102/108 (94.44%) | 90/90 (100%) |
| b6 | 71/87 (81.61%) | 29/29 (100%) | 69/77 (89.61%) | 50/54 (92.59%) | 60/68 (88.24%) | 24/25 (96%) |
| b7 | 108/115 (93.91%) | 18/18 (100%) | 94/101 (93.07%) | 68/69 (98.55%) | 95/98 (96.94%) | 54/54 (100%) |
| b8 | 141/149 (94.63%) | 67/67 (100%) | 128/138 (92.75%) | 72/72 (100%) | 105/108 (97.22%) | 40/40 (100%) |

Appendix table 1: Rhotic tokens out of total tokens per speaker / vowel combination

| **speaker** | **morpheme final** | **morpheme internal** | **word final** | **non-prepausal** | **prepausal** | **content word** | **function word** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 1 | 8/24 (33.33%) | 16/45 (35.56%) | 7/46 (15.22%) | 26/103 (25.24%) | 5/12 (41.67%) | 28/84 (33.33%) | 3/31 (9.68%) |
| 10 | 7/23 (30.43%) | 23/44 (52.27%) | 15/43 (34.88%) | 35/94 (37.23%) | 10/16 (62.5%) | 38/80 (47.5%) | 7/30 (23.33%) |
| 19 | 10/21 (47.62%) | 49/54 (90.74%) | 23/40 (57.5%) | 72/99 (72.73%) | 10/16 (62.5%) | 67/87 (77.01%) | 15/28 (53.57%) |
| 2 | 10/21 (47.62%) | 30/46 (65.22%) | 32/50 (64%) | 59/98 (60.2%) | 13/19 (68.42%) | 56/83 (67.47%) | 16/34 (47.06%) |
| 20 | 3/24 (12.5%) | 12/45 (26.67%) | 7/51 (13.73%) | 18/99 (18.18%) | 4/21 (19.05%) | 16/85 (18.82%) | 6/35 (17.14%) |
| 21 | 18/21 (85.71%) | 38/39 (97.44%) | 49/53 (92.45%) | 90/98 (91.84%) | 15/15 (100%) | 74/79 (93.67%) | 31/34 (91.18%) |
| 22 | 2/25 (8%) | 14/37 (37.84%) | 7/58 (12.07%) | 21/102 (20.59%) | 2/18 (11.11%) | 16/85 (18.82%) | 7/35 (20%) |
| 23 | 14/23 (60.87%) | 31/37 (83.78%) | 24/48 (50%) | 45/75 (60%) | 24/33 (72.73%) | 49/71 (69.01%) | 20/37 (54.05%) |
| 24 | 19/23 (82.61%) | 25/44 (56.82%) | 20/34 (58.82%) | 53/83 (63.86%) | 11/18 (61.11%) | 51/77 (66.23%) | 13/24 (54.17%) |
| 25 | 14/20 (70%) | 22/30 (73.33%) | 19/41 (46.34%) | 41/72 (56.94%) | 14/19 (73.68%) | 45/66 (68.18%) | 10/25 (40%) |
| 26 | 11/31 (35.48%) | 21/32 (65.63%) | 29/57 (50.88%) | 58/116 (50%) | 3/4 (75%) | 43/72 (59.72%) | 18/48 (37.5%) |
| 27 | 22/30 (73.33%) | 29/38 (76.32%) | 39/49 (79.59%) | 87/114 (76.32%) | 3/3 (100%) | 62/78 (79.49%) | 28/39 (71.79%) |
| 28 | 4/20 (20%) | 1/45 (2.22%) | 7/55 (12.73%) | 9/103 (8.74%) | 3/17 (17.65%) | 7/84 (8.33%) | 5/36 (13.89%) |
| 3 | 9/16 (56.25%) | 36/44 (81.82%) | 30/45 (66.67%) | 63/84 (75%) | 12/21 (57.14%) | 59/76 (77.63%) | 16/29 (55.17%) |
| 4 | 3/19 (15.79%) | 6/42 (14.29%) | 5/58 (8.62%) | 11/110 (10%) | 3/9 (33.33%) | 13/87 (14.94%) | 1/32 (3.13%) |
| 5 | 13/22 (59.09%) | 35/43 (81.4%) | 24/51 (47.06%) | 64/103 (62.14%) | 8/13 (61.54%) | 58/80 (72.5%) | 14/36 (38.89%) |
| 6 | 2/15 (13.33%) | 7/41 (17.07%) | 2/45 (4.44%) | 7/72 (9.72%) | 4/29 (13.79%) | 7/73 (9.59%) | 4/28 (14.29%) |
| 7 | 1/18 (5.56%) | 10/33 (30.3%) | 4/44 (9.09%) | 11/76 (14.47%) | 4/19 (21.05%) | 13/67 (19.4%) | 2/28 (7.14%) |
| 8 | 6/19 (31.58%) | 18/40 (45%) | 13/56 (23.21%) | 31/95 (32.63%) | 6/20 (30%) | 28/78 (35.9%) | 9/37 (24.32%) |
| b12 | 46/57 (80.7%) | 186/191 (97.38%) | 251/318 (78.93%) | 403/484 (83.26%) | 80/82 (97.56%) | 297/323 (91.95%) | 186/243 (76.54%) |
| b13 | 58/88 (65.91%) | 125/208 (60.1%) | 202/338 (59.76%) | 266/482 (55.19%) | 119/152 (78.29%) | 247/377 (65.52%) | 138/257 (53.7%) |
| b3 | 51/69 (73.91%) | 80/83 (96.39%) | 181/220 (82.27%) | 200/251 (79.68%) | 112/121 (92.56%) | 200/218 (91.74%) | 112/154 (72.73%) |
| b5 | 94/95 (98.95%) | 229/229 (100%) | 395/434 (91.01%) | 496/535 (92.71%) | 222/223 (99.55%) | 471/476 (98.95%) | 247/282 (87.59%) |
| b6 | 41/46 (89.13%) | 82/87 (94.25%) | 180/207 (86.96%) | 185/220 (84.09%) | 118/120 (98.33%) | 186/203 (91.63%) | 117/137 (85.4%) |
| b7 | 62/67 (92.54%) | 127/128 (99.22%) | 248/260 (95.38%) | 325/342 (95.03%) | 112/113 (99.12%) | 275/280 (98.21%) | 162/175 (92.57%) |
| b8 | 95/100 (95%) | 144/149 (96.64%) | 314/325 (96.62%) | 426/447 (95.3%) | 127/127 (100%) | 325/338 (96.15%) | 228/236 (96.61%) |

Appendix table 2: Rhotic tokens out of total tokens per speaker and other context

| **Study** | **variety/ies** | **direction** | **preceding vowel** | **tautosyllabic C** | **other /r/** | **prepausal** | **morpheme-final** | **word-final** | **stress** | **emphasis** | **functionword** | **word length** | **word frequency** |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Asprey 2007 | Black Country | non-rhoticity | \* | + |  |  |  |  |  |  |  |  |  |
| Barras 2010 | Lancashire | non-rhoticity | back vowels > front vowels\* |  |  | + | - | - | + |  |  |  |  |
| Baxter 2008 | Quebec | rhoticity | \* |  |  |  |  | + |  |  |  |  |  |
| Becker 2014 | New York City | rhoticity | \* | + |  | + | - | - | + |  | - |  |  |
| Dudman 2000 | Cornwall | non-rhoticity | \* |  |  |  |  | - | + |  |  |  |  |
| Elliott 2000 | American films | rhoticity |  |  |  |  |  |  |  |  |  |  |  |
| Ellis, Groff & Mead 2006 | Philadelphia | rhoticity |  |  | - |  |  |  |  |  |  |  |  |
| Feagin 1990 | Alabama | rhoticity | \* | + |  |  |  |  |  |  |  |  |  |
| French 1988 | Yorkshire | non-rhoticity |  |  |  | + |  |  |  |  |  |  |  |
| Hartmann & Zerbian 2010 | South Africa | rhoticity |  | 0 |  |  |  |  |  | + |  |  |  |
| Hinton & Pollock 2000 | Iowa | \* | 0 |  |  |  |  |  | + |  |  |  |  |
| Hollitzer 2013 | Berkshire, Wiltshire, Somerset | non-rhoticity | \* | + |  |  |  |  |  |  |  |  |  |
| Irwin & Nagy 2007 | Boston | rhoticity | back vowels > front vowels\* | + |  |  | 0 | + |  |  | - | - | 0 |
| Jones 1998 | Devon; West Somerset | non-rhoticity | \* |  |  |  |  |  |  |  |  |  |  |
| Labov 1966 [1972] | New York City | rhoticity | \* |  |  |  |  | + |  |  |  |  |  |
| Miller 1998 | Philadelphia | rhoticity | \* |  | - |  |  |  |  |  |  |  |  |
| Myhill 1988 | Philadelphia | non-rhoticity | \* | 0 | - | - |  | 0 | + |  |  |  |  |
| Nagy & Irwin 2010 | Boston; New Hampshire | rhoticity |  | + | 0 | + | - | - |  |  |  |  | - |
| Parslow 1967, 1971 | Boston | rhoticity | NURSE > other vowels |  |  |  |  |  |  |  |  |  |  |
| Piercy 2006, 2007, 2012 | Dorset | non-rhoticity | \* | + |  | + | \* | - | + |  | 0 |  | - |
| Pollock & Berni 1997 | Tennessee | \* | \* |  |  |  |  |  |  |  |  |  |  |
| Schützler 2010 | Edinburgh | non-rhoticity |  |  |  | + |  |  | + |  |  |  |  |
| Sharbawi & Deterding 2010 | Brunei; Singapore | rhoticity | 0 |  |  |  |  |  |  |  |  |  |  |
| Simpson 1996 | Shropshire | non-rhoticity |  |  |  |  |  | - | + |  |  |  |  |
| Sudbury & Hay 2002[[7]](#footnote-8) | New Zealand | non-rhoticity | back vowels > front vowels |  |  |  |  |  | + |  |  |  | - |
| Sullivan 1992 | Devon | non-rhoticity |  |  |  |  |  | - |  |  |  |  |  |
| Trudgill & Gordon 2006 | Australia | non-rhoticity | \* |  |  |  |  |  |  |  |  |  |  |
| Villard 2009 | New Hampshire; Vermont | rhoticity | \* |  |  |  |  |  |  |  |  |  |  |
| Vivian 2000 | Lancashire | non-rhoticity | \* |  |  |  |  | - | + |  |  |  |  |
| Watt, Llamas & Johnson 2014 | Scottish-English Border | non-rhoticity |  | \* |  |  |  |  |  |  |  |  |  |
| Williams 1991 | Isle of Wight | non-rhoticity |  |  |  |  |  |  |  |  |  |  |  |

Appendix table 3: Internal effects on rhoticity reported in previous studies  
Key: + = favours rhoticity, - = disfavours rhoticity, 0 = no effect, \* = mixed or multiple effects

| **Study** | **Variety** | **Effect of preceding vowel** |
| --- | --- | --- |
| Asprey (2007:96–98) | Black Country | NURSE > lettER > SQUARE > NEAR > NORTH > START |
| Barras (2010:115,175) | Lancashire | back vowels > front vowels  FORCE > NURSE > START > NORTH > SQUARE > NEAR > lettER |
| Baxter (2008) | Stanstead (Quebec) | NURSE > back vowels > front vowels > lettER |
| Becker (2014:155–156) | New York City | NURSE > NEAR > START > SQUARE > NORTH/FORCE[[8]](#footnote-9) |
| Dudman (2000:36) | Cornwall | CURE > START(f) > NURSE > NEAR > SQUARE > NORTH/FORCE > START(b) > lettER (?) |
| Feagin (1990:132) | Alabama | NURSE > NEAR > SQUARE > START > NORTH > FORCE > lettER |
| Hinton & Pollock (2000) | Davenport (Iowa) | no effect[[9]](#footnote-10) |
| Hollitzer (2013) | Berkshire, Wiltshire, Somerset | NURSE > lettER > other vowels  (?NURSE > NEAR > lettER > START > SQUARE > NORTH/FORCE)[[10]](#footnote-11) |
| Irwin & Nagy (2007:140–142), Nagy & Irwin (2010:256–257) | Boston & New Hampshire | NURSE > START > SQUARE > CURE > NEAR > NORTH/FORCE > lettER |
| Jones (1998) | Devon, West Somerset | START > FUR > ‘farmer, darning’, NORTH/FORCE > FIR |
| Labov (1972) | New York City | NURSE > lettER  back vowels > front vowels |
| Miller (1998) | Philadelphia | NURSE > all other vowels > lettER |
| Myhill (1988) | Philadelphia | NURSE > all other vowels > lettER (more integrated into white community)  NURSE > START > all other vowels (less integrated into white community) |
| Nagy & Irwin (2010:258–259, 277) | Boston | NURSE > START > CURE > FUR > NORTH/FORCE > NEAR > lettER > SQUARE (older speakers)  CURE > START > NURSE > SQUARE > NEAR > NORTH/FORCE > lettER (younger speakers) |
| Nagy & Irwin (2010:260,277-278) | New Hampshire | NURSE > SQUARE > NEAR > START > NORTH/FORCE > lettER (older speakers)  START > SQUARE > NORTH/FORCE > NURSE > NEAR > lettER (younger speakers)[[11]](#footnote-12) |
| Parslow (1967; 1971) | Boston | NURSE > other vowels |
| Piercy (2012:81–82)[[12]](#footnote-13) | Dorset | NURSE > NEAR > START > lettER > CURE > SQUARE > NORTH/FORCE |
| Pollock & Bernie (1997) | Memphis (Tennessee) | NURSE > front vowels > back vowels > lettER |
| Sharbawi & Deterding | Brunei, Singapore | no effect[[13]](#footnote-14) |
| Sudbury & Hay (2002:289–290) | New Zealand | back vowels > front vowels[[14]](#footnote-15) |
| Sullivan (1992:82–83) | Exeter | (NEAR) > NURSE > START > SQUARE > FORCE > lettER > NORTH |
| Trudgill & Gordon (2006:240) | Austalian English | NORTH/FORCE, lettER > others[[15]](#footnote-16) |
| Villard (2009) | Upper Valley (New Hampshire, Vermont) | NURSE > lettER |

Appendix table 4: Effects of preceding vowel on rhoticity reported in previous studies

| **Study** | **Variety** | **gender** | **class** | **ethnicity** | **locality** | **style** | **exposure** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Elliott 2000 | American films | female |  |  |  |  |  |
| Becker 2009, 2014 | New York | female | middle-class | change only for white & Jewish |  | formal |  |
| Feagin 1990 | Alabama | female | workin-class |  |  |  |  |
| Irwin & Nagy 2007 | Boston | \* | middle-class |  |  |  |  |
| Nagy & Irwin 2010 | Boston, New Hampshire | \* | \* | 0 |  |  |  |
| Ellis, Groff & Mead 2006 | Philadelphia | \* |  | disfavoured by African Americans |  |  |  |
| Villard 2009 | Upper Valley (New Hampshire, Vermont) | female | middle-class |  |  |  |  |
| Baxter 2008 | Stanstead (Quebec) | female | middle-class |  |  |  |  |
| Parslow 1967, 19711 | Boston (Massachusetts) |  |  |  |  |  |  |
| Labov 1966 [1972] | New York | female |  | favoured by whites |  | formal |  |
| Myhill 1988 | Philadelphia |  |  | 0 (but favoured by speakers more integrated into the white community) |  |  |  |
| Miller 1998 | Philadelphia |  |  | favoured by African Americans |  |  |  |
| Hinton & Pollock 2000 | Davenport (Iowa) |  |  |  |  | 0 |  |
| Pollock & Berni 1997 | Memphis |  |  |  |  | 0 |  |
| Cychosz & Johnson 2017 | American English (Buckeye Corpus) | female |  |  |  |  |  |
| Hartmann & Zerbian 2010 | South Africa | female | affluent |  |  |  |  |
| Sharbawi & Deterding 2010 | Brunei; Singapore |  |  |  |  |  |  |
| Asprey 2007 | Black Country |  |  |  | rural |  |  |
| Barras 2010 | Lancashire |  |  |  | rural |  |  |
| Vivian 2000 | Lancashire | male |  |  | \* |  |  |
| Jones 1998 | Devon; West Somerset |  |  |  |  |  |  |
| Piercy 2007 | Dorset | male |  |  | rural |  |  |
| Williams 1991 | Isle of Wight |  |  |  |  | minimal pairs wordlist > casual speech > wordlist |  |
| Sudbury & Hay 2002 | New Zealand |  |  |  | \* |  |  |
| Trudgill & Gordon 2006 | Australia |  |  |  |  |  |  |
| Watt, Llamas & Johnson 2014 | Scottish-English Border |  |  |  | \* |  |  |
| Schützler 2010 | Edinburgh | male |  |  |  | wordlist | more exposed to SSBE |
| Sullivan 1992 | Devon | male | working-class |  |  | casual speech |  |
| Simpson 1996 | Shropshire |  |  |  |  |  |  |
| Dudman 2000 | Cornwall |  |  |  |  | casual speech |  |
| French | Yorkshire |  |  |  |  |  |  |
| Hollitzer 2013 | Newbury, Swindon, Taunton |  |  |  | western |  |  |

Appendix table 5: External effects on rhoticity reported in previous studies (cells report the social group found to favour rhoticity)

# Appendix 2: penalised regression

The form of regression used in this study, elastic net regression, is not widely used in linguistics. For that reason, here we give a more detailed account of this tool. Since it is best understood through the matrix approach to regression, we start by describing ordinary least squares regression for context, before describing the different forms of penalised regression: ridge, lasso and elastic net regression.[[16]](#footnote-17)

## Least squares regression

In normal linear regression, we have a set ofpredictor variablesand a response variable. We aim to estimate the values of coefficientssuch that:

whereis Gaussian white noise. We haveobservations of our predictor and response variables, so that we actually have a vectorresponses of length, a bymatrix of predictorscalled the design matrix, a vector of random noise and a vector of coefficients. We can then express our model as

We estimate the best possible values ofusing a method called least squares, which minimises the sum of squared residuals:

The solution to this is the matrix equation

whereis the transpose of the design matrixandis the inverse of. This gives us an estimation ofwhich is unbiased and as precise as possible.

## Ridge regression

This procedure fails when some of the predictors are highly correlated. From a conceptual standpoint, this is easy to understand. If two predictors rise and fall in tandem, and these rises and falls are linearly related to changes in the response variable, it is difficult or impossible to determine which of the two predictors is responsible for the changes in the response. The ‘best’ result we can achieve will be coefficient estimates with very large errors, representing the fact that either predictor might actually be irrelevant if all of the observed effect is assigned to the other predictor. From the point of view of our least squares method, if two predictors (two columns of our design matrix) are perfectly correlated thenhas a determinant equal to zero and so has no inverse. If two predictors are nearly perfectly correlated, the determinant ofis close to zero and so it is difficult to find the inversion precisely.

In ridge regression, we solve this problem by using a different method of estimating our coefficients. Instead of minimising the sum of squared residuals, we minimise

As a result, in addition to minimising the residuals, we are also minimising the coefficients. The solution to this is the equation

Because we have addedto, we can now find an inverse even if our design matrix contains columns which are perfectly correlated. The result is no longer a truly unbiased estimate and will tend to underestimate the coefficients, but does give better results in cases of collinearity. The difference between the results of this method and the ordinary least squares method depends on theparameter. As we increase, we increase the penalty for large coefficients and so increase the degree to which coefficients are minimised: ifthen the result is identical to the least squares method; ifthen all of our coefficient estimates will be zero. Because we are minimising the sum of the *square* of the coefficients, this penalty is stronger for larger coefficients. The result is that large coefficients are shrunk to a ‘reasonable’ size while small coefficients are affected relatively little.

## Lasso regression

A different approach is Lasso regression (standing for Least Absolute Shrinkage and Selection Operator). Here, instead of minimising

we minimise

Again, we are penalising large coefficients: ifthen the result is identical to the least squares method and ifthen all of our coefficient estimates will be zero.

However, penalising the coefficient estimates themselves rather than the squared coefficient estimates gives lasso regression some quite different behaviours to ridge regression. Unlike ridge regression, shrinkage is not greater for larger coefficients, so lasso regression does not offer us a tool to deal with individual inflated coefficient estimates. However, at reasonable values of, lasso regression tends to reduce all small coefficients to zero, leaving only the larger coefficients in the model. Thus lasso regression builds in a form of feature selection: because only the larger coefficients are retained, it tends to give us as simple a model as possible.

## Elastic net regression

In cases with a very large number of predictors, neither of these options may suffice. With a sufficiently large number of possible predictors, some are likely to be highly correlated, making ridge regression an attractive option. However, variable selection is difficult with ridge regression: with normal regression we might use a stepwise procedure where we use significance tests to progressively add or remove predictors to the model; since there is no straightforward significance test for ridge regression, we cannot follow this approach and are left with a maximally complex model with all the potential predictors.

To solve this problem, we can use elastic net regression, combining the advantages of ridge regression (robust with highly correlated predictors) with lasso regression (automated variable selection). In elastic net regression, we include both the ℓ1- and ℓ2-penalty, minimising:

Elastic net regression has some of the properties of ridge and lasso regression: increasing eitherorsufficiently high will shrink all coefficient estimates to zero; if bothandare equal to zero, the model is the same as the ordinary least squares; the model performs well with highly correlated predictors; very high coefficient estimates are shrunk towards reasonable values; small coefficients are reduced to zero, leaving us with a relatively simple model.

## Parameter setting

We then have to determine the values ofand. There are two broad approaches to this. One is cross-validation. The idea here is to use the existing data to find the model which best predicts some new dataset. Because we generally can’t acquire a whole new dataset easily, we instead split our existing dataset into a training set and a test set. To avoid some accidental properties of the data we assign to the test set having disproportionate influence over the final model, we can use *k-*fold cross validation: we divide the dataset into *k* equally-sized subsets each of which is treated as the test set in turn; we then select the valuesandthat perform best on average across all the test sets.

An alternative approach is to select an ‘information criterion’ measure, a statistic which measures of model goodness-of-fit offset by model complexity, such as the Aikaike Information Criterion (AIC). By settingandso as to minimise the AIC of the model, we find the model with the optimal trade-off between complexity and fit.

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1. In terms of other external factors, female speakers probably lead the change, as expected for an ongoing change from above (Labov 1990), but interaction with effects of social class and occupation make it difficult to demonstrate this clearly for this small sample population. This is discussed further in (Blaxter et al. forthcoming). [↑](#footnote-ref-2)
2. Token counts broken down by speaker and by linguistic variables are given in Appendix Table Appendixtable and Appendix Table Appendixtable. [↑](#footnote-ref-3)
3. In variationist studies using mixed-effects regression it is common to include lexical item as a random effect. There is currently no equivalent of a random effect in elastic net models and so no control for lexical item was included in this study. The role of lexical item in the patterns identified here thus represents an interesting avenue for future investigation. [↑](#footnote-ref-4)
4. Coefficients from a logistic elastic net model can be interpreted just as coefficients from a normal logistic regression model (given here in log odds). [↑](#footnote-ref-5)
5. This and other individual speaker figures simply reproduce and enlarge panels from the composites Figure and Figure. [↑](#footnote-ref-6)
6. It is impossible to tell from these data alone whether this indicates that style is a particularly important control of rhoticity for these speakers or whether these were particularly stylistically dynamic interviews. [↑](#footnote-ref-7)
7. Internal factors only investigated for linking r. [↑](#footnote-ref-8)
8. However, Becker states that when the data is broken down into ethnic groups only the effect of NURSE is consistent and that “no overall pattern for preceding full vowels is evident” (2014:158–159). [↑](#footnote-ref-9)
9. As with Trudgill & Gordon’s study of Australian English and Nagy & Irwin’s of New Hampshire English, we might hypothesise that the lack of effect here is due to the fact that the change had almost gone to completion: either because conditioning systems tend to disappear in the final stages of change, or because the very low frequency of one variant inevitably makes it hard to detect significant effects without an extremely large sample. [↑](#footnote-ref-10)
10. Hollitzer’s analysis divides the data up into three towns: Newbury, Swindon and Tauton; although rates of rhoticity per vowel are calculated for each town (2013:34–35), several categorically non-rhotic speakers are included in these calculations for Newbury and Swindon, making the hierarchies suspect. Hollitzer’s only strong conclusion is that NURSE and lettER favour rhoticity, since this is consistent across the three towns (2013:35). [↑](#footnote-ref-11)
11. Nagy & Irwin point out that disagreements in constraint rankings between the younger New Hampshire speakers and all other groups might be the result of the fact that the change is almost gone to completion in this group and that constraints must necessarily fade as the conservative variant becomes vanishingly rare (2010:259–260). [↑](#footnote-ref-12)
12. The analysis of Piercy (2012) is used rather than the less statistically sophisticated analysis of the same data in Piercy (2006:55). [↑](#footnote-ref-13)
13. Sharbawi & Deterding examine only START, NORTH and NURSE. Comparison of their data for these vowels shows no significant difference in rates of rhoticity for either variety studied: for Brunei English, 10/18 START, 24/54 NURSE and 25/54 NORTH tokens were rhotic (χ²=0.68, p=0.7118); for Singapore English, 1/12 START, 4/36 NURSE and 2/36 NORTH tokens were rhotic (χ²=0.727, p=0.6952). However, as the sample size is tiny, no strong conclusions should be drawn from this. [↑](#footnote-ref-14)
14. Sudbury & Hay’s finding applies only to linking r and not coda r. [↑](#footnote-ref-15)
15. No statistical evidence of the relative effect of the different contexts is offered and the sample is relatively small; the authors suggest that the mismatch with other studies is the result of the fact that this “must represent the last surviving traces of earlier, fuller rhoticity” (2006:240). [↑](#footnote-ref-16)
16. Note that whilst the specific model actually used in the paper is logistic elastic net regression, here, for reasons of space, we describe linear elastic net regression. [↑](#footnote-ref-17)