“I can't see myself ever living any[w]ere else”: Variation in (HW) in Edinburgh English

“I CAN’T SEE MYSELF EVER LIVING ANY[W]ERE ELSE": VARIATION IN (HW) IN EDINBURGH ENGLISH

Short Title: Variation in (HW) in Edinburgh English

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Abstract

Sociolinguistic research across Scotland in recent decades has documented an erosion of the phonemic contrast between /ʍ/ (as in which) and /w/ (as in witch). Based on acoustic phonetic analysis of 1400 <wh> realisations produced by 18 Edinburgh women born between 1938 and 1993, I argue that in the context of Edinburgh this is best understood as a complex sociolinguistic variable (HW) encompassing (at least) six fricated and frication-less variants. Realisations vary in type and relative duration of frication, voicing and glide quality. Bayesian statistical analysis suggests that choice and realisation of variants is conditioned by speaker social class, style and phonetic context. Unlike some prior work, I do not find evidence of ongoing (apparent-time) change or an effect of contact with Southern British English. Fricated variants are most prevalent in formal speech styles and in the speech of middle class women, while working class speakers favour frication-less variants.

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Introduction

Historically, English pronunciations of the digraph <wh> differed from those of <w>, yielding minimal pairs such as which ~ witch and whine ~ wine. While this contrast has been lost in many varieties of English (e.g., in North America: Labov, Ash, and Boberg 2008:45), Scottish Englishes have traditionally been described as retaining it (Giegerich 1992:36; Jones 2002; Wells 1982: 409). However, sociolinguistic research across Scotland suggests this is changing (Brato 2014; Chirrey 1999; E. Lawson and Stuart-Smith 1999; Macafee 1983; Reiersen 2013; Robinson 2005; Schützler 2010; Stuart-Smith, Timmins, and Tweedie 2007). Based on a qualitative and quantitative analysis of 1400 tokens of <wh> produced by 18 female speakers of Edinburgh English, I propose that, in Edinburgh at least, this is best conceptualised as variation within the sociolinguistic variable (HW).

(HW) denotes a sociolinguistic variable which encompasses all pronunciations of <wh>. In the literature, variants of (HW) are often described as labial-velar fricative and labial-velar approximant. In contrast, I use the terms "fricated ," to refer to tokens characterised by a period of frication preceding a glide, and "frication-less" to refer to tokens which only consist of a glide. This distinction is useful because, as I show in this study, variants of (HW) differ with respect to type and duration of frication and quality of glide, voicing and phonation.

I find that middle class speakers (and those who orient towards Standard Scottish English) produce higher rates of fricated tokens, while working class speakers (and those who orient towards Scots) favour frication-less tokens. As with other sociolinguistic variables, the phonetic context is also a meaningful predictor of variant choice and variant realisation. Notably, I do not

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find evidence of a change in progress. Given the broader context this does not support an effect of contact with Southern British English(es) (as suggested in prior work), and points instead to variation based on social class and speech style.

Background

Setting the scene: Edinburgh, Leith and linguistic diversity

Home to the Scottish parliament, several universities and a finance sector, Edinburgh is a cosmopolitan city associated with power and wealth (in contrast to other areas in Scotland). The most prominent spoken varieties are Gaelic, Scots, Scottish Standard English (SSE), Southern British English, Polish and Urdu[i]. Gaelic, which has been repressed like other Celtic languages in the British Isles, has been the focus of revitalisation efforts in recent years and is visible on official signage (R. Lawson 2014). Scots differs from English on the levels of syntax, phonology and lexis (Jones 2002; R. Lawson 2014). SSE features some Scots lexis and syntax and differs from Standard Southern British English (SSBE) in terms of phonology (Giegerich 1992; Schützler 2015). Like other standard varieties, SSE is strongly associated with formal contexts, and middle and upper class speakers, rather than a particular place. Scots on the other hand, is generally associated with working class speakers and varieties of Scots are spoken in urban and rural areas of Scotland. Many speakers shift between Scots and SSE depending on the social context (Stuart-Smith, 2004). In Edinburgh, most people likely encounter Scots, SSE and SSBE every day.

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Most of the women interviewed for this study (16) have grown up in Leith. Historically an independent port town, Leith retains a distinct identity from Edinburgh (Doucet 2009; Marshall 1986). In recent years, deindustrialisation and gentrification have changed it dramatically. Today, the area around Leith Walk, a thoroughfare connecting Leith and Edinburgh city centre, and Easter Road, home to Leith's football team, is one of the most densely populated of Scotland. It features small international supermarkets and tailors, between pubs, bars and restaurants. The other two participants lived in Morningside; a neighbourhood of Edinburgh long perceived as middle class whose high street is dominated by upmarket boutiques and supermarkets, cafes, and pubs.

Historical Perspective: an unstable contrast

Old English featured several <h>-initial clusters including <hw>, which patterns of alliteration and rhyme suggest was pronounced as the voiceless labial-velar fricative [ʍ] (Minkova 2004: 16). This contrasted with <w>, produced as the labial-velar approximant [w]. This distinction was preserved in modern spelling as <wh> and <w>. While at first glance, it appears that some varieties of English retained a phonemic contrast until recently, Minkova (2004) suggest that this contrast has been unstable for a long time. Considering Old English texts, Minkova (2004: 17) argues that <h>-insertions in etymologically <h>-less words indicate variation or confusion on the part of authors, while <h>-less spellings of etymological <hw>-words suggest reduction (e.g., <wistle> instead of <hwistle> and <bilhwit> instead of <bilewit>). The contrast later reappeared in the speech of upper-class Southern English speakers but has since been lost in all Anglo-English varieties, including Standard Southern British English (Wells 1982)[ii], and in North American varieties

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(Bridwell 2019; Labov, et al 2008: 49; Thomas 2019). Minkova (2004) traces the fricated variant in Scottish English to an allophone of Old English /hw/, [xʍ] which developed to [hw̥].

Variation in type and duration of frication in fricated (HW) tokens found in several varieties of English today could indicate that the distinction between different allophones Minkova (2004) describes was never as clean. Similarly, the apparent "reappearance" of the contrast in Early Modern English could be evidence for a "reconstruction" of the contrast based on spelling (Minkova 2004) or variable retention (Milroy 2004). In any case, the diachronic perspective highlights that any variability in choice and realisation of variants found today is not necessarily new.

A contact-induced merger in progress?

Over the last 40 years, variable use of fricated and frication-less variants of (HW) in Scotland has been found to be conditioned by age, gender, socio-economic class, educational background and contact with Southern Standard British English, and linguistic factors such as phrasal position and phonetic context. (HW) has been described in Glasgow (E. Lawson et al., 1999; Macafee 1983; Stuart-Smith et al., 2007), Livingston (Robinson 2005), Edinburgh (Chirrey 1999; Fruehwald et al. 2019; Reiersen 2013; Schützler 2010) and Aberdeen (Brato 2014).

Schützler (2010) interprets differences by age and gender among 27 middle class speakers in Edinburgh as a change in progress, and argues based on effects of contact with Southern Standard British English and level of education that the loss of fricated (HW) is a contact effect. While fricated realisations seem to be straightforwardly favoured after pauses and in lexically stressed positions, the effects of lexical frequency and lexical category, phonetic context and word-specific effects are

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difficult to disentangle because the incidence of lexical items in the corpus is so heavily skewed toward what, when, why, where, which (Schützler 2010). Brato (2014) finds evidence of two concurrent changes in progress affecting the distribution of variants of (HW) in Aberdeen (44 speakers). Middle class teenagers (in particular girls) and older speakers shift from traditional, local, Scots variant [f] to the fricated supra-regional Scottish English [ʍ], younger working class speakers shift towards the frication-less variant [w] (Brato 2014). Like Schützler (2010), he argues that contact with non-Scottish varieties plays a role in this shift. He finds that fricated tokens are least likely to occur in word-internal contexts (e.g. somewhere), and, that frication-less variants are favoured word-initially, after vowels and (less strongly) after consonants (Brato 2014). Drawing on recordings of formal speech from 138 speakers in the ICE-Scotland corpus (e.g., parliamentary debates and television broadcasts), Li and Gut (2022) highlight variation in the distribution and realisation of (HW). Even in formal Scottish Standard English, none of the speakers fully retain the original phonemic contrast, while 12% of their speakers exclusively produce frication-less variants (Li et al., 2022). Similar to Schützler (2010) and Brato (2014), they note differences by age and gender, with women and younger speakers more likely to produce frication-less tokens (Li et al., 2022). In Glasgow, Stuart-Smith et al., (2007) and E. Lawson et al., (1999) describe effects of age and social class on (HW). Working class speakers, in particular young working class speakers, prefer frication-less variants, while middle class speakers favour fricated ones (E. Lawson et al., 1999; Stuart-Smith et al., 2007). The putative role of contact with Anglo-English varieties is particularly interesting among these Glaswegian speakers, as it highlights the complex relationship between social class, local and non-local linguistic standards and "contact". Middle class speakers retain the "Scottish" fricated variant despite contact with Southern British varieties (Stuart-Smith,

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et al., 2007). Young working class speakers adopt the "non-local" frication-less variant not due direct face-to-face contact with Southern British speakers or a positive orientation towards Southern British varieties or a non-Scottish identity, but rather, Stuart-Smith et al., (2007) argue, to distinguish themselves from middle class Glaswegians.

A range of variants

Many discussions of (HW) treat it as a merger (which ~ witch) between two variants (Fruehwald et al. 2019; Labov et al., 2008; Macafee 1983; Schützler 2010; Reiersen 2013): the voiceless labial-velar fricative [ʍ] which is characterised by a period of frication and the fully voiced labial-velar approximant [w]. However, some studies consider several intermediate forms. In their study of a corpus of Glaswegian children's speech, E. Lawson et al. (1999) describe two additional intermediate variants. One is perceived as voiceless but lacks characteristic period of frication. They further identify a category of tokens which "[are] neither like [hw] nor like [w]" which they describe as a "breathy [w̥]" (E. Lawson et al., 1999:2542) which are also found in a corpus of adult speakers from Glasgow collected in 1997 (Stuart-Smith et al., 2007). In her study of children's speech in Livingston, a town between Edinburgh and Glasgow, Robinson (2005) also finds a "continuum of phonetically intermediate forms" (186). In her notation, the most "traditional" form is a "voiceless lip-rounded consonant with audible friction at both velar and bilabial articulations" while an intermediate variant includes voiced fricated tokens (Robinson 2005:186). Working on Southern White American English Bridwell also describes "voiced [hw] tokens" (2019: 104) featuring both frication before the glide and voicing throughout the entire segment. Bridwell (2019) also notes differences in the centre of gravity of frication. In Aberdeen, Brato (2014) notes

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"auditorily intermediate" variants for both concurrent mergers affecting <wh>-words, involving /f/, /ʍ/, and /w/ (but doesn't describe them further).

Acoustic Phonetic Variation and (HW)

Most prior studies of (HW) rely on auditory coding of two (or more) variants (e.g., Brato 2014; Schützler 2010; Stuart-Smith et al., 2007) or minimal pair tests (e.g. Labov et al., 2008). However, acoustic phonetic analyses can provide insights into the relationship between variants, and reveal patterns which are not necessarily auditorily perceptible. Variants of (HW) consist of a glide, which can be characterised by formants, and an optional period of frication preceding the glide. Li et al., (2022) examine this frication by measuring harmonicity: the ratio of harmonics to noise. They find that while different pronunciations of <wh>, in their case [ʍ] and [w], generally differ in harmonicity, there is also considerable overlap of harmonicity values (Li et al., 2022). They furthermore find that [w] tokens in <wh>-words are different from those in other words (Li et al., 2022). Complementing these findings, I analyse the centre of gravity of the periods of frication preceding the glide.

Centre of gravity (CoG), or spectral mean, is a measure commonly used in phonetic research to describe fricatives (e.g. Gordon, Barthmaier, and Sands 2002; Jongman, Wayland, and Wong 2000; Zimman 2017). It represents a weighted average of the frequency components of a spectrum and shows the locus of high energy in the spectrum. The only other study of (HW) considering CoG is Bridwell's 2019 study of Southern White American English in South Carolina. She argues that there are two categories of frication, one very similar to [h] (as in [hw]) and one she associates with "true

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labiovelars" [ʍ]. For the former the aperiodic noise is spread across frequencies and thus associated with a high CoG. For the latter the noise is clustered at much lower frequencies, and thus associated with a lower CoG (Bridwell 2019).

Formants represent local peaks of acoustic energy which are estimated from the spectral envelope. In phonetics, the first three formants are commonly used to distinguish voiced sounds. E. Lawson et al., (1999) describe distinctive formant patterns for the voiced glides of their variants. [w] tokens in their sample are characterised by low F1 and low and weak F2 contours before rising towards the expected formant loci of the following vowel. [ʍ] is characterised by an abrupt start of both formants at the onset of voicing without this period of lower formants. Their "intermediate" breathy tokens appear to fall somewhere in between those extremes, with shorter periods of low F1 than the voiced variant. Notably, in their Glasgow-based study, E. Lawson et al., (1999) also find some apparently socially conditioned variation, with middle class children producing a slightly longer period of low F1 than working class children.

Data and Methods

Participants

The speech of 18 female L1 speakers of English born between 1938 and 1994 was analysed for this study. All women had spent most of their life in Edinburgh, 16 of them in Leith, a traditionally working class neighbourhood in North Edinburgh, and the remaining two in Morningside, a traditionally middle class neighbourhood in South Edinburgh. The group from Leith includes working class and middle class speakers, both Morningside speakers are middle class.

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Recordings

The data is comprised of 18 semi-structured sociolinguistic interviews. I conducted 15 of those interviews between December 2018 and February 2019 in Leith, as part of a research project on sociophonetic variation in Leith. These one-on-one conversations focused on the participants' experiences of growing up and/or living in Leith and other topics such as their work and hobbies. These interviews also featured a reading task (adapted from Schützler (2015)). The remaining 3 interviews were collected by Jonathan Berk as part of a Master's dissertation exploring differences between Leith and Morningside in 2014 (Berk 2014). They similarly focused on speakers' life in Morningside. All interviews were recorded using a portable digital recorder and a lavalier microphone in quiet, public spaces and digitized at 44kHz. Neither of the interviewers is from Scotland (or the UK), although we were both residents at the time of the interviews.

Manual annotation

I orthographically transcribed all recordings, force-aligned them using the Montreal Forced Aligner (McAuliffe et al. 2017) and annotated tokens in Praat (Boersma 2002). Using auditory perceptual information, spectrogram and waveform, I first coded each token as frication-less or fricated. During this process, I discovered a range of variants. In addition to the "fully voiced frication-less" (n=808) and "fully voiceless fricated" (464), like Bridwell (2019) I also identified "voiced fricated" (29) tokens where both frication and glide are characterised by voicing (see Table 1). While most of these occur after voiced segments, it is not clear that this is merely a coarticulation effect as 6 of the tokens occurred after voiceless obstruents or pauses. Conversely

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there are also 37 “voiceless frication-less” tokens featuring a voiceless glide (similar to E. Lawson et al., (1999:2543) which appear distinct (both visually and auditorily) from “typical” frication-less tokens. Glides in fricated and frication-less tokens can be breathy (42). In addition to these six variants, I also identified a small number (7) of tokens which are more similar to [f], [v] and [h]. I annotated the duration of frication manually using changes in spectrogram and waveform from glide to the following vowel as cues (see Figure 2).

Table 1: Counts of different variants. There were 7 tokens annotated as [f] (5), [v] (1) and [h] (1).

frication			no frication		
voiceless frication	voiced frication	breathy	voiced glide	voiceless glide	breathy
n = 464	n = 29	n = 13	n = 808	n = 37	n = 42

Acoustic phonetic measures

Formants were extracted from voiced parts of each <wh>-token (glides) and all “<w>-glides” (i.e. glides in words like water) using a semi-automated Praat script . Each <wh>-token was visually checked and the glide manually selected (for <w>-glides this process was fully automated). The script records the word and phonological environment of each token and segment duration. The first three to five formants (depending on trackability) were extracted in 5 millisecond intervals, with the maximum formant frequency set to 5500Hz and the window length set to 25ms. F1 and F2 measures taken between 45% and 55% of the voiced duration of the glide were retained in

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subsequent analysis in R. This narrow window effectively reflects the midpoint of the voiced glides and was preferable to a longer duration to avoid distortion from formant transitions . Furthermore, formants could not be reliably extracted for all tokens beyond this point. Measures were transformed from Hertz to Bark (Traunmüller 1990).

Centre of gravity of the fricated portion of each fricated token was measured using a Praat script adapted from DiCanio (2017). This script creates a set number of spectral slices across the middle 80% of the segment (to minimise context effects). CoG measures for each slice are averaged across the segment. To avoid overlap between windows, which would bias the averaged CoG measure towards the middle of the segment, the original script was adapted to automatically adjust the window length based on the duration of the segment. To ensure that each window contained enough data to make inferences a minimum window length of 5 milliseconds was implemented.

Data "tidying" and dataset construction

Three datasets were used for statistical analysis: the full manually annotated dataset of 1400 tokens of (HW), and two subsets of that dataset. The first subset contains only fricated tokens and is used to analyse variation in centre of gravity. There were no obvious outliers resulting from measurement errors, so no further tokens were excluded from analysis. The second subset contains measurements of F1 and F2 at the midpoint of the voiced portions of both fricated and frication-less glides as well as labial-velar approximants in <w>-tokens (e.g., in water). Formants could not be extracted for all annotated tokens. Some tokens were completely voiceless, in others the voiced portion of the segment was too short to reliably extract formants, and in some Praat's formant

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tracking was inadequate. While formant trajectories would be interesting, not enough formant measurements could be extracted for most tokens to reliably explore these. Instead, I opted to only look at the measurement closest to the midpoint within 45% to 55% of the glide duration. This second subset contains 262 fricated tokens, 388 frication-less tokens, and 2915 <w>-tokens.

Statistical Analysis

Statistical analysis was conducted with the R package brms (Bürkner 2017), which estimates generalized (non-)linear multivariate multilevel/mixed effects models using the probabilistic programming language Stan (Carpenter et al. 2017) in R. The key difference between popular frequentist regression models (as fitted with lme4 (Bates, et al. 2015), and their Bayesian equivalents, is the underlying philosophical approach to statistics. Bayesian models combine prior information with observed data to estimate (posterior distributions of) model parameters. [iii]

In this paper, four models are fitted to four dependent variables: proportion of frication (a rate, beta distribution), centre of gravity (a numeric outcome variable (Hertz), lognormal distribution), F1 (a numeric outcome variable (Bark), lognormal distribution) and F2 (a numeric outcome variable (Bark), lognormal distribution). In this analysis, I use "weakly informative" priors (see Gelman et al, 2008) to constrain the parameter space to appropriate estimates (for coefficients, intercept(s), standard deviations). For example, we know that formant values are likely to fall within a specific range (see supplementary materials for full model specifications).

Because Bayesian approaches estimate distributions of parameters, where some parameter values are more probable than others, we can avoid asking whether or not there is an effect of a

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factor (Null Hypothesis Testing[iv]) and instead ask what the most probable direction and magnitude of an effect is. In the context of this study, these questions are more relevant to our research questions. Accordingly, I use the metrics "probability of direction" and "region of practical equivalence" to interpret results (see also Makowski et al. 2019).[v] For completeness, I also include the median parameter estimate (M) and lower and upper bounds of the 89% Highest Density Interval (HDI) which captures the most probable parameter values.

Interpretation: Probability of Direction

The probability of direction (pd) captures the certainty that an effect has the same direction as the median estimate of the posterior distribution (i.e., is positive or negative) (Makowski et al. 2019). The simplest method of computing PD is by counting all samples in the posterior distribution which share a sign with the median estimate and dividing by the number of total samples (i.e., the PD is equivalent to the percentage of positive/negative samples). It answers the question "what's the probability of the direction of the effect of independent variable A?" In the results below I express PD as a direction (positive/negative) and the percentage of samples sharing that sign (e.g., - (100%) means that 100% of samples are negative). I also provide a description of this probability of direction along the following scale: "unclear" (<60.0%), "possibly positive/negative" (60.0-69.9%) "likely positive/negative" (70.0-89.9%), "very likely positive/negative" (90.0-100%).

Interpretation: Region of Practical Equivalence

The region of practical equivalence (ROPE) describes an interval which is "practically equivalent" to zero, based on subject knowledge of what represents a meaningful difference. Effect size can be

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gauged by considering what percentage of a given posterior distribution falls within that interval. The intuition here is while the coefficient might not be exactly zero, it may well be too small to be of any "practical significance." ROPE directly answers the question "what's the probability that this effect is of **not** of practical significance?" In the results below I express ROPE as the percentage of samples falling within ROPE. I also provide a description of the likely practical meaning of the effect along the following scale: "very unlikely meaningful" (>89.9% in ROPE), "unlikely meaningful" (50.0-89.9% in ROPE), "possibly meaningful" (20.0-49.9% in ROPE) "likely meaningful" (5.0-19.9%), "very likely meaningful" (<5.0%).

Variables and hypotheses

Social and linguistic independent variables under consideration in the statistical models are: social class, year of birth, style, phonetic context, speech rate, and (for formants) type of glide. Speaker and word were included as random effects (intercepts and slopes where appropriate). Social class is defined as "working class" (WC) or "middle class" (MC): the 15 participants recorded in 2019 chose a social class label for themselves during the interview, while the 3 participants recorded in 2014 were assigned a social class label based on their occupation. Year of birth was provided by the participants. Style was defined as either "conversation" or "reading," as speakers in the 2019 sample also completed a reading passage. The definition of phonetic context depends on the statistical model and outcome variable. For the model looking at presence and duration of frication, the relevant phonetic context is the preceding context (pause or non-pause, as also used by Brato (2014) and Schützler (2011)). For the CoG model, the relevant phonetic context is the preceding manner of articulation (fricative, plosive, approximant, nasal, vowel and pause). For F1

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the following vowel height (high, mid, low), and for F2 following vowel anteriority (front, central, back) matters. Speech rate was operationalised as number of syllabic consonants or vowels per second (measured within chunks not interrupted by pauses of more than 3 seconds). The glide type is only relevant for the formant models, and comprises fricated , frication-less and <w>-glides (e.g., the initial glide in water). Categorical variables (social class, phonetic context, style, glide type) were deviance-coded (see, e.g., Schad et al. 2020), and numeric variables scaled and centered.

The hypotheses for this study are summarised in Table 2. I expect fricated tokens to be more likely among middle class speakers and older speakers (Brato 2014; Robinson 2005; Schützler 2010; Stuart-Smith et al., 2007), and potentially formal styles. Based on work which associates lower CoG with "true labiovelars" (Bridwell 2019; Robinson 2005), I expect CoG to be lower in those "formal" contexts too. Otherwise, CoG is likely affected by the preceding manner of articulation (Bridwell 2019). Fricated tokens are expected to be more likely after pauses (Brato 2014; Schützler 2010), which might translate to longer periods of frication. Formants are expected to be influenced by phonetic context, social class and glide type (E. Lawson et al., 1999).

Table 2: Summary of all hypotheses explored in this paper.

Factor	Frication (rate)	Frication (relative)	CoG	F1	F2
Social class	MC: higher	MC: longer	MC: lower	MC: lower	??
Style	Reading: higher	Reading: longer	Reading: lower	not tested	??

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Year of Birth	Younger: lower	Younger: shorter	Younger: higher	no effect	??
Phonetic context	Post-pausal: higher	Post-pausal: longer	preceding manner	following vowel height	following vowel anteriority
Speech Rate	slow: higher	slow: longer	no effect	no effect	no effect
Glide Type	NA	NA	NA	fricated: higher	fricated: higher
Statistical model	zero-inflated beta regression		linear mixed effects	linear mixed effects	linear mixed effects

Probability and proportion of frication: Zero-inflated beta regression

The probability ("is a given token fricated?") and relative duration of frication ("how long is the period of frication in fricated tokens?") can be modelled using a zero-inflated beta regression. Beta regressions are commonly used for proportions as they can model outcomes bounded by the open interval (0,1) (Douma and Weedon 2019; Ferrari and Cribari-Neto 2004; Stewart 2013). Zero-inflated models can handle datasets containing many zeroes (i.e., in our case, many frication-less tokens), and are particularly suitable when there is theoretical reason to believe that the process generating a 0 or non-0 outcome (i.e., an frication-less or fricated token) is distinct from the subsequent process generating a positive outcome (i.e., a token with a particular rate of frication). A posterior predictive check, which simulates data based on priors and observed data, confirms that a zero-inflated beta regression is appropriate for the data.

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Centre of gravity: Bayesian linear mixed effects (log-normal)

To quantitatively analyse variation in centre of gravity, I use a Bayesian linear effects model. These models are specified similarly to frequentist mixed effects models, including fixed and random intercepts as well as random slopes. Centre of gravity (in Hertz) is commonly log-normally distributed (validated via a posterior predictive check).

F1 & F2: Bayesian linear mixed effects (log-normal)

F1 and F2 (in Bark) were modelled in two separate Bayesian linear mixed effects models. The log-normal distribution was chosen as the distributional family. A posterior predictive check confirmed that this distribution approximates the data better than a Gaussian would.

Results

Overall, frication-less tokens are more common than fricated tokens, though the exact distribution is conditioned by linguistic context, style and social class. Interestingly, there is no clear effect of speaker year of birth, as would be expected in a straightforward change in progress. Proportion and type of frication varies depending on linguistic and social context. The glide differs depending on whether or not the token is fricated . In the discussion of the statistical results, I focus on the direction and magnitude of effects, rather than exact coefficients. Recall that PD describes the probability of a particular direction of the effect, positive (+) or negative (-), on the dependent

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variable and that ROPE describes the probability that the effect is not of practical significance. For coefficient tables, visualisations and details about the models, see supplementary materials.

Frication-less tokens are more common

Frication-less tokens are less likely among middle class speakers, in a reading style, and following a pause; year of birth is likely not a meaningful predictor (Table 3). The zero-inflated component of the model is a logistic regression estimating the probability that a token is frication-less.

Table 3: Summary of the zero-inflated component of the zero-inflated beta regression. Outcome variable: probability of a frication-less token. ROPE is defined as [−0.18, +0.18]. (n = 1400)

Factors	Hypothesis	PD	ROPE	Interpretation	HDI (89%)
Preceding pause	less likely (negative)	- (100%)	0%	very likely negative, v. likely meaningful	M = -1.137 **[**-1.401, -0.872**]**
(Reading) Style	less likely (negative)	- (99.8%)	1.4%	very likely negative, v. likely meaningful	M = -0.847 **[**-1.319, -0.358**]**
(Higher) Social Class	less likely (negative)	- (94.6%)	3.4%	very likely negative, v. likely meaningful	M = -1.731 [-3.595, -0.035]
Social Class * YOB	more likely (positive)	+ (63.8%)	11.6%	possibly positive, likely meaningful	M = 0.404 [-1.574, 2.312]

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Year of Birth	more likely (positive)	- (59.0%)	24.0%	unclear, possibly meaningful	M = -0.132 [-1.054, 0.872]
Speech rate	more likely (positive)	+ (55.7%)	93.2%	unclear, v. unlikely meaningful	M = 0.014 [-0.142, 0.172]

The proportion of frication varies

While the probability of direction indicates that the proportion of frication is conditioned by the same factors (and in the same way) as the presence or absence of frication, ROPE ([-0.18, +0.18]) suggests that the effects are not practically meaningful.

Table 4: Summary of conditional component of the zero-inflated beta regression. Outcome variable: proportion of frication (in fricated tokens). ROPE is defined as [−0.18, +0.18]. (n = 1400)

Factors	Hypothesis	PD	ROPE	Interpretation	HDI (89%)
(Higher) Social Class	longer (positive)	+ 94.9%	19.9%	very likely positive, likely meaningful	M = 0.347 [0.008, 0.702]
Social Class * Year of Birth	shorter (negative)	+ 81.8%	42.9%	likely positive, possibly meaningful	M = 0.195 [-0.149, 0.567]
Year of Birth	shorter (negative)	+ 81.8%	76.7%	likely positive, unlikely meaningful	M = 0.099 [-0.083, 0.279]
(Reading) Style	longer	+	93.1%	possibly positive,	M = 0.040

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	(positive)	67.4%		v unlikely meaningful	[-0.105, 0.183]
Preceding: pause	shorter	-	99.1%	likely negative,	M = -0.054
	(negative)	83.7%		v. unlikely meaningful	[-0.140, 0.034]
Speech rate	shorter	-	100%	likely negative,	M = -0.043
	(negative)	88.4%		v. unlikely meaningful	[-0.102, 0.015]

The type of frication varies

Frication noise is either diffuse across the spectrum (as in Figure 2b) or clustered at low frequencies (see Figure 2a). Most speakers produce both types of frication. For all fricated tokens, F1 and F2 start abruptly and high at the onset of voicing and do not rise. The statistical analysis suggests: context is a meaningful predictor (higher CoG after fricatives, lower CoG after vowels, approximants and nasals); style is a possible predictor with lower CoG in a reading style; effects of year of birth (possibly positive) and social class (likely negative) are less likely to be meaningful.

Table 5: Summary of log-normal mixed effects linear regression model for CoG. Outcome variable: CoG of the period of frication in Hertz, ROPE is defined as an absolute difference of 100 Hz. (n = 508)

Factors	Hypothesis	PD	ROPE	Interpretation	HDI (89%)
Preceding:	lower	-	1.1%	very likely negative,	M = -0.241
approximant	(negative)	100%		v. likely meaningful	[-0.335, -0.141]

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Preceding: vowel	lower (negative)	- 100%	1.2%	very likely negative, v. likely meaningful	M = -0.197 [-0.266, -0.129]
Preceding: fricative	higher (positive)	+ 100%	1.2%	very likely positive, v. likely meaningful	M = 0.239 [0.142, 0.338]
Preceding: nasal	lower (negative)	- 100%	1.8%	very likely negative, v. likely meaningful	M = -0.227 [-0.322, -0.130]
(Reading) Style	lower (negative)	- 98.6%	19.5%	very likely negative, likely meaningful	M = -0.167 [-0.308, -0.037]
Year of Birth	higher (positive)	- 93.9%	40.7%	very likely negative, possibly meaningful	M = -0.116 [-0.232, 0.001]
(Higher) Social Class	?	+ 70.1%	45.5%	likely positive, possibly meaningful	M = 0.077 [-0.158, 0.329]
Preceding: plosive	?	- 53.9%	97.8%	unclear, v. unlikely meaningful	M = 0.004 [-0.065, 0.072]
Speech rate	?	- 57.1%	100%	unclear, v. unlikely meaningful	M = 0.003 [-0.026, 0.032]

F1 and F2 of glides vary

The qualitative analysis of spectrograms shows the formant patterns also reported by E. Lawson et al., (1999): frication-less tokens feature a period of low F1 and F2 before the appearance of

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higher formants and a movement towards the following vowel formants, while fricated tokens show an abrupt high start of F1 and F2. To confirm these observations quantitatively, F1 and F2 were measured at the midpoints of glides. In linear models, ROPE is often conventionally defined as $[-0.1\sigma, +0.1\sigma]$, where σ denotes the standard deviation of the dependent variable. For F1 this is equivalent to an absolute difference of 0.11 Bark from the intercept. For F2 this is equivalent to an absolute difference of 0.16 Bark from the intercept. For F1, I find: glides in fricated (<wh>) tokens have likely higher F1; glides with a shorter duration have a lower F1; middle class speakers have possibly a lower F1; most effects of linguistic contexts are very small. For F2, I find: glides in fricated tokens have a lower F2 (mediated by following vowel anteriority); glides with a shorter duration have a lower F2; middle class speakers have possibly a lower F2.

Table 6: Linear mixed effects regression for F1. ROPE is defined as a difference of 0.11 Bark. (n = 3565)

Factors	Hypothesis	PD	ROPE	Interpretation	HDI (89%)
Duration (log)	?	- 100%	<0.1%	very likely negative, v. likely meaningful	M = -0.072 [-0.084, -0.059]
Fricated	higher F1 (positive)	+ 95.1%	29.3%	very likely positive, possibly meaningful	M = 0.058 [0.002, 0.113]
(Higher) Social Class	?	- 86.3%	32.6%	likely negative, possibly meaningful	M = -0.058 [-0.143, 0.03]

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Year of Birth	?	+ 91.5%	46.6%	very likely positive, possibly meaningful	M = 0.042 [-0.009, 0.090]
Frication-less	lower F1 (negative)	+ 90.5%	63.4%	very likely positive, unlikely meaningful	M = 0.031 [-0.007, 0.071]
Following: high vowel	lower F1 (negative)	- 92.8%	84.4%	very likely negative, unlikely meaningful	M = -0.024 [-0.049, 0.003]
Following: low vowel	higher F1 (positive)	- 54.4%	99.6%	unclear, v. unlikely meaningful	M = -0.002 [-0.024, 0.020]
F2	higher F1	+ 100%	100%	v. likely positive, v. unlikely meaningful	M = 0.025 [0.022, 0.029]

Table 7: Linear mixed effects regression for F2. ROPE is defined as a difference of 0.16 Bark. (n = 3565)

Factors	Hypothesis	PD	ROPE	Interpretation	HDI (89%)
F1	higher F2	+ 100%	0%	very likely positive, v. likely meaningful	M = 0.034 [0.029,0.038]
Duration (log)	?	- 100%	0.02%	very likely negative, v. likely meaningful	M = -0.041 [-0.051, -0.032]
Fricated	higher (positive)	- 100%	0.14%	very likely negative, v. likely meaningful	M = -0.100 [-0.141, -0.058]

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Following: front vowel	higher (positive)	+ 100%	0.3%	very likely positive, v. likely meaningful	M = 0.105 [0.056, 0.151]
Fricated * front vowel	?	+ 97.1%	5.5%	very likely positive, likely meaningful	M = 0.097 [0.016, 0.177]
Following: back vowel	lower (negative)	- 96.7%	9.8%	very likely negative, likely meaningful	M = -0.062 [-0.116, -0.008]
Frication-less * front vowel	?	+ 88.6%	15.5%	likely positive, likely meaningful	M = 0.061, [-0.019, 0.141]
Frication-less * back vowel	?	+ 80.2%	20.0%	likely positive, possibly meaningful	M = 0.047 [-0.041, 0.136]
Fricated * back vowel	?	- 70.3%	24.6%	likely negative, possibly meaningful	M = -0.03 [-0.116, 0.060]
Frication-less	lower (negative)	- 91.3%	27.6%	very likely negative, possibly meaningful	M = -0.034, [-0.072, 0.006]
(Higher) Social Class	?	- 90.6%	32.8%	likely negative, possibly meaningful	M = -0.028, [-0.062, 0.007]
Year of Birth	?	- 99.4%	77.0%	likely negative, unlikely meaningful	M = -0.031 [-0.049, -0.012]

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Discussion

Beyond the binary distinction of which and witch there are a range of other variants, whose use appears conditioned by phonetic context, social class and style.

(HW) as a sociolinguistic variable: the variants

There are six main variants which differ in terms of frication (fricated / frication-less), glide quality, voicing (voiced/voiceless frication, voiced/voiceless glide) and phonation (breathy/modal).

Variation in frication

For tokens perceived as "fricated", frication accounts for at least 26% to 96% of token duration (see Figure 1b). Meaningful predictors conditioning this proportion of frication are speaker social class and preceding phonetic environment. Notably, year of birth is not a meaningful predictor here, suggesting that there's no ongoing gradual loss of frication.

Variation in centre of gravity is conditioned by style, preceding phonetic environment and speaker social class. If the preceding segment is a fricative, centre of gravity is significantly higher than after a pause. Conversely, CoG is significantly lower following an approximant, nasal or vowel. While these coarticulation effects are not particularly surprising, the effects of social class and preceding pause on the realization of fricated tokens is interesting.

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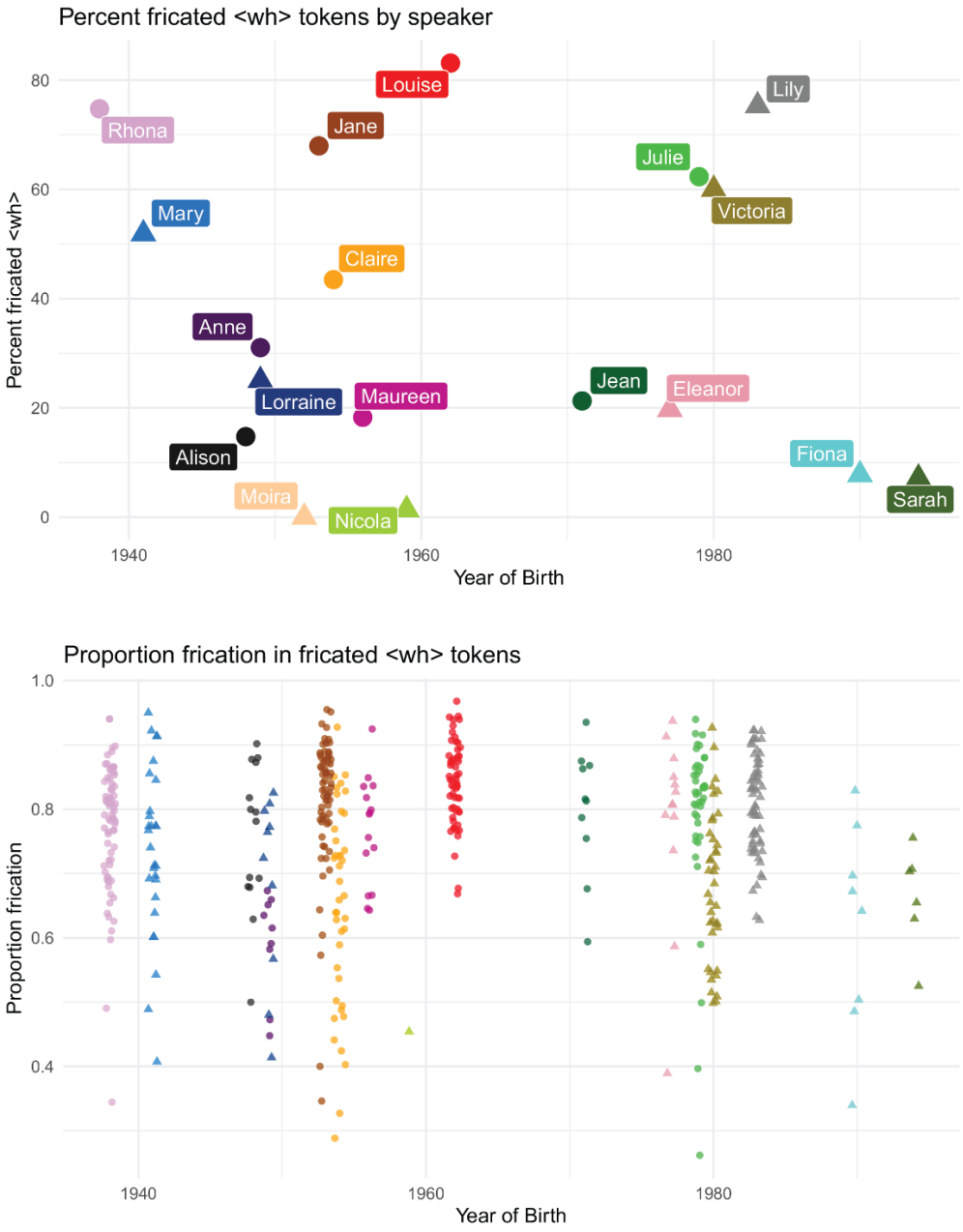

Figure 1 Rate and relative duration of frication varies greatly by speaker (colour), social class (circle = middle class, triangle = working class) and year of birth. Figure 1a shows the percentage of

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fricated tokens produced by each speaker and 1b shows the relative duration of the frication in every fricated token.

Figure 1a) Percentage of fricated tokens produced by speaker, year of birth and socio-economic class. Lily and Victoria stand out with their exceptionally high rates given their age and social class. Figure 1b) The relative duration of frication is highly variable. Each shape represents a fricated <wh>-token and the y-axis indicates which proportion of the total segment duration was annotated as frication.

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Figure 2 Frication is either spread across frequencies or clustered low. For fricated tokens, F1 and F2 start abruptly at the onset of voicing and do not rise. For frication-less tokens, F1 starts low and rises and F2 is weak.

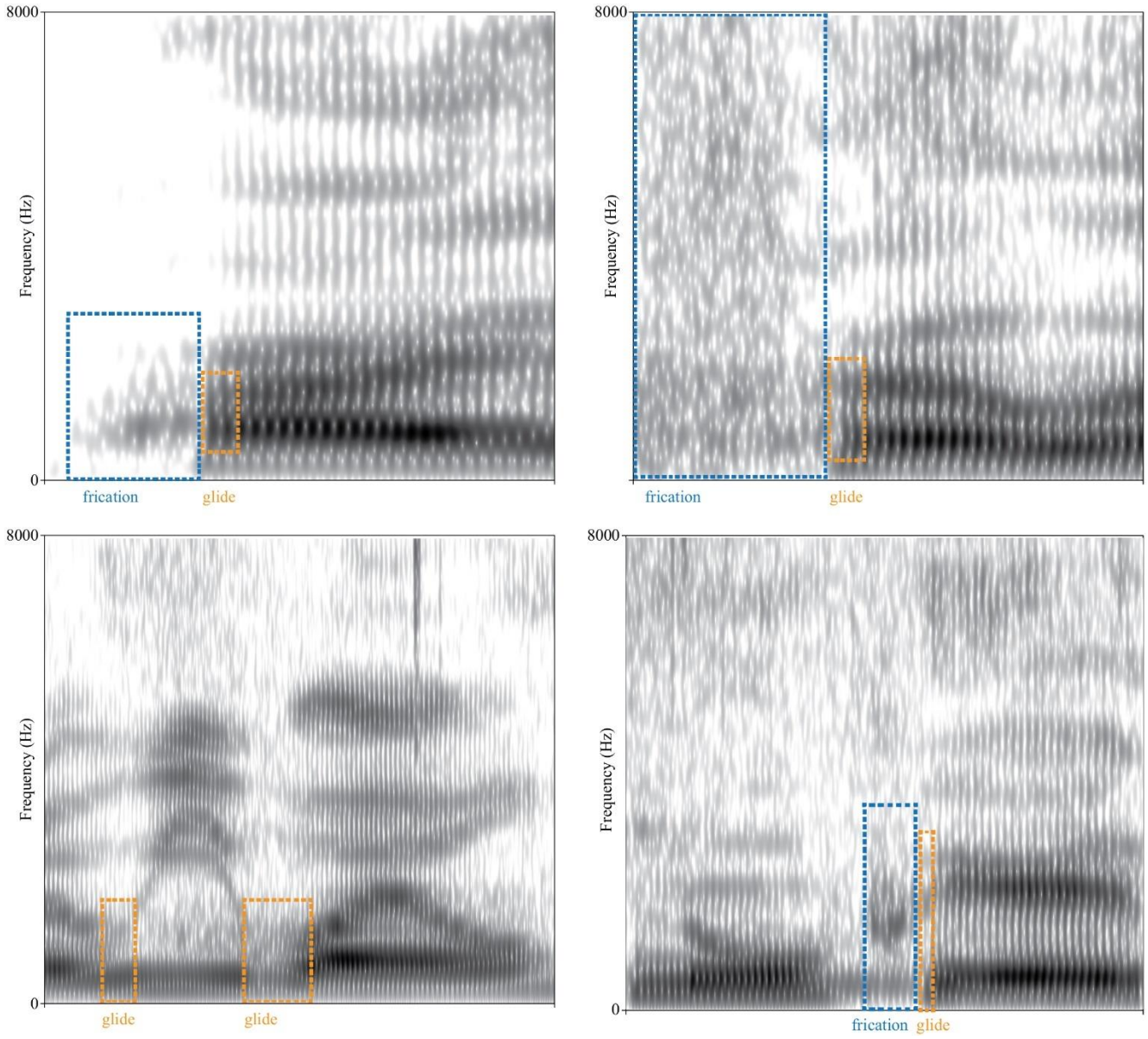

Figure 2a (top left). Younger working class woman (Lily) reading “why”. Frication is clustered at low frequencies
Figure 2b (top right) Lily saying “while”. Here the aperiodic noise is spread across frequencies.

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Figure 2c (bottom left) Young working class woman (Fiona) saying “a wee while”. Both glides are voiced and the (HW) realisation is frication-less. Glides are characterised by a period of low F1 and low and low and weak F2.
Figure 2d (bottom right) Lily saying “nowhere”. The period of frication is clearly visible and audible as is the voice bar throughout.

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Variation in glides

Fricated and frication-less variants differ not just in frication, but also in glide quality. The quantitative analysis confirms that the most meaningful predictors of F1 are frication and token duration. Glides in fricated tokens have a higher F1 at the midpoint than those in frication-less tokens. This confirms the observation (also made by E. Lawson et al., (1999)) that glides in frication-less tokens are characterised by a period of low F1, while fricated tokens show a very abrupt start of raised F1 and F2. I also identify a small effect of social class, whereby middle class speakers produce tokens with lower F1 than working class speakers. This echoes E. Lawson et al.'s finding that the middle class children in their sample produce a longer period of low F1 than the working class children, corresponding, presumably, to a lower midpoint (1999).

Fricated tokens have a lower F2. Effects of phonetic environment are also likely meaningful and follow expectations: tokens preceding front vowels show higher F2 while those preceding back vowels show lower F2. There is also an interaction effect of frication and phonetic context where fricated glides appear more strongly influenced by their phonetic context than frication-less tokens. This could be due to the, on average, shorter duration of fricated glides. Context effects could be more pronounced as their midpoint is closer to the next segment than in a frication-less glide.

A limitation of this analysis is that midpoints are not an ideal proxy for the formant trajectories considered in the qualitative analysis. While I have been assuming that tokens characterised by a rising F1 (frication-less) have a lower midpoint than those where F1 starts abruptly and high and remains stable (fricated), there could be a lot of variation regarding the formant trajectories.

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Variation in voicing

I also observe tokens which are either fully voiced (including frication) or fully voiceless. Notably, these do not exclusively occur in environments which would give rise to coarticulation effects. In their study of White Southern American English, Bridwell (2019) accounts for voiced [hw] by positing that the underlying representation of the voiceless labial-velar fricative among speakers who produce them is /hw/ which undergoes voicing in appropriate environments and surfaces as [w]. Since no participant in my study produces only voiced fricated tokens after voiced segments, this explanation does not apply here. The "devoiced [w]" tokens are perceptually voiceless while lacking frication.

Variation in phonation type

A sizeable subset of tokens are breathy. These variants are perceptually and acoustically hardest to pin down, as they vary in degree and duration of breathiness. While there aren't enough of these tokens for a robust quantitative analysis of formants, a qualitative analysis of single spectrograms suggests that they are highly variable and either pattern more with "prototypical"' fricated or frication-less tokens depending on whether they show frication preceding the glide.

Generally, they appear more common among the younger speakers. The youngest informants, Sarah (born 1993, working class) and Fiona (born 1990, working class) produced 8 (10% of all her tokens) and 5 (5% of her tokens) breathy tokens respectively. Notably, these two women have some of the lowest rates of frication (both under 10%). Similarly, Lily (born 1983, working class) produced 7 breathy tokens (8% of tokens). However, unlike Sarah and Fiona, Lily shows a very high

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rate of frication (over 70%). It's therefore not at all clear whether the rate of frication is related to the rate of breathiness. Social class could be an explanatory factor here. The prevalence of breathy (HW) realisations among young working class women mirrors E. Lawson et al.'s observation that breathy fricated variants are more common among working class children (who would have been born around the same time as Sarah and Fiona). However, the absence of any middle class women born after 1980 in this sample means this hypothesis remains untested here. To further complicate this picture, the highest rate of breathy tokens is found in Jean's speech (17%, born 1971, middle class, low rate of frication).

No apparent-time change in this sample?

Following the Apparent Time approach, speakers are expected to reflect the linguistic norms of their speech community when they acquired the variety (Sankoff 2006). If there was a change in progress, we would expect younger participants to produce higher rates of frication-less tokens than older participants. The probability of direction of the effect of year of birth in the zero-inflated component of the zero-inflated beta regression in Table 3 would then be positive (later year of birth ~ higher probability of frication-less token). 60% of speakers predominantly use frication-less tokens (Figure 1a) which suggests that some change probably has taken place since older descriptions of Edinburgh English such as Chirrey, who notes that (only) "some younger speakers" use frication-less variants variably (1999: 36). However, there is little evidence of ongoing change.

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Style and lexical variation

As hypothesised, tokens produced after a pause (about a third of the dataset) are much more likely to be fricated than those following a non-pausal segment. Unfortunately, other factors such as lexical frequency and lexical category are exceptionally hard to disentangle from phonetic context. Highly frequent words featuring (HW) tend to be closed class items (e.g. what, which, where, when, why), while open class items are much rarer (e.g. whisky, whistle, whale). Most instances (93%) of (HW) are furthermore word-initial (exceptions include elsewhere, anywhere, nowhere). Schützler (2010) argues that the preference for fricated tokens after a pause is an articulatory effect. At a lower speech rate or after a pause there is "more time" to articulate the "slightly more effortful" fricated variant after a pause (2010: 15). However, since I do not find such a speech rate effect, I would argue that the post-pausal context favours fricated tokens for the same reason that the reading style does: because fricated tokens are part of a more careful or formal speech style.

Style (conversation or reading) conditions whether or not tokens are fricated, and relative duration and CoG of frication. Tokens are more likely to be fricated in a reading style. This effect is one of the strongest predictors of frication. Tokens in a reading style are somewhat more likely to have a longer period of frication but this effect is likely very small. Read tokens do, however, have a meaningfully lower CoG. They appear to be most similar to Robinson's "voiceless lip-rounded consonant with audible friction at both velar and bilabial articulations" (2005: 184) which she posits to be the "traditional form", and Bridwell's "true voiceless labiovelar glides" (2019: 120). These can be contrasted with tokens in which frication is more diffuse across frequencies more similar to a glottal fricative. One interpretation of the effect of speech style on CoG is that tokens

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with lower CoG are produced by speakers when they pay more attention to their speech, for example when reading, because they are more prestigious. This prestige may be the result of their association with Scottish Standard English, as some of the speakers with the highest rates of fricated tokens, clearly orient towards the standard and/or describe negative attitudes towards Scots. Conversely, speakers who use more Scots lexis favour frication-less tokens.

The most common <wh>-noun featuring in this corpus is whisky. Family members of two informants, Louise and Jane, used to work in (now defunct) whisky companies in Leith. Of 8 occurrences of the word whisky, 5 are fricated. Jane produces two of three tokens with the fricated variant (a slightly higher rate than her average), Louise produces both tokens with frication (she also has the highest average rate of frication of all speakers at 83%), Julie produces one of two tokens with frication, and Mary produces the one token without frication. Another locally salient (HW) word is whaling. Leith used to be an active whaling port, and the oldest informant, Rhona (born 1938), recalls whaling boats in the Leith docks, and Moira (born 1951) notes that her father used to work as a whaler. Rhona, a retired teacher (middle class) who has one of the highest rates of frication, produces two tokens in this context with frication, while Moira, a retired laboratory technician (working class) who has the second lowest rate of frication (7%) produces two without.

Social class, identity and changing neighbourhoods

Speaker social class is a predictor of both amount and type of frication. Middle class speakers produce (HW) tokens which are both more likely to be fricated, and if fricated, more likely to be more fricated. Middle class speakers furthermore tend to produce fricated tokens with a higher

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centre of gravity than working class speakers (though this effect is likely smaller). These findings echo Stuart-Smith et al., (2007), who also report that Glasgow middle class speakers favour fricated variants, while working class speakers favour frication-less tokens.

While most speakers here follow this pattern, Lily and Victoria in particular buck this trend. The two women were born in 1980 (Victoria) and 1983 (Lily) in Leith and both identified themselves as "working class". They produce higher rates of fricated tokens than all other working class speakers (Victoria: 60%, Lily: 75%), and much higher rates than other working class women their age. Notably, their educational and professional backgrounds suggest that both often style-shift along the Scots-Scottish Standard English continuum (Stuart-Smith 2004), and that they could perhaps be described as upper working class or "new middle class" (Dickson et al., 2017).

Lily works in finance administration at a university, having previously worked in insurance but not attended university herself. While she describes herself as "working class," her upbringing in Leith could be described as middle class. In her interview she talks about shifting from "speak[ing] Leith," a variety she describes as having "its own words and phrases", to "an Edinburgh accent," especially when interacting with colleagues from outwith Scotland. This might account for the marked differences between her and other self-described working class women her age in the sample. Victoria is a community officer in Leith, who studied at Edinburgh University. She grew up in Leith and her upper-working class parents were from Leith (mother) and Birmingham (father). Victoria notes that, in her perception, the way people speak in Leith has changed between generations (though she wasn't asked about (HW) specifically). She finds that "the older generation definitely have a different dialect from [her]self and [her] brothers" and that people her age in Leith

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speak very similarly to people elsewhere in Edinburgh (likely referring to Scottish Standard English). These perceptions are potentially coloured by her broader negative attitudes towards Scots: she explains that she believes that children should not be taught Scots in schools and that she does not want her grandmother to speak Scots to her children. This metalinguistic commentary reveals that Victoria is very concerned with "speaking properly." Fricated (HW) appears to be part of this targeted style. Victoria's comments about language (however inflected by her attitudes) and both women's relationship to social class also speak to a real ongoing change in Leith.

Crucially, the apparent time construct assumes that adult speakers remain relatively stable over their lifetime and that the speech community they were raised in is fundamentally the same today as it was then. While real time and panel studies which consider data collected at different points in time provide strong support for a model of intergenerational language change and intragenerational stability (e.g., Denis et al. 2019; Fruehwald 2017), changes within speakers across the lifespan and broader external changes affecting the speech community are likely also factors. As shown above, speakers like Lily style-shift frequently and have (somewhat consciously) accommodated to another variety or standard than the one they spoke growing up. Furthermore, over the course of the twentieth century Leith has undergone drastic changes as the result of deindustrialisation. After a period of economic decline (somewhat infamously portrayed in Irvine Welsh's (1994) novel Trainspotting), Leith has become one of the most densely populated and diverse areas of Scotland, and, in recent years has been rapidly gentrifying (Doucet 2009). The speech community which the oldest participant Rhona (born 1938) grew up in, is therefore very different from the one the youngest informant Sarah was born into in 1993.

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Social class and local identity may also offer a better alternative account for variation than contact with Southern British English invoked in prior work. Looking only at middle class speakers from Edinburgh, Schützler (2010) argues that the adoption of frication-less [w] is an effect of higher education and contact with Southern British varieties of English (which in Edinburgh are closely intertwined). Most Standard Southern British English (SSBE) speakers, he argues, don't produce fricated variants at all, and the observed "merger" is thus an effect of language contact. Contrary to Schützler's argument though, the informants in this sample with the most contact to SSBE and higher education tend to also be the speakers with the highest rates of frication (i.e., the least likely to "merge"). This is especially apparent in young upwardly mobile working class women like Victoria and Lily, who appear to orient towards Scottish Standard English, or, as Lily puts it "Edinburgh" English. The idea that fricated variants are associated with Scottish Standard English can also account for the stylistic effect, as speakers are generally more likely to use a "more standard" form while reading. The lowest rates of frication are found among working class women who have not had much contact with higher education, both older (Moira, Nicola, Lorraine) and younger (Fiona, Sarah). In the context of Glasgow, Stuart-Smith et al., (2007) argue that young working class speakers use the frication-less variant, which may well have entered originally from Southern British varieties (though perhaps not face-to-face contact[vi]) to index distance from (or opposition to) the middle class norm. Like in Glasgow (Stuart-Smith et al., 2007), linguistic differences between social class groups observed in Edinburgh could be the result of changing neighbourhoods and social networks, changes in Scots among working class speakers and distinct linguistic norms for different social class groups.

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Conclusion: (HW) as a complex sociolinguistic variable

In this study I have described the so-called which ~ witch merger as a sociolinguistic variable with six internally heterogeneous variants. Realisations of (HW) differ most notably in presence or absence of frication, relative duration of frication, type of frication, glide quality, phonation and voicing. Contrary to other studies on (HW) in Scotland (and Edinburgh), I do not find evidence for ongoing change or effects of contact with Southern British English. Rather, variant selection and realisation are conditioned by social class, style and phonetic environment. Fricated variants are particularly prevalent in the speech of middle class and "new middle class"' or upwardly mobile working class women, as well as in formal speech styles.

There are many open questions regarding (HW). While the sociolinguistic interviews analysed here are a good representation of the distribution and realisation of (HW) in conversational speech and reading, a more specifically designed project (in particular using laboratory recordings) might provide further insights in the phonetic realisation and could shed some light on effects of lexical frequency, phonetic environment and semantic content. Another striking finding to explore further is that the variants identified here are very similar to those found in other varieties of English (in Scotland, but also in the United States).

References

Bates, Douglas, Martin Mächler, Ben Bolker, and Steve Walker. 2015. "Fitting Linear Mixed-Effects Models Using lme4." *Journal of Statistical Software* 67 (1): 1–48.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. "I can't see myself ever living any[w]ere else": Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

Berk, Jonathan. 2014. “The Scottish Vowel Length Rule in Morningside and Leith.” Master’s thesis, The University of Edinburgh.

Boersma, Paul. 2002. “Praat, a System for Doing Phonetics by Computer.” *Glot International* 5.

Brato, Thorsten. 2014. “Accent Variation and Change in North-East Scotland: The Case of (HW) in Aberdeen.” In *Sociolinguistics in Scotland*, 32–52.

Bridwell, Keiko. 2019. “The Distribution of [Hw]: An Acoustic Analysis of Sociophonetic Factors Governing the Wine-Whine Merger in Southern American English.” University of South Carolina.

Bürkner, Paul-Christian. 2017. “Brms: An r Package for Bayesian Multilevel Models Using Stan.” *Journal of Statistical Software* 80 (August): 1–28.

Carpenter, Bob, Andrew Gelman, Matthew D Hoffman, Daniel Lee, Ben Goodrich, Michael Betancourt, Marcus Brubaker, Jiqiang Guo, Peter Li, and Allen Riddell. 2017. “Stan: A Probabilistic Programming Language.” *Journal of Statistical Software* 76 (1).

Chirrey, Deborah. 1999. “Edinburgh: Descriptive Material.” In *Urban Voices: Accent Studies in the British Isles*, edited by Gerard Docherty and Paul Foulkes, 428–43. London, England; New York, NY: Arnold - Oxford UP.

Denis, Derek, Matt Hunt Gardner, Marisa Brook, and Sali A. Tagliamonte. 2019. “Peaks and Arrowheads of Vernacular Reorganization.” *Language Variation and Change* 31 (1): 43–67.

DiCanio, Christian. 2017. “Time Averaging for Fricatives.” 2017. HTTPS://WWW.ACSU.BUFFALO.EDU/~CDICANIO/SCRIPTS/TIME_AVERAGING_FOR_FRICATIVES_2.0.PRAAT.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. “I can’t see myself ever living any[w]ere else”: Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

Dickson, Victoria, and Lauren Hall-Lew. 2017. “Class, Gender, and Rhoticity: The Social Stratification of Non-Prevocalic /r/ in Edinburgh Speech.” *Journal of English Linguistics* 45 (3): 229–59.

Doucet, Brian. 2009. “Living Through Gentrification: Subjective Experiences of Local, Non-Gentrifying Residents in Leith, Edinburgh.” *Journal of Housing and the Built Environment* 24 (3): 299–315.

Douma, Jacob C., and James T. Weedon. 2019. “Analysing Continuous Proportions in Ecology and Evolution: A Practical Introduction to Beta and Dirichlet Regression.” *Methods in Ecology and Evolution* 10 (9): 1412–30.

“Elan (Version 5.2).” n.d. HTTPS://TLA.MPI.NL/TOOLS/TLA-TOOLS/ELAN/.

Ferrari, Silvia, and Francisco Cribari-Neto. 2004. “Beta Regression for Modelling Rates and Proportions.” *Journal of Applied Statistics* 31 (7): 799–815.

Fruehwald, Josef. 2017. “Generations, Lifespans, and the Zeitgeist.” *Language Variation and Change* 29 (1): 1–27.

Fruehwald, Josef, Hall-Lew Lauren, Eiswirth Mirjam, Zac Boyd, and Zuzana Elliott. 2019. “A Phonetic Analysis of the Which-Witch Merger in Edinburgh, Scotland.”

Giegerich, Heinz J. 1992. *English Phonology: An Introduction*. Cambridge: Cambridge University Press.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. “I can’t see myself ever living any[w]ere else”: Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

Jones, Charles. 2002. *The English Language in Scotland : An Introduction to Scots*. East Linton: Tuckwell.

Kruschke, John K. 2011. *Doing Bayesian Data Analysis: A Tutorial with r and BUGS*. Burlington, MA: Academic Press.

Labov, William, Sharon Ash, and Charles Boberg. 2008. *The Atlas of North American English: Phonetics, Phonology and Sound Change*. Berlin ; Boston: De Gruyter Mouton.

Lawson, Eleanor, and Jane Stuart-Smith. 1999. "A Sociophonetic Investigation of the Scottish Consonants /x/ and /Hw/ in the Speech of Glaswegian Children." *14th International Congress of Phonetic Sciences*, 2541–44.

Lawson, Robert. 2014. *Sociolinguistics in Scotland*. Palgrave Macmillan UK.

Li, Zeyu, and Ulrike Gut. 2022. "The Distribution of /w/ and /ʍ/ in Scottish Standard English." *Corpus Linguistics and Linguistic Theory*.

Macafee, Caroline. 1983. *Glasgow*. Varieties of English Around the World. Text Series ; v.3. Amsterdam: Benjamins.

Makowski, Dominique, Mattan S. Ben-Shachar, S. H. Annabel Chen, and Daniel Lüdecke. 2019. "Indices of Effect Existence and Significance in the Bayesian Framework." *Frontiers in Psychology* 10: 2767.

Marshall, James Scott. 1986. *The Life and Times of Leith*. Edinburgh: Donald.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. "I can't see myself ever living any[w]ere else": Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

McAuliffe, Michael, Michaela Socolof, Sarah Mihuc, Michael Wagner, and Morgan Sonderegger. 2017. “Montreal Forced Aligner: Trainable Text-Speech Alignment Using Kaldi.” In *Proceedings of the 18th Conference of the International Speech Communication Association*.

McElreath, Richard. 2016. *Statistical Rethinking: A Bayesian Course with Examples in r and Stan*. Chapman & Hall/CRC Texts in Statistical Science Series 122. Boca Raton: CRC Press/Taylor & Francis Group.

Milroy, Lesley. 2004. “An Essay in Historical Linguistics?: On Donka Minkova’s "Philology, Linguistics, and the History of [Hw] ~[w]".” In *Studies in the History of the English Language II: Unfolding Conversations*, edited by Anne Curzan and Kimberley Emmons, 46–53. De Gruyter Mouton.

Minkova, Donka. 2004. “Philology, Linguistics, and the History of [Hw] ~[w].” In *Studies in the History of the English Language II: Unfolding Conversations*, edited by Anne Curzan and Kimberley Emmons, 7–45. De Gruyter Mouton.

Nalborczyk, Ladislas, Cédric Batailler, Loevenbruck Hélène, Anne Vilain, and Bürkner Paul-Christian. 2019. “An Introduction to Bayesian Multilevel Models Using Brms: A Case Study of Gender Effects on Vowel Variability in Standard Indonesian.” *Journal of Speech, Language, and Hearing Research* 62 (5): 1225–42.

Parkinson, Fraser, and Jack Gillon. 2014. *Leith Through Time*. Stroud: Amberley Publishing.

Reiersen, Øystein. 2013. “Edinburgh Jockney? A Socio-Phonological Study of Accent Variation and Change in Edinburgh English.” Master’s thesis, The University of Bergen.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. “I can’t see myself ever living any[w]ere else”: Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

Robinson, Christine. 2005. “Changes in the Dialect of Livingston.” *Language and Literature* 14 (2): 181–93.

Sankoff, G. 2006. “Age: Apparent Time and Real Time.” *Encyclopedia of Language & Linguistics*, no. 1977: 110–16.

Schad, Daniel J., Shravan Vasishth, Sven Hohenstein, and Reinhold Kliegl. 2020. “How to Capitalize on a Priori Contrasts in Linear (Mixed) Models: A Tutorial.” *Journal of Memory and Language* 110 (February): 104038.

Schützler, Ole. 2010. “Variable Scottish English Consonants: The Cases of /Hw/ and Non-Prevocalic /r/.” *Research in Language* 8: 1–17.

———. 2011. “Charting Vowel Spaces in Edinburgh Middle-Class Speech.” *English World-Wide* 32 (1): 24–45.

———. 2015. *A Sociophonetic Approach to Scottish Standard English*. Amsterdam ; Philadelphia: John Benjamins Publishing Company.

Stewart, Connie. 2013. “Zero-Inflated Beta Distribution for Modeling the Proportions in Quantitative Fatty Acid Signature Analysis.” *Journal of Applied Statistics* 40 (5): 985–92.

Stuart-Smith, Jane. 2004. “Scottish English.” In *A Handbook of Varieties of English*, edited by Bernd Kortmann, Kate Burridge, Rajend Mesthrie, Edgar W. Schneider, and Clive Upton, 1:47–67. Mouton de Gruyter.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. “I can’t see myself ever living any[w]ere else”: Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

Stuart-Smith, Jane, Gwilym Pryce, Claire Timmins, and B. Gunter. 2013. "Television Can Also Be a Factor in Language Change: Evidence from an Urban Dialect." *Language* 89 (3): 501–36.

Stuart-Smith, Jane, Claire Timmins, and Fiona Tweedie. 2007. "'Talkin' Jockney'? Variation and Change in Glaswegian Accent." *Journal of Sociolinguistics* 11 (2): 221–60.

Team, R Core. 2017. *R: A Language and Environment for Statistical Computing*. Vienna, Austria: R Foundation for Statistical Computing. HTTPS://WWW.R-PROJECT.ORG/.

Thomas, Erik R. 2019. "Trends from Outside." In *Mexican American English: Substrate Influence and the Birth of an Ethnolect*, edited by Erik R.Editor Thomas, 125–48. Studies in English Language. Cambridge University Press.

Traunmüller, Hartmut. 1990. "Analytical Expressions for the Tonotopic Sensory Scale." *The Journal of the Acoustical Society of America* 88 (1): 97–100.

Vasishth, Shravan, Bruno Nicenboim, Mary E. Beckman, Fangfang Li, and Eun Jong Kong. 2018. "Bayesian Data Analysis in the Phonetic Sciences: A Tutorial Introduction." *Journal of Phonetics* 71 (November): 147–61.

Wells, John Christopher. 1982. *Accents of English*. Cambridge: Cambridge University Press.

Welsh, Irvine. 1994. *Trainspotting*. London: Minerva.

Wickham, Hadley. 2016. *Ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York.

AUTHOR ACCEPTED MANUSCRIPT: Markl N. "I can't see myself ever living any[w]ere else": Variation in (HW) in Edinburgh English. *Language Variation and Change*. 2023;35(1):79-105. doi:10.1017/S0954394523000078

Wickham, Hadley, Mara Averick, Jennifer Bryan, Winston Chang, Lucy D'Agostino McGowan, Romain François, Garrett Grolemund, et al. 2019. "Welcome to the Tidyverse." *Journal of Open Source Software* 4 (43): 1686.

Zimman, Lal. 2017. "Gender as Stylistic Bricolage: Transmasculine Voices and the Relationship Between Fundamental Frequency and /s/." *Language in Society* 46 (3): 339–70.

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[i] For a detailed introduction to language in Scotland, see R Lawson (2014).

[ii] As noted by Wells (1982:), in very formal registers of RP some speakers do retain a contrast.

[iii] For a detailed introduction to Bayesian statistics, I recommend McElreath (2016) and Kruschke (2011) and for an introduction to brms in the context of linguistics see Nalborczyk et al. (2019; Vasishth et al. 2018).

[iv] In a frequentist linear effects model, $p < 0.05$ attached to independent variable A means, "in any 100 samples, we would only expect fewer than 5 samples to contain data as extreme or more extreme if the null hypothesis ('there is no effect of A') is true."

[v] I direct any interested reader to the supplementary materials which contains the data, full model specifications, full model results and fitted models as well as all other diagnostics mentioned in the text: **HTTPS://GITHUB.COM/NINAMARKL/HW_EDINBURGH**

[vi] see also Stuart-Smith et al. (2013)

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