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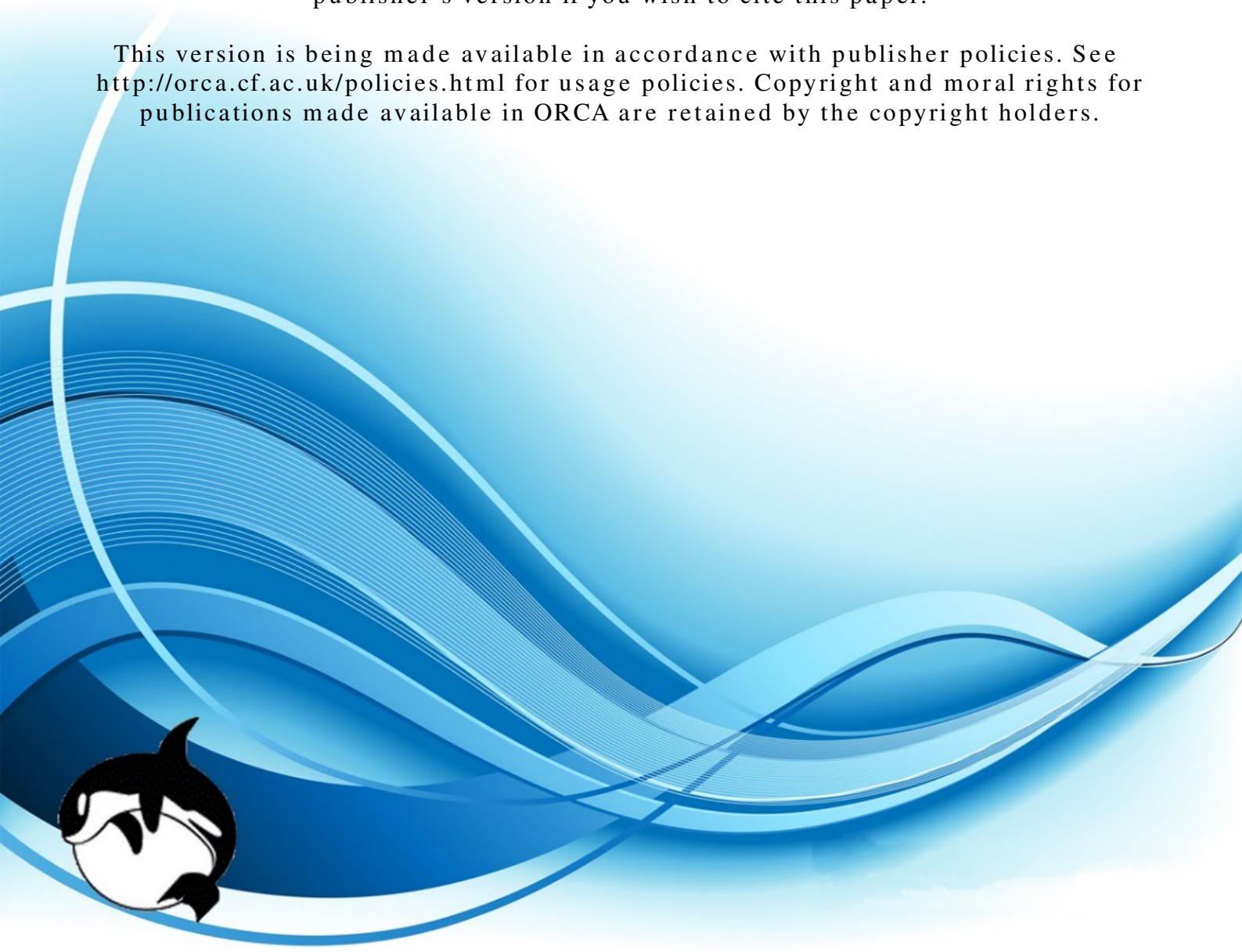

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Sociophonetic variation in a long-term language contact situation: /l/-darkening in Welsh-English bilingual speech[1].

Keywords:

Welsh; English; Bilingualism; Language Contact; Phonetic Variation; /l/-darkening

Abstract:

This study investigates /l/-darkening in the Welsh and English speech of bilinguals in North Wales. Although it is claimed that /l/ is dark in all syllable positions in northern varieties of both languages, there have been no quantitative investigations of this feature which consider cross-linguistic phonetic differences, the differing nature of language contact between North East and North West Wales, and differences in the way both languages are acquired by speakers. The dataset of 32 Welsh-English bilinguals, aged 16-18, was stratified by speaker sex, home language, and area. Tokens of /l/ in word-initial onset and word-final coda positions were analysed acoustically. The results show cross-linguistic differences in onset position and that such differences were found to be greater in the speech of female participants and those from North West Wales. Differences were also found between Welsh-dominant and English-dominant communities. These results are discussed with reference to the influence of extra-linguistic factors on speech production and the possible social meaning associated with dark /l/.

Mae'r astudiaeth hon yn archwilio /l/-dywyll yng Nghymraeg a Saesneg siaradwyr dwyieithog yng Ngogledd Cymru. Er y dywedir bod /l/ yn dywyll ar ddechrau ac ar ddiwedd sillafau mewn amrywiadau gogleddol ar y ddwy iaith, ni wnaethpwyd unrhyw astudiaethau meintiol o'r nodwedd hon sy'n ystyried gwahaniaethau rhwng y ddwy iaith, gwahaniaethau cyffyrddiad iaith rhwng Gogledd Ddwyrain a Gogledd Orllewin Cymru, a gwahaniaethau caffael iaith rhwng siaradwyr. Mae'r set ddata yn cynnwys 32 o siaradwyr dwyieithog Cymraeg-Saesneg rhwng 16 a 18 mlwydd oed. Gwahaniaethwyd rhwng rhyw'r siaradwr, iaith ar yr aelwyd, ac ardal. Dadansoddwyd /l/ ar ddechrau ac ar ddiwedd sillafau gan ddefnyddio dulliau acwstig. Dengys y canlyniadau y ceir gwahaniaethau rhwng y ddwy iaith ar ddechrau'r sillaf a bod y gwahaniaethau hyn yn fwy yn lleferydd cyfranogwyr benywaidd. Darganfuwyd hefyd y ceir gwahaniaethau rhwng ardaloedd. Trafodir dylanwad ffactorau allieithyddol ar leferydd a'r ystyr gymdeithasol bosibl a gysylltir ag /l/-dywyll [Welsh].

1 INTRODUCTION AND BACKGROUND

Previous work has shown that a categorical distinction can be made between 'light' and 'dark' realisations of /l/. The production of light /l/ involves an apicoalveolar closure whereas dark /l/ involves both an apicoalveolar and either a dorsovelar or dorsopharyngeal constriction (Recasens, Fontdevila and Dolors Pallarès 1995:38). This binary distinction leads to a three-way classification between languages with light realisations of /l/ in all syllable positions (e.g. German, Spanish, French and Italian), those with dark realisations (e.g. Catalan), and those where light allophones occur in word-initial onset position and dark allophones in word-final coda position (Recasens 2012: 368). Dialectological descriptions of varieties of English in England show that the patterning of /l/ varies regionally and that the clear allophonic distinction which is found in many southern English dialects (and RP) does not exist in more northern varieties (Wells 1982: 370). In northern varieties of both Welsh and English in Wales, dark /l/ is expected in all syllable positions in both languages (Jones 1984: 49; Thomas and Thomas 1989: 33-34; Ball and Williams 2001: 112; Hannahs 2013:19; Wells 1982: 390). In northern dialects of Welsh English, particularly dark /l/ has been said to occur in north-western areas where the concentration of Welsh speakers is highest (Penhallurick 2008: 118). This differs from southern areas where light /l/ is expected in both onset and coda position in both languages (e.g. Ball and Williams 2001: 112; Carter and Cooper 2012) or (in the case of some south-eastern areas) where there is an allophonic distinction in English between light /l/ in onsets and dark /l/ in codas (Wells 1982: 390).

This study presents an acoustic phonetic analysis of /l/ in the Welsh and English of bilinguals aged 16-18 in North Wales. The secondary constriction involved in producing dark /l/ is seen acoustically in higher F_1 and lower F_2 values. Higher F_1 is said to be a correlate of the predorsum and jaw lowering whereas F_2 decreases with tongue body backing (Recasens

et al. 1995: 41; Recasens 2012: 369). Crucially, previous articulatory and acoustic phonetic work has shown that /l/-darkening (the *degree* to which productions of /l/ are velarised or pharyngealised, see Turton 2014: 41) is also a gradient feature (Recasens 2004) which may vary cross-linguistically and which can be influenced by linguistic and community-specific social factors (e.g. Slomanson 2004; Simonet 2010; Stuart-Smith, Timmins, and Alam 2011; Van Hofwegen 2011; Davidson 2012, 2015; Kirkham 2013; Marotta 2014; Nance 2014; Thomas and Van Hofwegen 2014; Kirkham and Wormald 2015) [2].

The study aims to ascertain (1) whether the production of /l/ in both languages is susceptible to the linguistic influences found in previous phonetic studies and (2) the extent to which the linguistic and social conditioning of /l/ variation can be explained with reference to the social context of Welsh-English bilingualism in North Wales. Specifically, the study focusses on two towns which differ in the extent to which Welsh is spoken and includes both speakers from Welsh-speaking homes and speakers from English-speaking homes who have acquired Welsh through formal education. The remainder of this section presents a brief overview of Welsh and Welsh English. Section 2 outlines the socio-cultural background of the two towns chosen for the study and backgrounds of the speakers, and provides information on the methodology. Section 3 comprises the results of the analysis and Section 4 discusses the results with reference to the research aims.

1.1 Welsh and Welsh English in North Wales

The sociocultural history of Welsh and English across Wales can (until the twentieth century) be described with reference to historical Anglicisation as English gradually gained prestige amongst the gentry (Jones 1993: 540). This was accompanied by language shift and the westward retreat of Welsh which intensified as the Industrial Revolution brought mass

inward migration to the eastern lowland areas and as English-medium education became systematised. Despite the continued existence of Welsh-speaking communities in eastern areas, the areas with the highest proportions of Welsh speakers (who are now bilingual in English) tend to be located in the west and particularly in the north-western county of Gwynedd (Carter and Williams 1978: 150).

Despite dialectal differences between north-western and north-eastern varieties of Welsh (see Thomas and Thomas 1989 for an overview), the linguistic consequences of language contact are mainly attested in varieties of Welsh English in the region. Welsh influence on the English spoken throughout Wales is thought to differ according to the history of language contact in the area (Mees and Collins 1999: 185-186) with a Welsh influence being strongest in predominantly Welsh-speaking areas as transfer effects from bilinguals and weakest in other areas as substrate effects (Thomas 1997: 67; Paulasto 2006). Transfer features in North West Wales are said to include lengthened post-stress consonants (Webb 2012), the lack of a phonemic distinction between [ə] and [ʌ] in stressed vowels (Welsh has no [ʌ] vowel, see Penhallurick 2008: 111), heavily velarised or pharyngealised /l/ (Penhallurick 2008: 118), Welsh variants of /r/, and the realisation of /r/ in coda position (Wells 1982: 390). Transfer effects from Welsh do not appear to be as salient in north-eastern dialects of English in Wales which are also said to include features from neighbouring dialects in North West England such as the STRUT-FOOT merger and 'velar nasal plus' (whereby the velar plosive is realised following a nasal in words such as 'sing' [sɪŋg], see Wells 1982: 351; Thomas 1994: 112-113). Work in perceptual dialectology has also shown that speakers (and especially those from North Wales) tend to differentiate between north-western areas which they perceive as heavily influenced by Welsh and north-eastern areas which they classify as 'Scouse' (the name for the accent of the English city of Liverpool and

its suburban area, which borders parts of North East Wales, see Williams, Garrett & Coupland 1996; Garrett, Coupland & Williams 1999).

Despite a lack of recent work in the variationist paradigm in either Welsh or English in North Wales, an examination of Welsh-English bilingual speech is timely in light of changes to the demography of the Welsh language. Both inward migration to western areas by those who do not speak Welsh, and the establishment of bilingual and Welsh-medium schools in the latter half of the twentieth century across Wales (Jones 1998: 17), means that the number of Welsh-speaking families is declining and the majority of children in Welsh-medium education have not acquired Welsh via parental transmission (Jones 2008: 550). This gives rise to interesting dynamics between those from Welsh-speaking and English-speaking backgrounds in different communities and especially young people in Welsh-medium education where both those from Welsh-speaking and English-speaking homes are taught together (Musk 2006; Morris 2014). In previous work on (r) variation in the current dataset, Morris (2013) found that the realisation of coda /r/ as well as the Welsh variants [r] and [ɾ] in non-coda position (noted as being features of north-western dialects of Welsh English, see above) were found only in the English speech of those from Welsh-speaking homes in the North West whereas the English [ɹ] was found in the Welsh of all speakers (Morris 2013: 259). A question for the current study is whether such patterns of phonological variation influenced by home language are evident for /l/ as well as /r/.

2 COMMUNITIES AND METHODS

As stated in Section 1.1, previous work has shown that there are clear accentual differences between the English of the North West, where accentual features are more likely to show a clear Welsh influence, and the English of the North East where Welsh influences exist as a

substrate and dialects also include features from neighbouring English dialects. In order to examine the extent to which areal differences are present in the production of /l/ in both the English and Welsh of bilinguals, the study compares data collected in a town in North West Wales with data from North East Wales. The north-western town of Caernarfon and the north-eastern town of Mold (*Yr Wyddgrug*) were chosen as they had comparable population sizes (around 10,000). Figure 1 shows the area under discussion.

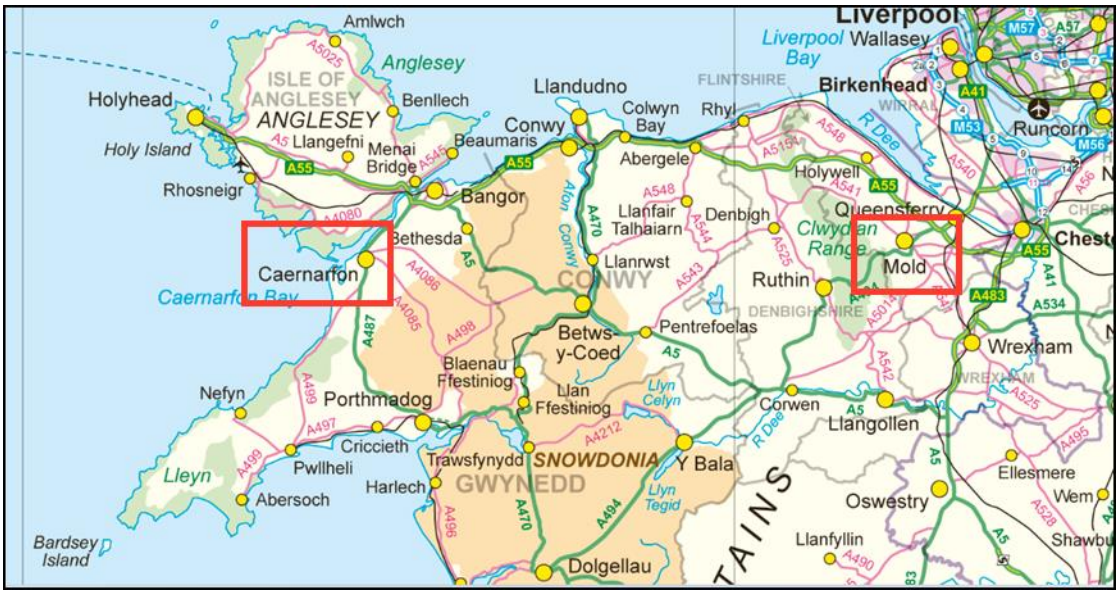

Figure 1: North Wales. Contains Ordnance Survey Data © Crown copyright and database copyright 2012 (created from 1: 1,000,000 scale digital data).

2.1 Communities

Caernarfon is frequently cited as the most Welsh-speaking town in Wales (Davies, Jenkins, Baines and Lynch 2008: 104-105). 80.6% of the population are reported as being able to speak Welsh and it is the predominant language of the town regardless of age or socioeconomic background (Office for National Statistics 2012). Consequently, Caernarfon remains one of the few places where both family and social lives are more likely to be lived wholly through the medium of Welsh. Given the linguistic nature of the town, and in keeping with the county's education policy, all schools in Caernarfon use Welsh as the primary

language of instruction (Gwynedd Council 2015) meaning that all young people are able to speak Welsh regardless of home language.

Mold is located approximately ten miles from the Welsh-English border and the attestation of English place names as early as 1750 (Aitchison and Carter 1994: 29-31) is one indication of early language shift. 20.8% of the population speak Welsh (Welsh Language Commissioner 2015), meaning that it is not used as the language of the wider community and that its use is restricted to closer knit social networks. For instance, there are local Welsh-medium societies, chapels and community groups (aimed at both fluent speakers and learners) as well as local branches of national organisations which promote the use of Welsh by organising activities in the language for both adults and children. Contrary to the situation in Caernarfon, parents in Mold decide whether to send their children to Welsh-medium schools (where all subjects are taught in Welsh with the exception of English) or English-medium schools (where Welsh is taught as a second language for a few hours each week).

2.2 Speakers

Speakers were aged between 16 and 18 at the time of data collection and were recruited from local schools where most subjects were delivered in Welsh. All speakers had therefore either acquired Welsh at home and/or had received all of their education through the medium of Welsh. A random stratified sampling approach was taken to participant recruitment in order to examine the possible effects of speaker sex and home language in addition to area. A binary distinction was made between speakers who spoke only Welsh at home and those who spoke English at home. Table 1 shows the composition of the dataset. Students who fitted the profile of each cell were approached either by the author (a Welsh-English bilingual from

North East Wales) or teacher and those who were available for two recording sessions, one in Welsh and one in English, were recruited.

Table 1: The sample

	Caernarfon		Mold	
	Male speakers	Female speakers	Male speakers	Female speakers
Welsh at home	4	4	4	4
English at home	4	4	4	4

Given the focus on potential differences between Caernarfon and Mold, and the two home-language groups, rather rudimentary information was collected on speakers' backgrounds via questionnaire and during the interview. Admittedly, this information does not allow me to present a full analysis based on ethnographic observation (e.g. Eckert 1988). Particularly, more information on speakers' and parents' socio-economic background and social networks would have been useful given the variation which will be shown to be present in the English of bilinguals (see Section 3).

The data do show, however, that home language and, to a lesser extent area, were highly correlated with speakers' language use outside of the classroom (see Morris 2014). This supports the results of previous work which show that Welsh is more likely to be spoken on a daily basis by speakers who come from Welsh-speaking homes and who live in areas where over 60% of the population speak the language (Jones 2008: 552). Speakers from Welsh-speaking homes in Caernarfon mostly reported little use of English in their everyday

lives. In fact, some participants from this group expressed embarrassment about how they spoke in English and said that they did not feel confident speaking the language. This was not the case for those from Welsh-speaking homes in Mold, where Welsh was used much less outside of the family and some social networks. In the case of those from English-speaking homes in both Caernarfon and Mold, the speakers reported using little Welsh outside of the classroom.

The reported language use among the different groups matched my own observations and the peer-group dynamics in both areas. In Caernarfon, attitudes towards Welsh and English were expressed more frequently during the interviews. Some speakers from Welsh-speaking homes commented on the increased use of English in the area and the use of English among different gangs. Three speakers from English-speaking homes expressed overtly negative views towards Welsh and members of both groups commented on the 'funny' way in which English is spoken in the local area. Unsurprisingly perhaps, peer group membership in Caernarfon tended to be based on language (Morris 2014: 82). In Mold, it was clear that English was the main language of peer-group interaction and little attention was paid to the issue of bilingualism in the wider community and local accents of English and Welsh.

The accentual differences noted in previous descriptions of North West and North East Wales were found in the dataset. As noted in Section 1.1, the transfer of Welsh variants of /r/ was found in the English of speakers from Welsh-speaking homes in Caernarfon (Morris 2013: 259). Impressionistic observations included a more Welsh-influenced patterning of stress in Caernarfon and particularly (though not exclusively) among those from Welsh-speaking homes (cf. Webb 2012). In the English of speakers in Mold, two features associated with northern varieties of English in England, merged STRUT and FOOT vowels and 'velar nasal plus' (see Section 1.1) were observed.

2.3 Data

Data were collected by sociolinguistic interview and wordlist tasks in both languages. The decision to include both the data from the interview and wordlist tasks was taken due to the differences found in previous studies where darker /l/ carries social meaning for speakers (Davidson 2012; 2015, though not for English or Welsh) and due to the results for (r) variation in the current dataset where speakers were more likely to produce the Welsh alveolar tap or trill when they were reading words more carefully in Welsh than during their interview (Morris 2013: 248).

The Welsh and English sessions took place at different times. Each recording session lasted on average 35 minutes and was recorded on a Zoom H2 recorder. All interviews were recorded in WAV format with a sampling frequency of 44,100 KHz and 28 Bit quantization. An omnidirectional Audio-Technica Lavalier microphone with 50 - 18,000 Hz frequency response and -54 dB sensitivity was also used. Data were transferred to laptop computer and transcribed in ELAN (Sloetjes and Wittenburg 2008).

2.4 Tokens

In each interview, 60 tokens containing /l/ in all word and syllable positions were identified and transcribed. A further 60 tokens were transcribed from the word-list data (n = 7680). No more than three instances of the same word in each interview were transcribed. There were instances of within-clause (or intra-sentential) code-switching in the Welsh data (Deuchar 2005: 255-256) and 43 tokens of the English discourse marker ‘like’ were found. These tokens were not transcribed or included in the study.

All tokens were inspected auditorily and acoustically and unclear instances of /l/ were removed from the dataset. A total of 388 tokens were removed (5.1% of the dataset) at this

stage, the majority of which (n = 228) were tokens from which a reliable spectrogram reading could not be obtained due to background noise (for example, someone entering the room or the school bell). 155 tokens were removed as they were judged to be partially or fully devoiced upon examination of the spectrograms. Such tokens occurred in the context of voiceless stops (e.g. *tlws* 'pretty') but devoicing did not happen categorically in this context. Given the relatively small number of voiceless tokens and the aims of the study, the devoicing of /l/ is not investigated here. Similarly, a further 5 tokens, from two speakers' Welsh data, were judged impressionistically to be vocalised (see Hall-Lew and Fix 2012 on the difficulties of differentiating between dark and vocalised instances of /l/ acoustically) and were removed. Syllable stress was also coded for impressionistically at this stage.

Previous work across various languages has shown that the realisation of /l/ tends to be lighter in word-initial syllable onset than in word-final syllable coda position regardless of whether /l/ is categorically light or dark (Recasens 2012: 381). A subset of the dataset is used in this study in order to control for word and syllable position. Table 2 defines the syllable positions in which /l/ occurred in the final dataset and gives token examples.

Table 2: The dataset

Position	***N***	**Welsh examples**	**English examples**
Word-initial onset (including clusters) when preceded by a pause or a stop and followed by a vowel (C_V and #_V positions).	1572	*Lwc* 'Luck' *Lol* 'Nonsense' *Blaen* 'Front' *Glas* 'Blue'	Look Lump Clean Glass

Position	***N***	**Welsh examples**	**English examples**
Word-final coda when preceded by a vowel and followed by a pause or consonant (V_# and V_C# positions).	2399	*Ysgol* 'School' Haul 'Sun' Diogel 'Safe' Gweld 'To see'	Actual Idol Shameful Mold

As Table 2 shows, the word-initial tokens also include cases where /l/ occurred in onset clusters with stops (e.g. *blow*, *clean*). Many previous studies across languages, and particularly those which focus on an allophonic distinction between light and dark /l/ (Huffman 1997: 116), compare /l/ in absolute word-initial position (where /l/ may be light) with tokens in word-final coda position (where /l/ is typically dark) or include a number of phonological and/or morphosyntactic environments as separate factors (e.g. /l/ in word-initial clusters). The current study is, however, concerned with *phonetic* rather than *allophonic* variation (cf. Sproat & Fujimura 1993) in two languages in which /l/ is said to be universally dark. For this reason, it was decided to include syllable position as an independent factor to neighbouring consonant. The influence of neighbouring consonants is less clear than that of syllable position though some studies have shown that /l/ tends to be darker in the context of velar and labial consonants when compared to coronals (Giles and Moll 1975; Scobbie and Wrench 2003; Davidson 2012). In the statistical modelling, interactions were tested between syllable position and neighbouring consonant in order to examine the relative influence of both (1) syllable position and (2) neighbouring consonant independently in addition to (3) both syllable position and neighbouring consonant (see Section 3).

2.5 Acoustic analysis

Tokens were analysed acoustically using Praat (Boersma and Weenink 2015), which was set to 0.025 seconds window length, 30.0dB dynamic range, and 1.0mm dot size. The formant range was set to 0-4000Hz. When /l/ occurred in word-initial onset position, a marker was placed at the onset of voicing. Another marker was placed at the end of the transition out of the lateral where F_2 had stabilised and intensity had increased for the onset of the vowel. When /l/ occurred in word-final coda position, a marker was placed at the beginning of the transition into the lateral which was characterised by a decrease in intensity and a transition in the F_2 (Carter and Local 2007: 467). The end of the lateral was marked at the point where there was a drop in intensity and where regular periodic phonation ended (De Leeuw 2009: 101). The labelling of the onset of /l/ in coda position can be particularly difficult as the transitional phase is very gradual (De Leeuw 2009: 101; Turton 2014: 101). In addition, a possible schwa off-glide can occur between the vowel and dark /l/ in this position (Turton 2014: 46). Unlike in Cardiff Welsh English (Mees and Colins 1999: 193), where a clear break is noted before the final /l/, this was not the case in these data. Figure 2 shows an example of how the data were segmented.

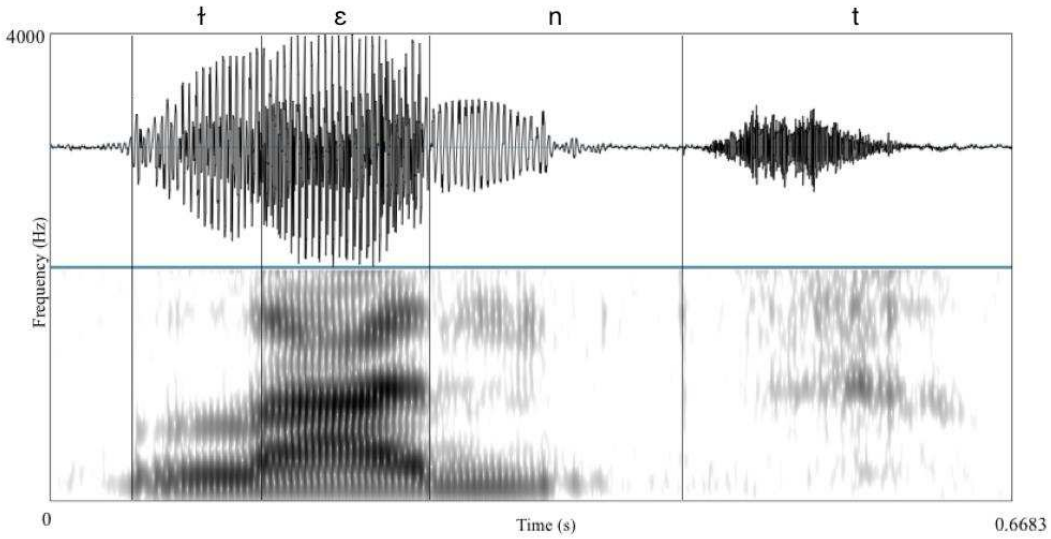

Figure 2: Spectrogram showing segmentation of the word 'lent'

As stated in Section 1, darkening correlates acoustically with higher F_1 and lower F_2 values. This study uses the difference between Bark-transformed F_2 and F_1 values (Traunmüller 1990) taken at the midpoint of the lateral (Simonet 2010; Van Hofwegen 2011; Nance 2014). Lighter tokens of /l/ have higher F_2-F_1 (Bark) values compared to darker tokens.

Duration effects have also been noted in certain varieties of English with /l/ being lighter in tokens with a shorter duration (Sproat and Fujimura 1993; Van Hofwegen 2011; Yuan and Liberman 2011). The duration of the /l/, as labelled in Figure 2, was also extracted and the log-transformed data were used in the analysis. Log-transformed durations are used in many phonetic studies in order to centralise data (Rosen, 2005). Skewness and Shapiro-Wilk tests data confirmed that the log-transformed data were less skewed than the linear durational data but that both were skewed in onset (p <.001) and coda positions (p <.001). Both linear and log-transformed duration were included in the statistical analyses in separate models in order to ascertain whether this affected the overall results. As it did not, log-durations were used in the models reported here based on the Skewness test results and in order to enable comparison with other studies (e.g. Van Hofwegen 2011; Turton 2014).

Neighbouring vowels have also been shown to influence the degree of /l/-darkening cross-linguistically with lighter productions expected in the context of front vowels (e.g. Oxley, Buckingham, Roussel and Daniloff 2006; Van Hofwegen 2011; Davidson 2012). This influence is, however, weaker for dark /l/ than light /l/ (Recasens and Espinosa 2005). In order to assess possible coarticulatory effects, the F_2 value of the preceding or following vowel was taken at 30ms into the onset or offset or the vowel. Taking measurements at 30ms is arbitrary, but allowed formant values to be taken at the steady state of the vowel. This measurement was then transformed into Bark (Traunmüller 1990) and was normalised by calculating the difference between the Bark-transformed F_2 of the vowel and the Bark-

transformed F_2 of the preceding or following /l/ (Van Hofwegen 2011: 383). A higher normalised F_2 value corresponds to a fronter vowel.

The formant and durational data were extracted using automated Praat scripts. 40% of tokens in onset (n = 629) and coda positions (n = 960) were manually checked. No durational errors were found. Formant errors were found in 11.3% (n = 71) of onset tokens and 15% of coda tokens (n = 144). Of these errors, 92% (n = 198) were caused by serious errors in the formant tracking. Such errors included tokens where small differences between F_1 and F_2 (mainly in coda position) led to the same values being recorded in both instances or where the formant tracker failed to extract F_2. In the remaining cases (n = 17), formant values were corrected in cases where my judgement differed from any of the values extracted by the formant tracker by 50Hz[3]. Where errors were found, F_1 and F_2 values for the token were calculated manually and included in subsequent analyses. The errors found are problematic considering the fine-grained phonetic data upon which the results are based and should be kept in mind. Having said that, gross errors have been rectified and any values which differed from the speaker's mean in each syllable position and language by 50Hz or more have been subsequently checked and found to be correct.

2.6 Statistical testing

Mixed effects linear regression analyses were conducted on the data in R (R Core Team 2015) using the lme4 (Bates, Maechler, Bolker and Walker 2016) and lmerTest (Kuznetsova, Brockhoff and Christensen 2016) packages in RStudio. Mixed-effects modelling was chosen as it is able to deal with continuous data (F_2-F_1 (Bark) and coarticulation measures in this study) and distinguish between fixed and random effects (Baayen 2009: 241). Fixed effects (e.g. speaker home language) are those factors which are replicable in further studies whereas

random effects (such as speaker and word) are sampled randomly (Baayen 2009: 241). By including speaker and word as random effects, the modelling is able to account for inter-speaker or inter-item variation when predicting which factors influence variation (Johnson 2009: 365).

A series of models were fitted to predict the influence of linguistic and extra-linguistic factors on the Bark-transformed F_2-F_1 (the degree of darkening). Speaker and word were included as *random* effects in all models. Table 3 shows the independent variables included as *fixed* effects in the modelling and the levels of those factors taken as the baseline. Interactions between the main fixed effects were also tested. Step-up modelling was applied to the dataset whereby predictors were added to the model one at a time and were retained in if they significantly improved the model based on the results of a log-likelihood test (Strycharczuk 2015: 90).

The best-fitting models are presented in the results section which follows. The individual results tables show the fixed factors (independent variables) which are significant predictors of F_2-F_1 (Bark) and the coefficients (β), *t*-values and *p*-values for the levels associated with each factor. Taking into consideration the random factors (see above), these coefficients represent a deviation from the baseline (see Table 3 for the levels for each factor taken as the baseline). A positive significant coefficient indicates that there is a correlation between the level(s) not taken to be the baseline and lighter /l/. In the case of the continuous independent variable of coarticulation (which does not comprise different levels), a positive coefficient indicates that as the coarticulation measure increases by one, the F_2-F_1 (Bark) changes by the coefficient value (either increasing or decreasing). Similarly, a negative significant coefficient indicates that the level(s) not included as the baseline are more likely to influence the production of a darker /l/.

Table 3: Independent Variables included in the analysis of /l/-darkening

Factor	**Levels**	**Explanation**	**Baseline in the statistical modelling**
Syllable position	Coda	Darker realisations of /l/ are expected in coda position (e.g. Recasens 2012: 369).	Coda
	Onset		
Coarticulation	Difference between Bark-transformed F_2 values at 30ms into onset/offset of neighbouring vowel and F_2 and /l/ midpoint.	Lighter realisations of /l/ are expected preceding or following fronter vowels. Front vowels have a higher F_2 and there is a greater difference between the F2 of the vowel at the F2 at the midpoint of the /l/ (e.g. Van Hofwegen 2011: 383).	N/A
Log-duration	Log-transformed duration of /l/	Some studies have found that longer realisations of /l/ tend to be darker (e.g. Sproat and Fujimura 1993) although this is not always the case (see Van Hofwegen 2011: 376).	N/A
Syllable stress	Stressed	There is a possibility that /l/ will be darker in stressed syllables	Stressed
	Unstressed		

		due to hyperarticulation (see Davidson 2012: 325).	
Neighbouring consonant	Coronal Glottal Labial None Uvular Velar	Some studies have found that /l/ is darker when produced preceding or following velar or labial consonants (e.g. Davidson 2012: 325).	Coronal
Sex	Female Male	/l/ has often been found to be lighter in the speech of female speakers (e.g. Fitch and Giedd 1999:1512) or for the patterning of darker /l/ to be different in women's speech (e.g. Marotta 2014).	Female
Language	English Welsh	As /l/ is expected to be dark in northern varieties of both languages, data from the English and Welsh recording sessions were included in order to ascertain whether there were any cross-linguistic differences.	English
Home Language	English Welsh	Linguistic background has been found to be significant in	English

		previous studies of /l/ in bilingual speech (e.g. Simonet 2010) and of (r) variation in North Wales (Morris 2013).	
Area	Caernarfon Mold	/l/ has been reported as being darker in the English of Gwynedd (the county in which Caernarfon is located) where a strong Welsh-influenced English is expected (Penhallurick 2008: 118).	Caernarfon
Task	Interview Word-list	Difference between interview and word-list tasks have been found in communities where /l/-darkening is socially stratified (Davidson 2015: 155).	Interview

3 RESULTS

The best-fitting model of /l/-darkening in Welsh-English bilingual speech included a four-way interaction between language, syllable, area, and speaker sex. Log-duration and task were not significant and did not significantly improve the fit of the model. They were therefore removed. The full model is included in Appendix 1. As stated in Section 2.6, speaker and word were included as random factors.

Three of the main effects were found to be significant. Firstly, the model indicates that /l/ was lighter in onset than in coda position ($\beta = 0.88$, $t = 6.39$, $p < 0.001$). The mean for onset tokens was 4.12 Bark compared to 3.5 Bark for tokens in coda position (recall that higher F_2-F_1 (Bark) values indicate lighter /l/). This yielded a mean difference of 0.62 Bark between onset and coda positions. Secondly, coarticulation was found to be a significant factor. The model therefore indicates that higher F_2 frequencies in the preceding or following vowel (associated with fronter vowels) resulted in lighter productions of /l/ ($\beta = 0.43$, $t = 37.85$, $p < 0.001$). Thirdly, /l/ was also significantly darker when produced without an adjacent consonant when compared to /l/ occurring in the context of coronal consonants ($\beta = -0.33$, $t = -5.19$, $p < 0.001$). The mean value for /l/ adjacent to coronals was 4.1 Bark compared to 3.55 Bark where there was no adjacent consonant (a mean difference of 0.55 Bark).

There were also significant interactions between a number of the factors included in the model. In particular, the interaction between syllable position and neighbouring consonant was significant when comparing coronals and no adjacent consonant ($\beta = 0.32$, $t = 3.46$, $p < 0.001$). This suggests that the difference between the two is greater in either onset or coda position. Furthermore, there was a significant interaction between language, syllable position and sex ($\beta = 0.57$, $t = 3.61$, $p < 0.001$) and language, syllable position and area ($\beta = 0.34$, $t = 2.11$, $p = 0.035$).

The results of the regression model show the clear influence of linguistic factors, namely syllable position, coarticulation and to a lesser extent neighbouring consonant on /l/-darkening in Welsh-English bilingual speech. The interactions also show, however, that there are differences in the extent to which linguistic and extra-linguistic factors influence /l/-darkening in onset and coda positions. In order to interpret these interactions, mixed-effects

modelling was conducted on the onset and coda data separately. The alpha level for these models was adjusted via Bonferroni correction ($\alpha = 0.025$) and are presented below.

In order to investigate the linguistic and extra-linguistic influences on /l/-darkening in word-initial onset position ($n = 1572$), a regression model was fitted which included /l/-darkening as the dependent variable and neighbouring consonant, area, language, speaker sex, home language, syllable stress, coarticulation, task, and log-duration as independent variables. The latter two factors were removed from the analysis during the modelling. Again, speaker and word were set as random factors and interactions between language, speaker sex, area and home language were included. The results of the regression modelling on the subset of onset tokens are shown in Table 4.

Table 4: Regression coefficients with *t* and *p* values for the model predicting /l/-darkening of onset tokens.

Term	**Level**	***β***	**SE**	***t***	***p***
(Intercept)		5.58	0.19	29.66	<0.001
Neighbouring consonant	Labial	-0.11	0.14	-0.80	0.425
	None	-0.11	0.08	-1.32	0.189
	Velar	-0.19	0.16	-1.19	0.236
Area	Mold	-0.30	0.21	-1.45	0.158
Language	Welsh	-0.89	0.13	-6.92	<0.001
Sex	Male	-0.61	0.21	-2.92	0.006
Home language	Welsh	-0.20	0.14	-1.40	0.174
Syllable stress	Unstressed	0.30	0.25	1.24	0.219
Coarticulation	+1	0.36	0.02	20.36	<0.001
Area * Language	Mold, Welsh	0.39	0.12	3.26	0.001

Area * Sex	Mold, Male	0.06	0.30	0.21	0.834
Language * Sex	Welsh, Male	0.36	0.12	3.08	0.002
Area * Language * Sex	Mold, Welsh, Male	-0.07	0.17	-0.39	0.700

Welsh tokens tended to be darker than English tokens in onset positon (β = -0.89, t = -6.92, p <0.001). The mean F_2-F_1 (Bark) value for Welsh was 3.93 Bark compared to 4.29 Bark in English (a mean difference of 0.36 Bark). As seen in previous studies, male speakers tended to producer darker tokens of /l/ in onset position than female speakers (β = -0.61, t = -2.92, p <0.006). The mean F_2-F_1 (Bark) value was 3.89 Bark for the former group compared to 4.34 Bark for the latter group (a mean difference of 0.45 Bark). As suggested in the model conducted on the entire dataset, /l/ tended to be lighter when preceding fronter vowels as shown in the significance of coarticulation in Table 4 (β = 0.36, t = 20.36, p <0.001). There is no significant influence, however, of the presence of a preceding consonant (or indeed preceding consonant type) on the onset data subset.

Interestingly, there were significant interactions between language and area (β = 0.39, t =3.26, p = 0.001) and language and sex (β = 0.36, t =3.08, p = 0.002). The interaction between language and area is are explored further in Figure 3.

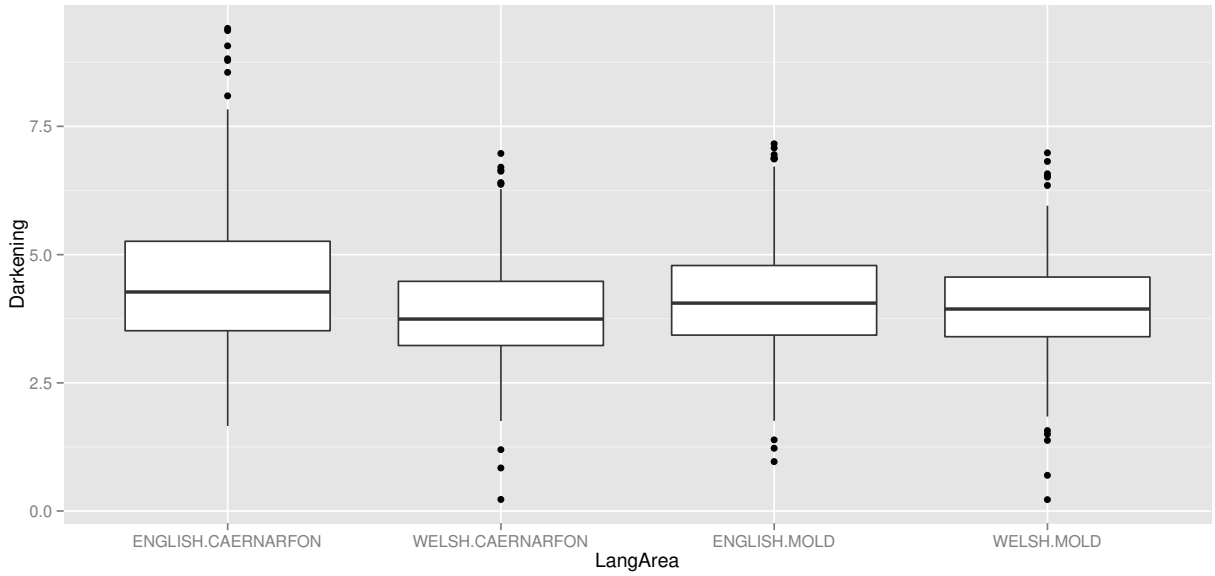

Figure 3: F2-F1 (Bark) Values of /l/ in onset position by language and area (Caernarfon or Mold).

The interaction between area and language indicates that there are greater differences between Welsh and English in Caernarfon than there are in Mold. The mean F_2-F_1 (Bark) value for Welsh in Caernarfon was 3.89 Bark compared to 4.44 Bark in English. In Mold, the F_2-F_1 (Bark) value for Welsh was 3.98 Bark compared to 4.13 Bark in English. This yields a difference of 0.55 Bark between Welsh and English in Caernarfon compared to 0.15 Bark in Mold. Figure 4 explores the interaction between language and speaker sex.

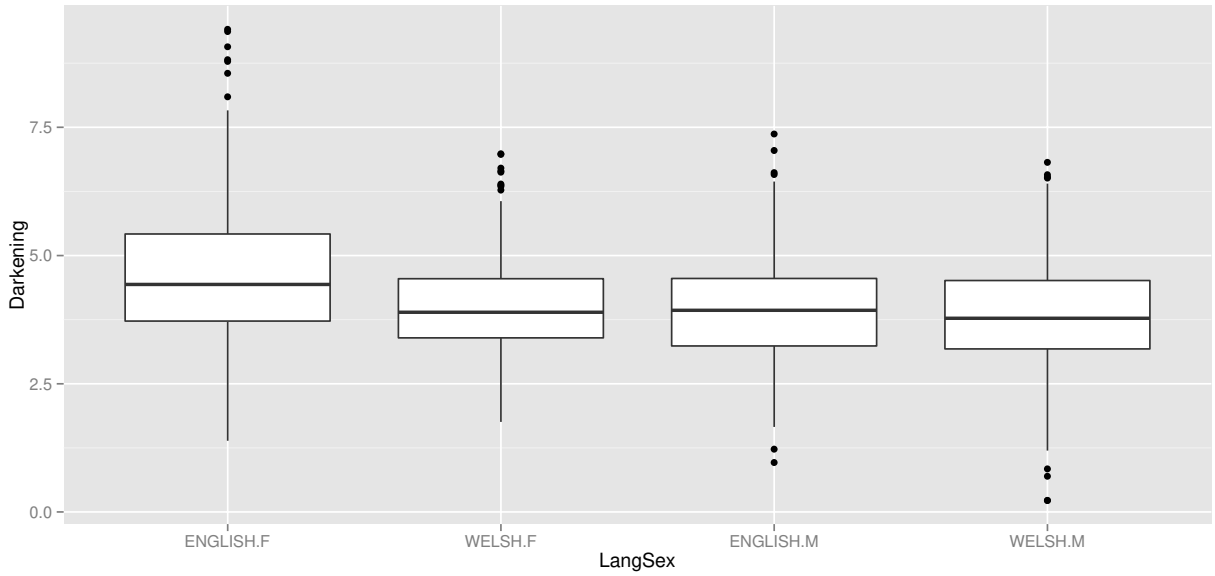

Figure 4: F2-F1 (Bark) Values of /l/ in onset position by language and speaker sex.

The interaction between speaker sex and language, explored in Figure 4, suggests that the influence of language was different for female and male speakers. An examination of the mean F_2-F_1 (Bark) values suggests that female speakers differentiated more between the two languages. The mean F_2-F_1 (Bark) value for this group was 4.0 Bark in Welsh compared to 4.63 Bark in English (a mean difference of 0.63 Bark) compared to 3.86 Bark in Welsh and 3.92 Bark in English for male speakers (a mean difference of 0.06 Bark).

The data subset used for the analysis of /l/ in coda position (n = 2399) contained instances of /l/ found post-vocalically in word-final coda position and preceding a consonant or a pause. In the mixed effects linear regression analyses, the F_2-F_1 (Bark) values were the dependent variable and speaker and word were included as random effects. The independent variables were neighbouring consonant, area, language, speaker sex, home language, syllable stress, coarticulation, task, and log-duration. Again, the latter two factors were removed from the analysis during the modelling. Table 5 shows the results of the best-fitting model.

Table 5: Regression coefficients with *t* and *p* values for the model predicting /l/-darkening of coda tokens.

Term	**Level**	***β***	**SE**	***t***	***p***
(Intercept)		4.65	0.18	26.41	<0.001
Neighbouring consonant	Glottal	-0.16	0.25	-0.65	0.516
	Labial	-0.11	0.10	-1.13	0.258
	None	-0.25	0.07	-3.61	<0.001
	Uvular	-0.07	0.45	-0.16	0.870
	Velar	0.04	0.23	0.16	0.874
Area	Mold	-0.21	0.20	-1.04	0.308
Language	Welsh	-0.10	0.12	-0.83	0.405

Sex	Male	-0.38	0.21	-1.85	0.074
Home language	Welsh	0.02	0.14	0.11	0.913
Syllable stress	Unstressed	-0.18	0.10	-1.72	0.127
Corarticulation	+1	0.46	0.01	31.65	<0.001
Language * Area	Welsh, Mold	0.04	0.10	0.44	0.663
Language * Sex	Welsh, Male	-0.17	0.10	-1.64	0.101
Area * Sex	Mold, Male	0.10	0.29	0.36	0.724
Language * Area * Sex	Welsh, Mold, Male	0.22	0.14	1.52	0.130

The results shown in Table 5 indicate that /l/-darkening in coda position tended to be influenced by linguistic factors only. This differs from the results for /l/-darkening in onset position which found a more complex patterning of variation involving both linguistic (coarticulation) and extra-linguistic factors (area, sex, and language).

Coarticulation was the strongest predictor of /l/-darkening in coda position ($\beta = 0.46$, $t = 31.65$, $p = 0.001$). The model therefore indicates that higher F_2 frequencies in the preceding vowel (associated with fronter vowels) resulted in lighter productions of /l/. A smaller effect was found for neighbouring consonant ($\beta = -0.25$, $t = -3.61$, $p < 0.001$). Similar to the results for the whole dataset, there was a significant difference between /l/ produced before coronal consonants and those produced before a pause but not between coronals and other consonant types. The mean F_2-F_1 (Bark) value for /l/ before a coronal was 3.93 Bark compared to 3.31 Bark for /l/ before a pause (mean difference = 0.62 Bark).

4 DISCUSSION AND CONCLUSION

The mixed-effects modelling indicated that there are fine-grained influences on the production of /l/ in Welsh-English bilingual speech. The linguistic factors shown to be significant have been found in previous acoustic studies of /l/-darkening in other languages. The strongest predictor of /l/-darkening was syllable position, with /l/ being lighter in word-initial onset position. Such findings can be attributed to the differences in tongue position when producing consonants in initial and final positions (Recasens 2012: 369). In addition, /l/ was found to be significantly lighter when neighbouring fronter vowels, and tokens of /l/ produced preceding coronal consonants were found to be lighter than those tokens produced before a pause in word-final coda position. These results support previous work which suggest that adjacent consonants can affect /l/-darkening (e.g. Giles and Moll 1975; Scobbie and Wrench 2003; Recasens and Espinosa 2005; Oxley et al. 2006; Van Hofwegen 2011; Davidson 2012) but do not suggest that there are differences between /l/ in absolute word-initial syllable onsets and /l/ in word-initial stop clusters (see Section 2.4).

The relatively low coefficients shown in the statistical modelling suggest a large degree of phonetic overlap in the data (as shown in Figures 3 and 4). This is not surprising given that /l/ is expected to be dark in both languages in all syllable positions (see Section 1) and may indicate that there are no perceptual differences. A full perceptual or even auditory investigation is not within the scope of the present study. Impressionistically, there were five female speakers from Caernarfon (two from Welsh-speaking homes and three from English-speaking homes) who tended to produce a clearly lighter /l/ in their English compared to both their Welsh and the English of the other groups. The influence of social factors on /l/-darkening and the possibility that /l/ carries socio-indexical meaning in Caernarfon is discussed below.

The fact that speakers' home language was not found to be significant might suggest that /l/ carries little socio-indexical meaning in both Caernarfon and Mold. In a study of Welsh-English bilingual speech in a community in South Wales, Mayr, Morris, Mennen and Williams (2015) examined phonetic variation in the production of monophthongs in Welsh and English. Despite previous studies across languages which have shown that linguistic background can influence phonetic variation in bilingual speech (Mayr et al. 2015: 3), they did not find this to be the case in their data. They state that 'the effects of linguistic experience can be overridden under certain circumstances, and that one of these may be a highly homogeneous peer group with shared values and social practices' (Mayr et al. 2015: 17). While this was also the case in Mold, speakers in Caernarfon were acutely aware of their linguistic background to the extent that peer group membership was largely based on home language (see Section 2.2). In previous work on (r) variation in the same dataset, Morris (2013) found that speakers from Welsh-speaking homes in Caernarfon often produced the Welsh voiced alveolar trill and post-vocalic /r/ when speaking English whereas Welsh features were absent from the speech of those from English-speaking homes and all speakers from Mold. He suggests that this might be due to an orientation away from markedly Welsh English by those from English-speaking homes in Caernarfon and a lack of Welsh influence in the speech of the majority monolingual population in Mold (Morris 2013: 263).

The study has shown, however, that other social factors do influence the production of /l/ and, particularly, that some speakers may differentiate between English and Welsh. A comparison between Caernarfon and Mold was included due to previous work which associated heavily Welsh-accented English with areas such as Caernarfon where a greater proportion of the population speak Welsh (see Section 1.1). Although even the most casual observer would have cause to agree with this in general, the results for /l/-darkening in onset

position indicated, however, that speakers in Caernarfon are more likely to differentiate between their two languages and produce lighter tokens in English.

Similarly, female speakers were found not only to produce lighter tokens than male speakers in word-initial onset position, but their speech also showed greater differences between Welsh and English. This suggests that the differences between the male and female speakers cannot be attributed to the reported tendency for male speakers to have longer vocal tracts which results in lower resonant frequencies (Fant 1960). Morris (2013) found that female speakers in Caernarfon were more likely to produce the Welsh voiced alveolar trill in their Welsh speech compared to male speakers who were more likely to use the English alveolar approximant. The consequence of this was that the female speakers tended to produce the standard variant in their Welsh and differentiate to a greater extent between their two languages when compared to male speakers. Wilson (2014) investigated the production of the realisation of the GOAT and FACE vowels in English by Welsh-English bilinguals from across Wales. Similar to Morris (2013), he found that female speakers were more likely to produce the standard variants ([əʊ] and [eɪ] respectively) than the more localised monophthongal variants.

Despite the somewhat general observation that the results for /l/ and sex in the current study mirror a general tendency for women to orient towards overtly prestigious forms in situations of stable sociolinguistic variation (Labov 2001:264), it is clear that the lack of information on community-specific social structures on both language variation and the creation of socio-indexical meaning (Moore and Carter 2015: 31) is a limitation in the current study. In the case of English, previous work has shown that perceptions of Welsh English dialects are inherently linked with the notion that 'Welshness' is a gradient property (e.g. Williams et al. 1996; Garrett et al. 1999). Accents in North West Wales are categorised as being very Welsh compared to accents in the North East which are not perceived as being

Welsh at all. Interestingly, negative evaluations of north-western accents have been found to be linked to the influence of Welsh which is operationalised in comments which define north-western accents as 'strongly influenced by Welsh', 'nasal' and 'guttural' (Williams et al. 1996: 189). This raises the question as to whether some speakers in North West Wales are acutely aware of speaking a heavily Welsh-accented variety of English which is open to stigmatisation and, in particular, associate heavily velarised or pharyngealised speech as a feature of Welsh which should be avoided in English. The fact that some Caernarfon participants seemed to be more aware of their bilingualism than those in Mold (see Section 2.2), either expressing discomfort in being asked to speak in English (in the case of some participants from Welsh-speaking homes) or negatively evaluating the English spoken in the area would lend support to this claim.

This discussion has implications for studies of bilingual speech communities as it shows that cross-linguistic interactions between languages may be subject to a complex interaction of social factors. This corresponds to the notion of 'language mode' in bilingualism studies, whereby the interaction between a bilingual's two languages will depend on a number of contextual, linguistic, and socio-psychological factors (e.g. Grosjean 1989: 6). By examining the Welsh and English of bilinguals within the variationist paradigm, I hope to have demonstrated that variation may pattern differently in the two languages in a speaker's repertoire and that the driving force of this variation may extend beyond differences in the way the two languages were acquired by individuals into aspects of speaker identity and socio-indexical meaning in specific communities.

NOTES

[1] I would like to thank Dr Maciej Baranowski, Dr Yuni Kim, Prof. Devyani Sharma, and Prof. Erik Schleef for comments on earlier versions of this work. I would also like to thank Dr Patrycja Strycharczuk for her advice on statistical modelling and both the editors and anonymous reviewers for their insightful and constructive feedback and suggestions. Any remaining errors are my own responsibility.

[2] The term /l/-darkening (similar to the terms velarisation and pharyngealisation) refers to degree to which /l/ is produced with a reduced tongue tip gesture and anterior articulation (Recasens 2012: 369; Turton 2014: 27). It is not assumed that light /l/ is the default phonetic position nor that the categorical distinction between light and dark /l/ is misleading.

[3] The decision to correct formant values which differed from my own judgment by 50Hz is arbitrary. It was felt, however, that it would be difficult to reach a final decision in confidence in cases where the extracted formant values which differed from my own judgment by less than 50Hz.

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APPENDIX

Appendix 1: Regression coefficients with *t* and *p* values for the model predicting /l/-darkening across the entire dataset.

Term	**Level**	***β***	**SE**	***t***	***p***
(Intercept)		4.65	0.16	28.86	<0.001
Language	Welsh	-0.12	0.12	-0.96	0.339
Syllable position	Onset	0.88	0.14	6.39	<0.001
Area	Mold	-0.19	0.18	-1.02	0.312
Home language	Welsh	-0.07	0.12	-0.62	0.541
Sex	Male	-0.33	0.18	-1.78	0.082
Syllable stress	Unstressed	-0.16	0.10	-1.58	0.116
Coarticulation	+1	0.43	0.01	37.85	<0.001
Neighbouring consonant	Glottal	-0.18	0.25	-0.71	0.476
	Labial	-0.11	0.10	-1.14	0.255
	None	-0.33	0.06	-5.19	<0.001
	Uvular	-0.07	0.45	-0.15	0.882
	Velar	0.02	0.23	0.10	0.918
Language * Syllable position	Welsh, Onset	-0.69	0.17	-3.98	<0.001
Language * Sex	Welsh, Male	-0.21	0.10	-2.03	0.043
Syllable position * Sex	Onset, Male	-0.33	0.12	-2.81	0.005
Language * Area	Welsh, Mold	0.04	0.10	0.38	0.703
Syllable position * Area	Onset, Mold	-0.11	0.11	-0.93	0.351

Area * Sex	Mold, Male	0.06	0.26	0.22	0.828
Syllable position * Neighbouring consonant	Onset, Labial	0.08	0.17	0.45	0.650
	Onset, None	0.32	0.09	3.46	<0.001
	Onset, Velar	-0.18	0.28	-0.63	0.526
Language * Syllable position * Sex	Welsh, Onset, Male	0.57	0.16	3.61	<0.001
Language * Syllable position * Area	Welsh, Onset, Mold	0.34	0.16	2.11	0.035
Language * Area * Sex	Welsh, Mold, Male	0.25	0.14	1.78	0.075
Syllable position * Area * Sex	Onset, Mold, Male	0.03	0.16	0.20	0.839
Language * Syllable position * Area * Sex	Welsh, Onset, Mold, Male	-0.33	0.22	-1.48	0.140