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Bilingual language exposure and the peer group: Acquiring phonetics and phonology in Gaelic Medium Education

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Abstract

Aims and objectives: This paper aims to examine the acquisition of phonetics and phonology in the context of Scottish Gaelic immersion schooling. I explore the effect of differing home language backgrounds among primary school children on the production of laterals and stop consonants.
Design/methodology/approach: Acoustic analysis was performed on Gaelic and English speech data collected from children in Gaelic Medium Education in the Outer Hebrides, Scotland.
Data and analysis: Word list data were collected from 18 children aged 7–11 and analyzed using measurements of formants and duration of stop phases. Half of the sample had little or no exposure to Gaelic in the home, while the other half had differing degrees of family input. Statistical analysis was conducted using Conditional Inference Trees.
Findings and conclusions: This study finds that any initial differences between children who enter Gaelic Medium Education as fluent speakers and those who do not are leveled out by late primary school, at least in terms of pronunciation. I suggest that leveled varieties of minority languages can develop in pre-adolescence in peer group settings such as minority language education.
Originality: This study is the first to examine phonetic and phonological acquisition in Gaelic-English bilingual children. It is one of a small number of studies to examine bilingual phonological acquisition in immersion schooling. The study supports recent research exploring the development of peer group varieties among young minority language speakers.
Significance and implications: This research aims to expand traditional models that consider the extent of exposure to two languages as key in predicting phonetic and phonological production. I suggest that the impact of the peer group and the context of language use are also significant factors. Results suggest potential development of education varieties of Gaelic. These findings have implications for future revitalization strategies for minority languages across the world.

Keywords

Scottish Gaelic, phonetics, laterals, stops, acoustics, Celtic

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Introduction

A central question for studies of bilingual language production is the relative contribution of different language exposure, use, and environmental factors towards an individual's output (Cohen, 2016; De Houwer, 2011; Gass & Mackey, 2007; Krashen, 1985; Thordadottir, 2017). In other words, to what extent are speakers a product of their language exposure and use, and to what extent are they social actors? In this paper I address this question by examining the effect of home language background and social identity factors on the phonetic and phonological acquisition of Scottish Gaelic and English consonants by primary-age children.

Bilingual acquisition of phonetics and phonology

Theoretical accounts of child bilingualism typically differentiate between simultaneous bilinguals who acquire two languages simultaneously from birth, and sequential acquirers who acquire one language after another (e.g., Vihman, 2014). In terms of their phonological development, it is expected that simultaneous bilingual children will acquire the full sound system of both languages, but may differ in phonetic implementation from monolingual speakers of either language (Sundara, Polka, & Baum, 2006). As such, simultaneous bilinguals acquire separate, but interacting, phonologies for both languages (Paradis, 2001). Speakers who acquire their second language after the age of three are typically considered as sequential acquirers (McLaughlin, 1978). As sequential acquirers, children are typically less likely to achieve monolingual-like phonetic and phonological systems in the sequentially acquired language (e.g., Flege, 2007). The effects of early, substantial, exposure to a language appear long-lasting and persistent in some cases. For example, Amengual (2017) showed that simultaneous Spanish-English bilinguals and L2 learners of Spanish behaved similarly with respect to stop spirantization, but speakers who grew up in a monolingual Spanish-speaking household and learned English sequentially behaved differently.

On the other hand, instead of considering sequential acquirers as young second language learners and different from simultaneous acquirers, Genesee, Paradis, and Crago (2004) instead suggest a continuum between these two categories of speaker. Similarly, other experimental accounts have begun to challenge the simultaneous/sequential dichotomy; Thordardottir, 2017, for example, suggests that amount of exposure is more important than timing of exposure in predicting competence in French expressive vocabulary and word morphology among bilingual children in Canada. It must also be noted that language acquisition continues across the lifespan and adult acquirers can achieve monolingual-like performance in phonetics and phonology (Bongaerts, Mennen, & van der Slik, 2000).

In accounts that assess the extent of phonetic and phonological acquisition in bilingual children, factors such as quantity, quality, and consistency of input in both languages are considered crucial. For example, numerous studies have shown that increased input by different caregivers across contexts leads to more balanced bilingualism, or nearer native-like performance in sequential acquirers (Cohen, 2016; De Houwer, 2011; Gathercole & Thomas, 2009; Krashen, 1985; MacLeod, Fabiano-Smith, Boeger-Pagé, & Fontolliet, 2012; Pearson, 2007). In addition to input, active production (output) of both languages and interaction with other speakers can also affect performance (Bohman, Bedore, Peña, Mendez-Perez, & Gillam, 2010; Gass & Mackey, 2007; Swain, 1985). In the context of minority languages, such as the Scottish Gaelic under consideration here, acquisitional differences are typically found between children who have acquired the language at home, and those who have acquired it later on through immersion education (Gathercole &Thomas, 2009; Morris, 2014; Munro, Ball, Muller, Duckworth, & Lyddy, 2005). The implication in these studies is that reduced, and later, input and output in the latter group of speakers may lead to differences in linguistic systems.

Phonetic variation in young people

While the research considered above describes the nature of bilingual acquisition and the effect of language exposure factors, research conducted within a sociolinguistic framework suggests that social identity factors are also important when explaining aspects of speech production. Previous sociolinguistic accounts of young people's language typically describe a childhood phase, where the child's use of linguistic features closely patterns with that of their caregiver once the system has been acquired. The implication behind this is that a child will complete most of their meaningful language acquisition via input from the caregiver, so logically their language use will reflect this input (Foulkes, Docherty, & Watt, 2005; Kerswill, 1996; Kerswill & Williams, 2000; Smith, Durham, & Fortune, 2007, 2013). At some point in a child's development into adolescence, the social and linguistic focus shifts from the caregiver to the peer group and young people begin to develop patterns of linguistic behavior that are unique to themselves and divergent from their caregivers (Eckert, 2008; Kirkham & Moore, 2013). The timing at which this transition occurs may well vary from community to community, but research so far suggests that it begins at least in pre-adolescence—that is, in the latter stages of primary education (Eckert, 2008).

In terms of bilingual speakers, little research has investigated the possible development of peer group use of language in pre-adolescence. However, recent investigations into adolescent speakers of minority languages provide some very relevant context to the current study and suggest the use of particular linguistic variants for social identity reasons. For example, Mayr, Morris, Mennen, and Williams (2017), in a study of monophthongal vowels, found that there were few phonetic differences in their sample of adolescent Welsh speakers between those who had a Welsh-speaking home background and those who had an English-speaking one. Similarly, Nance (2015) found few differences in the Gaelic phonetics between adolescents from a Gaelic-speaking background and those from an English-speaking background in the case of vowels and laterals, and Morris (2017) reports parallel findings for adolescent speakers of Welsh in laterals. Such findings would typically go against received notions of the importance of input and interaction factors in bilingual acquisition (see above), but are explained in terms of the development of peer group varieties in adolescence. It is important to note that these findings have all emerged from the study of minority language education pupils, where young people spend significant periods of time together and use the minority language in question for the purposes of education.

Gaelic Medium Education

This study considers data from children in Scottish Gaelic immersion education, usually referred to as Gaelic Medium Education (GME). The language Scottish Gaelic is referred to as "Gaelic" among its speakers, and henceforth in this paper. Gaelic is a Celtic language which is closely related to Irish. According to the latest census figures from 2011, there are currently approximately 58,000 Gaelic speakers across Scotland (National Records of Scotland, 2015). The number of speakers has been in decline for several hundred years, but Gaelic is now the subject of an intense revitalization effort including national policy making, GME, community initiatives, media and cultural programs (McLeod, 2006). The greatest concentration of Gaelic speakers is in the northwestern islands of Scotland, known as the Western Isles or the Outer Hebrides. There are also significant communities of Gaelic speakers in other highland areas such as Skye and Inverness, and in lowland cities such as Glasgow and Edinburgh.

Across Scotland there are currently approximately 3,000 children participating in primary-level GME (Bòrd na Gàidhlig, 2018), with further young people attending pre-school, secondary, and

university level education in Gaelic. The majority of GME is delivered in Gaelic units within otherwise English medium schools, although there are now dedicated Gaelic medium schools in Glasgow, Edinburgh, Inverness, Portree, and Fort William. Most children in GME attend Gaelic medium pre-school from age 2 before starting their primary education at age 4. Across the sector, the majority of pupils do not speak Gaelic as their first language (Foghlam Alba, 2015:8). Similar to other Celtic language revitalization programs, GME simultaneously delivers immersion education for children from non-Gaelic-speaking backgrounds and education in Gaelic for children from Gaelic-speaking backgrounds (O'Hanlon et al., 2013).

Methods

Participants

In this paper I consider data from 18 children in a GME class on the Isle of Lewis, Outer Hebrides. Like the majority of GME settings, the school the children attend is an English medium school, with Gaelic provision. Within the surrounding community and among the school's teaching staff, Gaelic is widely viewed as a positive aspect of local culture and history. Gaelic is also widely spoken among the school staff, so children in GME are exposed to Gaelic inside the classroom and as they move around school. Among themselves in the classroom, the GME children use a mixture of Gaelic and English. Gaelic is generally used for focused education-related tasks, whereas English is generally used for more informal discussion. In peer-on-peer settings outside the classroom, English is usually the language of choice as the children are from a small community and have friends in both English and Gaelic classes, so make use of their shared language. There are two GME primary classes in the school: one for infant pupils and one for junior pupils. These data were collected from the junior class, where the children are aged 7–11. There were 20 pupils in the class and 18 decided to take part in this study. The school is large compared to most Outer Hebridean primary schools, and the catchment area covers a wide geographical area of Lewis. It is exceptionally rare for a Gaelic-speaking child to not attend GME, so this sample represents almost every, if not every single, Gaelic speaker aged 7–11 in one region of Lewis.

Data on the language background of the children were collected via short interviews with the author conducted in Gaelic. I asked them with whom they spoke Gaelic and to give a little detail on the circumstances in which they would use the language. Out of the 18 children recorded for this study, nine children spoke little or no Gaelic in the home. Among the remaining children, three spoke Gaelic with three or four of their grandparents, four spoke Gaelic with three or four grandparents and one parent, and two children spoke Gaelic with three or four grandparents and both parents. The intergenerational language shift context of Gaelic is such that there were no children who had Gaelic-speaking parents but not grandparents. Due to the close-knit nature of this island community, where grandparents were Gaelic speakers they were from the local area and were often heavily involved in bringing up the children. These data were coded as follows for inclusion in the statistical modeling: a bilingualism score of 0 means little or no Gaelic input at home, 1 means Gaelic from grandparents, 2 means Gaelic from one parent and grandparents, and 3 means Gaelic input from both parents and grandparents. I recognize that this coding scheme is a simplification of the diversity of bilingual input contexts experienced by children, but it is appropriate for the social context of Lewis and can capture the main differences in the sample for the purposes of analysis and some generalization. (See Smith-Christmas, 2016 for a detailed ethnographic approach to Gaelic-English bilingual language use in the family.) Table 1 shows the age, gender, and bilingualism score for all the participants in this study.

Table 1. Age (years), gender, and bilingualism scores for all participants.

Bilingualism	0		1		2		3		**Total**
Age/gender	f	m	f	m	f	m	f	m	
7	2	1	1	1	0	0	0	0	5
8	2	1	0	0	0	1	0	0	4
9	2	0	0	0	0	1	0	0	3
10	1	0	0	1	0	1	1	1	5
11	0	0	0	0	1	0	0	0	1
Total	9		3		4		2		18

Features analyzed

This paper considers lateral and stop consonants in Gaelic and English. In this section I provide some background on the expected realizations of these sounds.

Scottish Gaelic has two stop series distinguished by the presence or absence of aspiration. In word-initial position, the contrast is realized as the presence or absence of *post*-aspiration, but in word-medial position, the contrast is realized as the presence or absence of *pre*-aspiration (Borgstrøm, 1940; Ladefoged, Ladefoged, Turk, Hind, & Skilton, 1998; Nance & Stuart-Smith, 2013; Oftedal, 1956; Ternes, 2006). Closure voicing in word-medial stops is rare or non-existent (Nance & Stuart-Smith, 2013). Coronal stops are realized as dentals. There is also a palatalization contrast, but this was not considered here and I only analyzed data from the non-palatalized series. Including the palatalized stops as well would have resulted in a very lengthy word list for children. Lewis English is a relatively new variety of Scottish English which has developed with a high level of contact with Gaelic (Shuken, 1984). Shuken suggests that Lewis English as a distinct variety developed in the late 19th and early 20th centuries due to the enforced use of English in education and resulting language shift (1984: 152). As such, the stops in Lewis English are similar to Gaelic, with pre-aspirated stops in word-medial position (Clayton, 2017; Shuken, 1984). Some closure voicing may be present in the stop series typically considered "voiced" in British English (Shuken, 1984; Wells, 1982). In summary, Gaelic stops in word medial position are as follows: [^{h}p ^{h}t̪ ^{h}k p t̪ k]. Lewis English stops in word medial position are realized as follows: [^{h}p ^{h}t̪ ^{h}k b d̪ g].

In Gaelic, there are three lateral phonemes: a dental velarized lateral /l̪^{ɣ}/, an alveolar lateral /l/, and a dental palatalized lateral /l̪^{j}/ (Borgstrøm, 1940; Ladefoged et al., 1998; Nance, 2014; Oftedal, 1956; Ternes, 2006). For example, there is a contrast between (near) minimal triplets such as *balach* "boy" /pal̪^{ɣ}ɔx/, *baile* "town" /palə/, and *cailleach* "old woman" /k^{h}al̪^{j}ɔx/. The acoustic characteristics of these laterals are typically as follows: the velarized lateral is produced with a high first formant and low second formant, the palatalized lateral is produced with a low first formant and high second formant, and the alveolar lateral has intermediate values for the first two formants (Nance, 2014; Shuken, 1980). In English, there is only one phonemic lateral, which is described as a "clear" lateral in Lewis English with (expectedly) low first formant and high second formant values (Shuken, 1984).

Data collection

Data were collected via a word list from the children in a quiet corner area of their classroom. Information about each child's linguistic background was collected via a questionnaire and short interview after the word list recordings. The Gaelic data were recorded first. As all adults in the

Table 2. Word list used.

Target phoneme	Gaelic	IPA	Translation	Target phoneme	English
^{h}p	cupa tì	k^{h}u^{h}pə t̪^{h}i:	*cup of tea*	p	hippo
^{h}p	mapa	ma^{h}pə	*map*	p	happy
^{h}t̪	peata	p^{h}ɛ^{h}t̪ə	*pet*	t	knitting
^{h}t̪	geata	ke^{h}t̪ə	*gate*	t	butter
^{h}k	acrach	a^{h}krɔx	*hungry*	k	cracker
^{h}k	seacaid	ʃa^{h}kɪtʃ	*jacket*	k	rocket
p	rabaid	rapatʃ	*rabbit*	b	rabbit
p	sabaid	sapatʃ	*fight*	b	robber
t̪	a' cadail	ə kat̪əl	*sleeping*	d	daddy
t̪	sgudal	skut̪əl^{ɣ}	*rubbish*	d	wedding
k	baga	pakə	*bag*	g	dagger
k	eagal	ɛkəl^{ɣ}	*fear*	g	dragon
l^{ɣ}	salach	sal^{ɣ}ɔx	*dirty*		
l^{ɣ}	balach	pal^{ɣ}ɔx	*boy*		
l	baile	palə	*town*	l	salad
l	eilean	ɛlan	*island*	l	smelly
l^{j}	duilleag	t̪ul^{j}ak	*page*		
l^{j}	cailleach	k^{h}al^{j}ɔx	*old woman*		

classroom environment speak Gaelic to the children, I initially collected the Gaelic data and explained the study in Gaelic. I then switched to English to collect the English words, before completing the background questionnaire in Gaelic. The words were presented on picture cards with the orthographic representation shown below. Each word was presented twice in random order with some distractor items. Care was taken to ensure consistency of vowel quality across the stimuli, but the first priority was that the words would be familiar to the children and were easily represented via pictures. Two words were included per phonemic context. I opted to include only two words per context and two repetitions in order to keep the word list short and manageable for young children, but acknowledge that this does lead to relatively small token counts and the data should be interpreted with this in mind. The word list is given in Table 2 and the questionnaire used given as Table 3. Recordings were made using a Beyerdynamic Opus 55 headset microphone attached to an Xbox headset. Data were recorded onto a laptop computer using a Sound Devices USBPre2 pre-amplifier and analogue-to-digital converter. The sampling rate was 44,100Hz, 16 bit quantization.

Phonetic analysis

The data were labeled for each phase of the word medial stops according to the conventions described in Nance and Stuart-Smith (2013). Durational measures were taken of vowel preceding the stop, pre-aspiration if present, pre-aspiration divided into breathy voicing and voiceless pre-aspiration, stop closure, stop closure voicing if present, and stop release. These measures were hand labeled in Praat (Boersma & Weenik, 2014) and then durations were extracted using a Praat script. For an example spectrogram showing the labeling strategy, see Nance and Stuart-Smith (2013: 133). In this study I compare the production of aspirated/voiceless stops in Gaelic and English, so focus on the duration of voiceless pre-aspiration. In order to normalize for potential speech rate differences, which have been shown to affect pre-aspiration duration and realization

Table 3. Background questionnaire. These questions were used as a guide. I allowed the children to expand where necessary and asked small follow-up questions where appropriate.

Gaelic question	English translation
Ainm	*Name*
Aois	*Age*
Cò-latha breith agad	*Birthday*
An robh thu a-riamh a' fuireach ann an àite eile?	*Have you ever lived in another place?*
Cò às a tha do mhàthair?	*Where is your mother from?*
Cò às a tha d'athair?	*Where is your father from?*
Cò às a tha do sheanair agus do sheamhair?	*Where are your grandparents from?*
Air taobh do mhàthair?	*On your Mum's side?*
Air taobh d'athair?	*On your Dad's side?*
A bheil thu a' bruidhinn Gàidhlig aig an taigh le do theaghlach?	*Do you speak Gaelic at home with your family?*
Le do mhàthair?	*With your mother?*
Le d'athair?	*With your father?*
Le do sheanair agus do sheanmhair?	*With your grandparents?*
A bheil bràthair neo piuthar agad?	*Do you have any brothers or sisters?*
A bheil thu a' bruidhinn Gàidhlig còmhla ri do bhràthair neo do phiuthar?	*Do you speak Gaelic with your brothers and sisters?*
A bheil thu a' coimhead telebhisean anns a' Ghàidhlig?	*Do you watch television in Gaelic?*

significantly (Parrell, 2012), I concentrate on the duration of voiceless pre-aspiration as a proportion of the total vowel+pre-aspiration interval (described in more detail in Nance & Stuart-Smith, 2013). The total numbers of tokens analyzed is shown in Table 4.

As discussed above, the three lateral phonemes in Gaelic are easily distinguished by differences in the first and second formants, so this was chosen as the variable of investigation (e.g., Kirkham, 2017; Morris, 2017; Nance, 2014). In order to measure the first two formants, an initial auditory analysis was conducted to ensure each lateral was produced with laterality. In a small number of cases, palatalized laterals in Gaelic were produced as palatal glides by some young speakers (Nance, 2014). This was the case with 21 tokens, including all the palatalized laterals from speakers f05 and m04. These tokens were subsequently removed from the analysis. In the remaining dataset, the lateral steady state was hand labeled in Praat using the conventions outlined in Nance (2014), and used in other studies such as Carter and Local (2007) and Kirkham (2017). (See Nance (2014: 7) for an example spectrogram showing the lateral labeling techniques.) The data were then downsampled to 22,050Hz and low pass filtered at 11,025Hz. The Praat files were converted to an Emu database for formant estimation (Winkelmann & Raess, 2014). The first two formants were estimated via LPC estimation with a 20ms Blackman window with 5ms shift using the wrassp::forest R function (Bombien, Winkelmann, & Scheffers, 2016). Each token was manually checked and formant traces adjusted where necessary in the Emu web app. Further data processing and analysis was carried out in R (R Core Team, 2013), including converting the data to Bark before F1 was subtracted from F2 (Traunmüller, 1990). The total tokens analyzed is shown in Table 4.

Statistical testing

The statistical testing aims to investigate the realization of systems within the children. To this end, the first model compares proportion of voiceless pre-aspiration in the two-stop series, pre-aspirated

Table 4. Total token counts for both variables in the acoustic analysis. Note the 21 tokens of palatalized laterals, which were not included in the acoustic analysis due to being produced as glides, are not included here.

Context	Gaelic	English	Total
Aspirated stops	198	219	417
Unaspirated stops	212	170	382
Velarized laterals	72	NA	72
Palatalized laterals	51	NA	51
Alveolar laterals	72	142	214

and unaspirated at three places of articulation—bilabial, coronal, and velar; and the second model compares F2-F1 in the three lateral phonemes—palatalized, alveolar, and velarized. Both models contain the language (Gaelic or English) and the social factors of bilingualism score, age, and gender.

The modeling technique employed here is Conditional Inference Trees (CTrees) (Breiman, 2001). For an overview of the application of CTree and Random Forest analysis to linguistic data, see Levshina (2015) and Tagliamonte and Baayen (2012). In particular, Tagliamonte and Baayen (2012) compare regression modeling and CTrees and include code in order to conduct future analyses. For recent implementation in sociolinguistic studies, see Kirkham and Moore (2016). CTree analysis is a non-parametric technique which is effective for small datasets with high degree of collinearity or empty cells. Exploratory mixed effects regression modeling of the dataset proved unstable due to the nature of the dataset, but CTree analysis provides an opportunity to investigate factors which would not have been possible through regression modeling. For example, there are no male 10-year-olds who do not speak Gaelic at home in this sample, which may lead to non-convergence or instability in a traditional regression model. A drawback of this method is that factors cannot be structured hierarchically in the manner of a mixed effects regression model. As such, tokens cannot be nested within speakers, etc.

CTrees work as follows (for a more comprehensive explanation see Levshina (2015: 291)): the algorithm tests which of the independent variables is most closely associated with the dependent variable. If an association is made at the pre-defined level of significance, the data are split and the process repeated. In this way, the variable that explains the most variation in the dataset will be located highest in the tree. For example, in the laterals model described below, the highest branch is according to lateral phoneme, meaning that this is the strongest predictor in the dataset. *p* values and significant results are obtained via permutation, a resampling process similar to boot-strapping. The results are displayed as binary splits into "branches" and "leaves," which show significant interactions in the dataset. CTree analysis was implemented here using the partykit::ctree R function (Zeileis & Hothorn, 2018).

Results

Stops in Gaelic and English

The final CTree for the stops analysis is shown in Figure 1. The data reveal a significant difference in stop series, where—unsurprisingly—phonologically aspirated stops have more pre-aspiration ($p < .001$). This implies that the distinction between pre-aspirated and unaspirated stops has been acquired across this group of children. In the pre-aspirated stops, coronal and velar stops have more

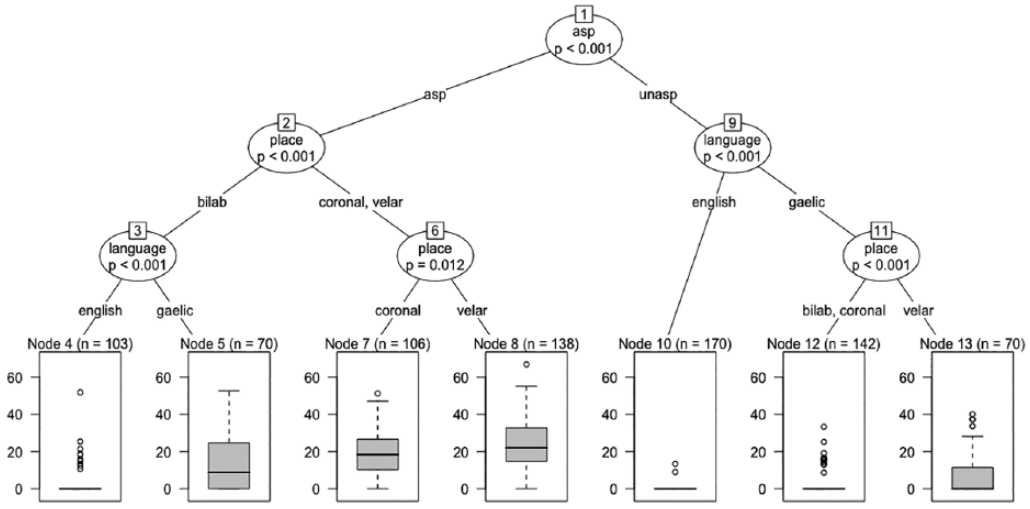

Figure 1. Final CTree for the stops analysis.

pre-aspiration than bilabial stops (p <.001) and velar stops have more pre-aspiration than coronal (p = .012). This supports the results of previous studies of Gaelic pre-aspiration in adults where there is a similar Place of Articulation hierarchy (Ladefoged et al., 1998; Nance & Stuart-Smith, 2013), and also in other languages (e.g., Stevens & Hajek, 2004). Within the pre-aspirated stops, there are differences between English and Gaelic only in the bilabial stops, with more pre-aspiration in Gaelic than in English (p <.001). In the unaspirated series, there is more pre-aspiration in Gaelic than in English (p <.001), and in the Gaelic unaspirated stops, there is more pre-aspiration in the velar stops than in the coronal/bilabial stops (p <.001).

There are no differences for bilingualism, age, or gender, suggesting that home language background does not predict production for this contrast, and the system is fully acquired at age 7. There are also few differences between Gaelic and English stops. I return to this point in the discussion alongside the results from the lateral data.

Laterals in Gaelic and English

The final CTree for the laterals analysis is shown in Figure 2. The first partition in the dataset is according to phoneme, suggesting that all children have a distinction between at least two phonemic laterals. Velarized laterals are different (lower F2-F1) than alveolar and palatalized (p <.001). There is no further branching in the model according to phoneme across any subgroup of children, suggesting that there are no significant differences here between the palatalized and alveolar laterals. Within alveolar/palatalized laterals, 7-year-olds have higher F2-F1 and over-7s have lower (p < .001). Within the velarized laterals, 7-year-olds have higher F2-F1 and over-7s have lower (p = .019). The significant differences according to age in the data are in phonetic implementation, rather than phonological contrast—that is, there are no differences according to age in the number of lateral contrasts made, but there are some differences in the formant values between 7-year-olds and the rest of the children. This finding implies that the system is acquired by age 7 in so far as two laterals are contrasted here instead of the traditional three-way contrast. However, some phonetic differences according to age, for either physiological or social reasons, are present within the sample.

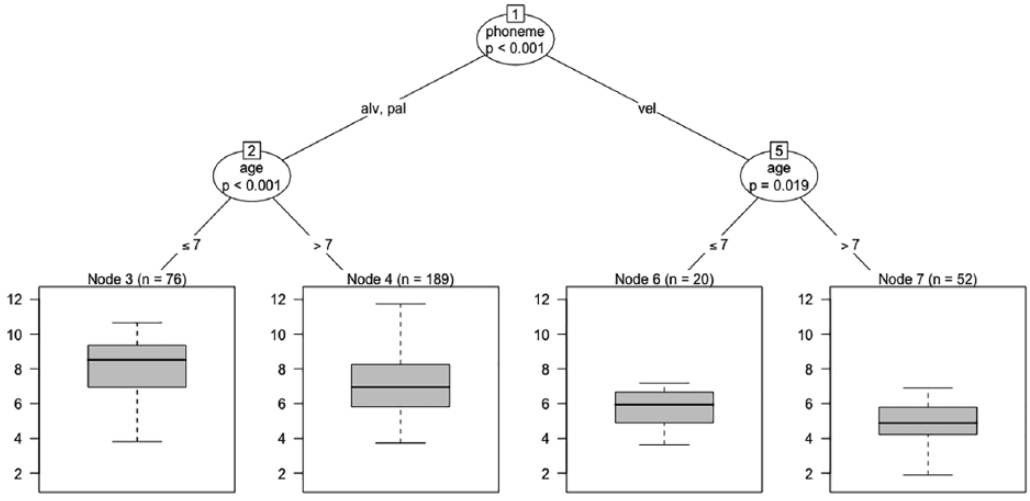

Figure 2. Final CTree for the laterals analysis.

There are no significant differences for bilingualism score or gender. There are also no significant branches according to language. Such a difference would only be apparent in the alveolar laterals as English has only this one phonemic lateral, and there are no significant differences here according to any of the variables measured.

Discussion

This paper aimed to examine the relative contribution of environmental/exposure factors and social identity factors in an individual's bilingual production. In order to test this, I examined the phonetic production and phonological system of stops and laterals in Gaelic and English among primary school GME pupils. While most of the expected aspects of the stop and lateral systems have been acquired by these 7–11-year-old children, there were no significant differences in the dataset according to the home language background of the pupils. In this discussion section, I focus first on this lack of home language background effect, and second on the two-way distinction found in the lateral system instead of Gaelic's traditional three-way distinction. Third, I discuss the age effects found in the lateral analysis, where 7-year-olds performed differently to the rest of the children, and finally I consider the similarities between Gaelic and Lewis English.

Home language background

Some of the previous studies of minority language education contexts similar to the one under consideration here have described large differences in the production of minority language phonetics and phonology between children acquiring a language simultaneously at home, and those who acquired one language sequentially through immersion education (Gathercole & Thomas, 2009; Munro et al., 2005). In contrast, a number of socially oriented studies of adolescent bilinguals have considered such factors in more depth and find that the influence of adolescent peer groups is more important, with home background differences among adolescents disappearing (Mayr et al., 2017; Morris, 2017; Nance, 2015). The point at which the peer group becomes more important is not clear from the previous literature, but is hypothesized to occur sometime in pre-adolescence

(Eckert, 2008; Kerswill, 1996). The current results suggest that there are few or no differences in phonetics and phonology apparent according to home language background in these pre-adolescent Gaelic speakers aged 7–11. Similar to Gathercole and Thomas (2009), these results suggest that the majority societal language (English) is acquired equally across all home language backgrounds, but additionally, similar to the adolescent speakers in Mayr et al. (2017), Morris (2017), and Nance (2015), I find no differences in production among these 7–11-year-old children.

These results suggest that in pre-adolescence, initial differences in language input and output resulting from simultaneous acquisition compared to immersion school acquisition have been leveled out. As an explanation for these findings, I suggest that two processes are most likely at work. On the one hand, by the time they reach pre-adolescence, children educated through the medium of Gaelic will have had at least five years' exposure to the language and will have had an opportunity to acquire the phonetic and phonological structures under consideration here. As such, these results support those in Thordardottir (2017), who advocates that a distinction between more and less input may be more appropriate than a dichotomy between simultaneous and sequential bilinguals. In other words, the first process applying here is that children acquiring Gaelic through schooling have had enough input and opportunity to "catch up" on any initial differences in language production.

Lateral phonology

On the other hand, there were also differences between the children in this dataset and both adolescents and adults in the community. Here, there were no significant differences between alveolar and palatalized laterals, a contrast that is traditional for Gaelic (Borgstrøm, 1940), and is also present in the speech of adolescents and adults in Lewis (Nance, 2014). This would suggest that although all children are now producing phonetics and phonology in a similar manner to each other, they still sound different to older speakers in the community. As such, I suggest that the second crucial factor in explaining these data is that, to some extent, specific ways of speaking Gaelic emerge in the community of practice that is the classroom. The young people in this study represent possibly the entirety of the Gaelic-speaking population in their age bracket in their part of the island and they come together on a daily basis to speak Gaelic during their education. As such, it is perhaps unsurprising that unique ways of speaking develop within this focused community of practice. Such a phenomenon may be short-lived and evolve over time. Indeed, Nance (2014) considered data from adolescent speakers in the secondary school on Lewis. For secondary education, pupils from all over the island come together to form one Gaelic medium class. These speakers produced Gaelic's traditional three-way lateral system, suggesting any features of primary school language can continue to evolve and traditional structures can be acquired later on. Similarly, Kennard (2018) found that some complex structures of Breton morphophonology were not acquired until early adulthood in those speakers motivated enough to continue using Breton after school.

A further question from this finding is why it is that the alveolar and palatalized laterals have merged acoustically instead of any other combination. I suggest this is because these two laterals are the closest in terms of acoustics. In the data from traditional older Gaelic speakers presented in Nance (2014), the F2-F1 values for palatalized and alveolar laterals are much closer together (while still being significantly different) compared to other possible pairs of lateral phonemes. I suggest that this acoustic similarity had led to these laterals being merged in the children here rather than, for example, velarized and palatalized laterals.

A final point to note is that two speakers produced all their palatalized laterals as palatal glides. These tokens are not included in the acoustic analysis as they cannot be compared against tokens

with laterality. It could also be the case, however, that some speakers are moving towards maintaining a three-way contrast, but that contrast is made up of palatal glide versus alveolar lateral versus velarized lateral.

Age differences

In the lateral acoustic data, there were some significant differences according to age where 7-year-old children have higher F2-F1 in the alveolar/palatalized laterals and also higher F2-F1 in the velarized laterals. There were no differences in the number of phonological lateral categories—that is, all ages of children only produced two distinct laterals—so the difference here lies in phonetic implementation. Potentially, the differences could be either due to physiological reasons associated with the development of children's vocal tracts, or due to sociolinguistic reasons. In general, formant values are higher in younger children (see Vorperian and Kent (2007) for an overview of a wide range of developmental studies in English). Fant (1975) suggests that the length of the pharyngeal cavity is closely associated with the frequency of the second formant, and imaging studies such as Fitch and Giedd (1999) suggest growth of the pharyngeal cavity throughout childhood. The 7-year-olds in this study may therefore have a tendency towards higher F2-F1 values. However, Fitch and Giedd (1999) show that the vocal tract continues to lengthen throughout childhood and adolescence, so this does not explain why there were no differences between, for example, 8- and 10-year-olds in the sample. I suggest that social factors may contribute to the formant differences: the data were collected in September, only three weeks after the 7-year-olds had moved up to the junior GME class after leaving the infant class. As such, they may be exhibiting learned phonetic behaviors from their previous Gaelic community of practice. I argue that here a combination of the physiological tendency to produce higher formants, coupled with social behaviors of the younger school class, may explain the results here.

Gaelic and Lewis English

The data in this study showed few differences between English and Gaelic. In the stops, there was longer pre-aspiration in the Gaelic bilabial aspirated stop series, and in the Gaelic unaspirated stops. This might be considered unexpected, as English is not canonically described as having pre-aspirated stops. However, one of the immediately noticeable aspects of the Lewis variety of English is the presence of pre-aspirated stops, due to long-term contact with Gaelic on the island (Clayton, 2017; Shuken, 1984; Wells, 1982). Considering the local variety of English, it is not unexpected at all to find lengthy durations of pre-aspiration present in the children's stops. Similarly, in the laterals, there were no differences between English and Gaelic alveolar laterals, which is most likely due to the centuries of contact between Gaelic and English in Lewis (Shuken, 1984).

A further possibility is that the language mode of the experimental setup may have reduced any potential differences between languages (Grosjean, 1998; Simonet, 2014). This previous research has shown that activating the mode of a bilingual's other language may influence production. In this case, it may be that the mainly Gaelic mode of the experimental setup shifted phonetic production in English in the direction of Gaelic. The current research was mainly conducted in Gaelic as it took place in classroom time and I did not wish to undermine the school's considerable efforts to provide a Gaelic environment. Future research should control language mode more carefully where possible. Similarly, a very interesting comparison could be made by expanding this study to contexts where Gaelic is less widely spoken in the community. For example, Cortés, Lleó, and Benet (2018) showed that Catalan vowel production can vary depending on whether a speaker is from a

more or less Catalan-speaking district of Barcelona. As such, it would be fascinating to compare the data presented here to data from children in a lowland, less Gaelic-speaking area of Scotland.

Conclusion

The data presented here suggest that any initial linguistic differences between children who enter GME as fluent Gaelic speakers and those who do not are leveled out by later primary school, at least as far as pronunciation is concerned. This finding is optimistic in the sense that GME appears to be successful in producing young speakers who can acquire phonetic and phonological competence in Gaelic. Second, these findings demonstrate that pre-adolescent speakers can develop their own ways of speaking that are oriented towards peer models instead of factors such as amount of input in a particular language. In terms of policy and planning implications, the data suggest that approaches that build opportunity for language use within a structured community where young people can interact with one another in the target language can lead to successful phonological acquisition, regardless of background.

This study considers data from a small sample of children in the limited context of production of some consonant sounds. Future research could enlarge the sample, sounds acquired, and expand to consider acquisition of morphosyntax. However, taken alongside previous studies of minority language education, the findings here contribute to a growing body of sociolinguistically oriented studies of young people in minority language education settings and suggest that the influence of the peer group is of paramount importance in explaining patterns in speech.

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