Articulation and Neutralization: A Preliminary Study of Lenition in Scottish Gaelic

Diana Archangeli[1,2], *Samuel Johnston*[2], *Jae-Hyun Sung*[2],
Muriel Fisher[2], *Michael Hammond*[2], *Andrew Carnie*[2]

[1]University of Hong Kong
[2]University of Arizona

darchang@hku.hk, dba/sjcjohnston/jhsung/murielf/hammond/carnie@email.arizona.edu

Abstract

Initial Consonant Mutation in Scottish Gaelic is considered to be morphological, somewhat idiosyncratic, and neutralizing, that is merging either the mutated sound and some underlying sound or merging two mutated sounds. This study explores articulation in one class of mutation, called Lenition (also Aspiration), asking the question of whether these sounds are articulated in the same fashion or not. Comparison of relevant ultrasound images collected from 3 native speakers of Scottish Gaelic shows that speakers maintain distinctions between True Lenition and False Lenition, suggesting that there is incomplete neutralization. Furthermore, when Lenition of two distinct sounds converge on the same target, subjects again keep the two articulations distinct. These results are consistent with a phonological model which distinguishes between surface forms corresponding to different sources, showing very little complete articulatory neutralisation.

Index Terms: articulatory phonetics, ultrasound, lenition, Scottish Gaelic, consonant mutation

1. Introduction

Neutralization refers to the surface merger of two sounds that are distinct at an abstract level; this is a hallmark of the "abstractness in phonology" debate [1, 2, 3]. Initial Consonant Mutation in Scottish Gaelic (Gàidlig, henceforth SG), presents two types of apparent neutralization (along with multiple other challenges for phonological theory) [4, 5, 6, 7, 8].

In all cases of neutralization, a question remains of whether the two sounds truly are merged, or whether there are subtle physical distinctions that are not consciously perceptible. There is some recent work that suggests that at least some instances of apparent absolute neutralization are, in fact, not neutralizing [9, 10]. The goal of this project is to add to our understanding of neutralization and of the articulatory properties of Initial Consonant Mutation in SG specifically with respect to neutralization in Lenition: Do the speakers maintain an articulatory distinction between sounds that are underlyingly distinct but that appear on the surface to be the same?

SG exhibits a rich, highly morphologized consonant mutation system: the contrast [sad] *sat* 'toss, 2-imperative' but [hat] *shad* 'toss-past' shows that Lenition changes the morphosyntactic role of the verb. Lenition in SG is described as a neutralization phenomenon in two respects, schematized in Table 1. First, there are a few words with False Lenition, non-alternating words occurring only in a lenited form, e.g. [ha] *tha* 'be; present'. "Merger" results when the True Lenition matches a False Lenition form, e.g. [h] results both from True Lenition of /s/ and from False Lenition of /h/, shown in Table 1 row 1. Second, "Convergence" results in cases of True Lenition where two distinct source consonants converge on the same sound, as with /s/, /t$^{\text{h}}$/ both leniting to [h], shown in Table 1 row 2.

Table 1: *Two types of neutralization*

Study		Surface	Underlying	Type
1.	Merger	[h]	/h/	False
			/s/	True
2.	Convergence	[h]	/s/	True
			/t$^{\text{h}}$/	True

The same question arises in both cases: are the sounds articulated in the same way, matching their impressionistic acoustic properties, or are they articulatorily distinct, matching their lexical distinctness? To answer this, we compared ultrasound images from three SG speakers producing words with the relevant sounds to determine whether there are articulatory differences, for example, between [h] from False Lenition vs. from True Lenition, and/or between [h] derived from /s/ and [h] derived from /t$^{\text{h}}$/.

2. Methods

2.1. Participants

Data were collected on the Isle of Skye in Scotland from 26 participants. Here, we report on results from three of these (based on ultrasound image quality), ranging in age from 19 to 50, 2 females and 1 male. The three participants reported on here used SG exclusively from birth until elementary school, and have continued to use SG on a daily basis throughout their lives.

2.2. Stimuli

Potential stimuli were identified by searching SG dictionaries and databases, and checked with a native speaker, the fourth author. From the pool of items, partial minimal sets were selected. True minimal sets were not possible because only attested SG words were used. Stimuli were controlled for identical following vowels and for stress placement. All items were presented in standard SG orthography.

2.3. Data collection

Ultrasound enables the researcher to record the midsaggital (or coronal) view of the tongue during speech. [11, 12, 13, 14]

Figure 1: *The adjustable-height head-rest/probe-holder*

show how ultrasound can be used in fieldwork; [15, 16, 19, 18], among others, demonstrate that ultrasound results inform not only our understanding of articulation, but also of phonological systems. To collect the ultrasound data, the participant was seated in a rolling, adjustable-height chair. The ultrasound probe was held in position using a custom-made adjustable-height device (see Figure 1) which holds the probe in place and gives the participant a forehead rest, to help keep the head in a stable position throughout data collection. Some participants were more comfortable without using the forehead rest.

The ultrasound probe was spring-mounted, allowing minor adjustments to the position of the participant's jaw during speech. The participant faced a computer screen where the prompts were presented using custom-designed software. This software randomized the order of the prompts, and recorded the audio, video, and prompt order with time stamps. Prompts were advanced by a member of the research team whose job was to monitor presentation of the data and provide back-up in monitoring image quality. A second team member was the primary for observing image quality. After collecting one instance of each word, the participant participated in a translation task, then did the second round with ultrasound, a second round with translation, and finally the third round with ultrasound. In this way, three repetitions were collected for each stimulus item.

As is typical with fieldwork, while we tried to control for extraneous noise, there were unavoidable disruptions that affected the quality of the audio recordings: birds singing, cars pulling up, voices in the courtyard, a vacuum cleaner in the hall, bagpipes in the next room. Because our primary focus is on the tongue's movements for articulation, and not the audio signal, these disruptions had minimal impact on the quality of the data collected.

2.4. Data extraction and analysis

We created textgrids in Praat [20, 21] for each recording and identified frames of interest in the audio recording based on acoustic landmarks in the signal, selecting the last full frame of the sound before the vowel. Frames of interest were hand-traced and adjusted based on neutral tongue position [22]. SSANOVAs [23, 24] were created, comparing sounds targeted in each study.

3. Merger of True and False Lenition (Study 1)

3.1. Stimuli

To determine whether the articulations of True and False Lenition are distinct, we identified corresponding True and False Lenition forms, e.g. *dhall* 'blind-past' (True) and *dha* 'to him' (False). The complete list of stimuli for this study is presented in Table 2. Table 2 also includes the unlenited counterpart of the lenited item, e.g. *dall* 'blind-imperative', to show that the True Lenition forms do, indeed, undergo Lenition.

Table 2: *Merger stimuli: Unlenited forms are the imperative verbs; lenited forms are the same verbs in the past tense*

ICM	Unlenited	True Lenition	False Lenition
s → h	sad 'toss'	shad 'toss'	tha 'be' irr.pr
t^h → h	tachd 'choke'	thachd 'choke'	tha (*above*)
t → ɣ	dall 'blind'	dhall 'blind'	dha 'to him'
k → ɣ	gabh 'take'	ghabh 'take'	dha (*above*)
k^j → j	giùlain 'behave'	ghiùlain 'behave'	dhiubh 'to you pl.'
k^h → x	cas 'oppose'	chas 'oppose'	cha negative particle

3.2. Results

To determine whether True Lenition results in an articulation that is distinct from that of False Lenition, we inspected SSANOVAs for the initial sounds of the Unlenited, True Lenited, and False Lenited items in each row of Table 2, for each of the three participants. We inspected the contours for whether or not the two contours were distinct in any part of the tongue, for example whether the contour of True Lenition *shad* was distinct from that of False Lenition in *tha*.

3.2.1. Control study

The 6 Unlenited-True Lenited pairs from columns 1 and 2 of Table 2 served as our control cases, pairs where we expect a real difference in articulation because in most cases the Unlenited sound is a stop and the Lenited sound (True or False) is a fricative. This comparison is made with SSANOVAs using a 95% confidence interval, as illustrated in Figure 2 and tabulated in Table 3. The Unlenited forms typically show a higher tongue position, as expected since the unlenited sounds have closure in all cases except [s]. In all but two cases, the articulations were clearly distinct.

3.2.2. Merger of True & False Lenition (Study 1)

Of interest for Merger of True & False Lenition are cases where True Lenition and False Lenition have distinct contours. Figure 3 shows the SSANOVAs for the initial [h] sounds of *thachd*, and *tha*, as produced by Subjects 10 and 07. As inspection
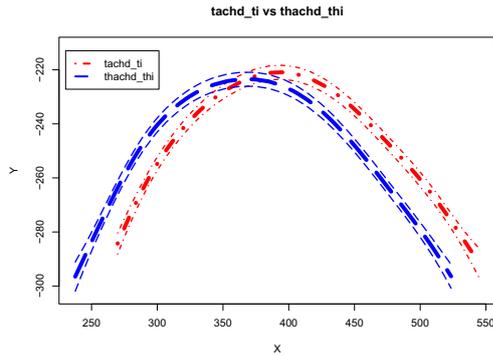
tachd_ti vs thachd_thi

Figure 2: *Control SSANOVA for "t/th", Subject 05, showing a more front tongue position for [t]. In all images, tongue tip is to the right and dotted lines are 95% confidence intervals. The Y axis shows distance from the floor of the mouth; axis values correspond to pixels.*

Table 3: *Control results: A check (✓) indicates no distinction between Unlenited & True Lenited; X shows a distinction exists*

lenition	05	07	10
s/sh	X	X	X
t/th	X	X	X
d/dh	X	X	X
c/ch	X	X	X
g/gh	✓	X	X
gi/ghi	X	X	✓

reveals, there is complete overlap of the confidence intervals for the length of the tongue for Subject 10 (left side), showing Merger, the case for most sound pairs for Subjects 05 and 10. For Subject 07 (right side of Figure 3), the articulations are distinct, showing no Merger.

Table 4 show the patterns for each participant. Merger of True and False Lenition is marked with a check (✓). Subjects 05 trends towards Merger, Subject 10 is split evenly between Merger and no Merger, and Subject 07 has no Merger at all.

Table 4: *Merger of True & False Lenition (Study 1). A check (✓) indicates Merger (no distinction between False & True Lenition); an X shows no Merger.*

spelling	ipa	05	07	10
s/sh	$s \rightarrow h$	✓	X	X
t/th	$t^h \rightarrow h$	X	X	✓
d/dh	$t \rightarrow \gamma$	✓	X	X
c/ch	$k^h \rightarrow x$	✓	X	✓
g/gh	$k \rightarrow \gamma$	✓	X	X
gi/ghi	$k^j \rightarrow j$	✓	X	✓

4. Convergence of True Lenition from Distinct Sources (Study 2)

This study examines cases where distinct unlenited consonants converge on lenited forms that are described as identical. For
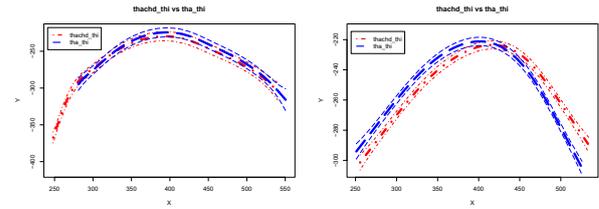

Figure 3: *Merger of True & False Lenition. SSANOVAs for "thachd/tha", Subject 10 (left) showing merger (no distinction between contours), but no merger for Subject 07 (right). Tongue tip right, 95% confidence intervals, Y axis distance from mouth floor; axis values correspond to pixels.*

instance, both /s/ and aspirated /tʰ/ are said to lenite into [h]. Do the resulting articulations differ in subtle ways depending on the nature of the source consonant?

4.1. Stimuli

The critical stimuli for this study are pairs of sounds that are distinct when unlenited, but that are described as the same sound when lenited. The complete list is given in Table 5. Stimuli identified for Study 1 were used for Study 2, with the addition of *dhiùlt*. In Table 5, this is the only item glossed, as it is the one that does not appear in Table 2.[1]

Table 5: *Convergence stimuli*

Lenition	Base/Len.	Example	Base/Len.	Example
h	s/sh	shad	t/th	thachd
ɣ	d/dh	dhall	g/gh	ghabh
j	di/dhi	dhiùlt 'refuse' past	gi/ghi	ghiùlain

4.2. Results

To determine whether there are differences in the articulation of lenited forms from distinct underlying sounds, even when the lenited forms are described as "the same sound", we examined SSANOVAs of the initial sounds in the rows of Table 5 for each of the four participants. The results are shown in Table 6: Subject 07 shows no Convergence at all: the articulations of the various lenited sounds are distinct from each other, even though perceptually they are the same. Subjects 05 and 10 have Convergence in at least one of the pairs, and the lack of Convergence in at least one other pair.

Table 6: *Convergence of True Lenition from Distinct Sources (Study 2). A check (✓) indicates Convergence of True Lenition from different sources; X shows no Convergence; "—" insufficient data*

spelling	ipa	05	07	10
sh/th	[h]	X	X	✓
dh/gh	[ɣ]	✓	X	✓
dhi/ghi	[j]	—	X	X

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[1] We inadvertently omitted the non-lenited counterpart of *dhiùlt* when collecting data so this item does not appear in Study 1.
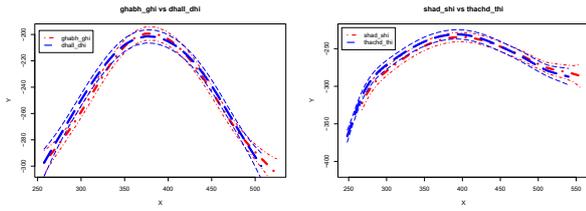
Figure 4: *Convergence of True Lenition from Distinct Sources. SSANOVAs for Subject 05 "gh/dh" (left) and for Subject 10 "sh/th" (right), both showing Convergence. Tongue tip right, 95% confidence intervals, Y axis distance from mouth floor; axis values correspond to pixels.*
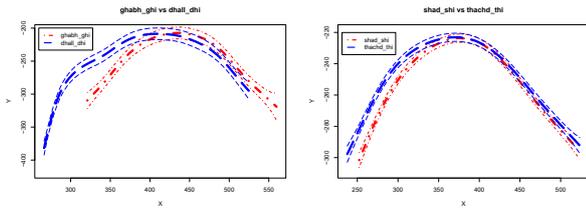

Figure 5: *Lack of Convergence of True Lenition from Distinct Sources. SSANOVAs for Subject 07 "gh/dh" (left) and for Subject 05 "sh/th" (right), both showing the lack of Convergence. Tongue tip right, 95% confidence intervals, Y axis distance from mouth floor; axis values correspond to pixels.*

Examples of Convergence are shown in Figure 4 for the Subject 05 with *ghabh/dhall* and for Subject 10 with *shad/thachd*. There is almost complete overlap of the confidence intervals in these items. By contrast, Figure 5 shows the lack of Convergence for the same two items, for Subject 07 *ghabh/dhall* and for Subject 05 with *shad/thachd*.

5. Discussion

While the work here is preliminary, based on data collected from 3 participants out of 26, the results are striking, showing the absence of complete neutralisation in two types of cases involving SG Lenition.

The results from Merger of True and False Lenition (Study 1), indicate that SG Lenition is not generally neutralising, consistent with results from a pilot study reported in [25], which shows that Irish Gaelic eclipsis mutations are longer in duration than the same sounds in non-eclipsis contexts (one subject). The data here show that one speaker, Subject 07, shows no Merger at all between cases of True and False Lenition: there is no complete neutralisation for this participant. This contrasts with the other participants: Subjects 05 and 10 merge some items but maintain a distinction in some cases.

The results from Convergence of True Lenition from Distinct Sources (Study 2), again show Subject 07 maintaining articulatory distinctions, while the other participants maintain some, but not all, distinctions in their articulation. Inspection of the Convergence results reveals no consistent pattern among the various participants or even within participants.

Could this be a dialectal effect? The answer at this point is a clear "maybe". Subject 07 was raised on the island of Lewis, with parents and grandparents from Lewis, while the other two

are from the island Uist, suggesting the possibility of a dialectal difference. However, there is only one speaker from Lewis analysed thus far. Furthermore, the Uist participants are not consistent among themselves in which forms neutralise and which do not, suggesting that this is idiolectal not dialectal.

Could this be an orthographic effect? [26] shows that the lack of absolute neutralisation reported in [9] corresponds to an orthographic difference and when that difference is removed, there is complete acoustic merger in final devoicing in Dutch. The SG case is particularly interesting in this regard. In Merger of True and False Lenition (Study 1), the orthography of items with True and False Lenition is the same: True *thachd* vs. False *tha*, etc., while in Convergence of True Lenition form Distinct Sources (Study 2), the orthography corresponding to the distinct sources is itself distinct: *shad* vs. *thachd*, both pronounced [h]. As shown here, we find neutralisation occurring in both types of cases for two participants, and not occurring in either case for one. Thus, it appears that orthography is not a driving factor in whether or not Lenition involves neutralisation in SG.

6. Conclusions

Initial Consonant Mutation (ICM) is reasonably rare typologically, and is poorly understood both descriptively and theoretically. This work adds to the small literature on the articulatory properties of Gaelic languages [25, 22, 10]; here we make an important and surprising contribution to understanding the articulatory properties of Lenition in Scottish Gaelic, a demonstration that what has been viewed as neutralising is for some people not neutralising after all: The articulations of True and False Lenition and of True Lenition from different sources are kept distinct even when the resulting sounds are described as the same sound.

7. Acknowledgements

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