An Acoustic and Articulatory Study of /l/ Allophony in Newfoundland English

Sara Mackenzie, Paul De Decker, Rosanna Pierson

Memorial University of Newfoundland
sjmackenzie@mun.ca, pauldd@mun.ca, rkp216@mun.ca

ABSTRACT

This paper reports on an acoustic and articulatory study of /l/ in Newfoundland, Canada. English spoken in Irish-settled areas of the province is reported to exhibit light /l/ in all positions, in contrast to the standard North American English pattern with dark /l/ in codas and light /l/ in onsets. Our study reports on /l/ productions from 9 male and 13 female speakers from across the province. /l/ productions were elicited preceding and following word boundaries (e.g. *steal assets* vs. *see lapses*). Articulatory measures of tongue body height and retraction were determined using ultrasound imaging and F2-F1 values were used as an acoustic measure of /l/ darkness. As a group, participants show the standard North American pattern with significantly darker /l/s in word-final position. There is significant variation among speakers, however, with some speakers failing to show a distinction between final and initial /l/ in the acoustic or articulatory measures.

Keywords: ultrasound, socio-acoustics, accents of English, laterals

1. INTRODUCTION

English has two well-known allophones of /l/. Light [l] is characterized acoustically by a higher F2 and a lower F1, while dark [ɬ] has a relatively low F2 and high F1. In terms of articulation, dark [ɬ] has greater tongue root retraction and tongue body lowering than light [l]. The realization and distribution of these allophones is subject to significant dialectal variation [e.g 4, 17] and the relevant linguistic factors which affect the distribution of dark and light /l/ include syllabic position, morphological constituency, and rime duration [e.g. 16, 20]. This paper reports on the first acoustic and articulatory study of the allophonic distribution of /l/ in Newfoundland, Canada. Newfoundland is an area of rich dialect diversity with dialect areas closely linked to settlement patterns. English spoken in Irish-settled areas is reported to exhibit light /l/ in all positions, in contrast to the standard North American English pattern which has a dark [ɬ] in coda position and light [l] in onsets.

Research on /l/ allophony patterns in Newfoundland has been limited to a few acoustic and impressionistic studies, none of them very recent [1, 2, 14]. Since these studies, Newfoundland has experienced several major social and economic changes, which have in turn affected local dialects and have led to the loss of certain features, including a reported reduction in the prevalence of the light /l/ pattern [5]. Our study uses instrumental methods to examine the realization of /l/ among Newfoundland speakers of different ages from different regions of the province. Using both acoustic and articulatory measures, this study investigates the extent to which the Irish, light /l/ pattern persists and how different patterns of /l/ allophony are distributed among the population. Our results show that, when considered as a group, our speakers have significantly lighter /l/s in word-initial position than in word-final position. There is substantial variation between speakers and the acoustic data show that women in our study have significantly darker /l/s than men.

2. DATA COLLECTION

Participants were recruited using posters, social media, and the friend-of-a-friend method. To date we have 22 speakers, distributed by age and gender as shown in Table 1 below.

Table 1: participants

Age	Male	Female	Total
20-29	6	7	13
30-39	2	1	3
40-49	1	1	2
50+	0	4	4
Total	9	13	22

/l/ productions were elicited using orthographic representations presented on a monitor. Elicitation materials are from previous work [13] and include intervocalic /l/s preceding and following a word boundary under phrasal stress (e.g. *steal assets* vs. *see lapses*) and compound stress (e.g. *coil amp* vs. *toy lamp*). Items were produced within the carrier phrase, 'please say X, again.' Each participant produced six items in which the position of /l/ relative to the word boundary varies within a phrase and six items which compare initial and final /l/s within compounds. Items contain a variety of vowels

with the vowel preceding and following the /l/ remaining constant in the word-final and word-initial condition for each item. Participants also produced a number of fillers. All items, including fillers, were repeated, yielding two repetitions of each utterance.

3. ACOUSTICS STUDY

3.1. Methodology

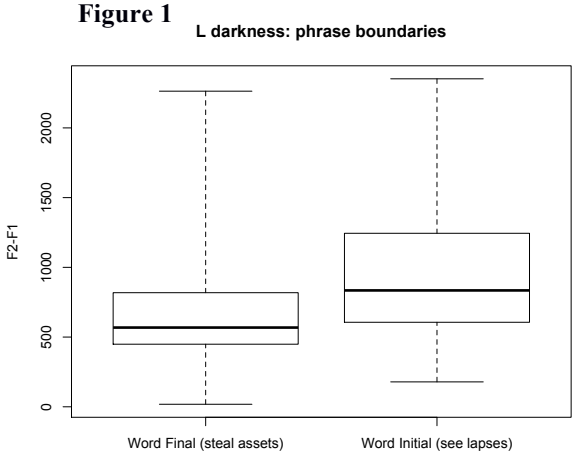
Each recorded utterance was automatically aligned using the Prosodylab-aligner [8]. F1 and F2 measurements were taken at five points across the duration of the /l/ using a Praat [3] script. In order to facilitate comparison between speakers, data were normalized following the Lobanov z-score method using the 'vowels' package in R [10]. Normalized values are used when reporting cross-speaker comparisons. Otherwise, raw formant values are reported. Our reported acoustic measure of /l/ darkness is the F2 - F1 value at its temporal midpoint. Dark /l/s generally have a high F1 and low F2 relative to light /l/s. The F2-F1 value is a measure of overall darkness with higher F2-F1 values being interpreted as lighter /l/s [16].

3.2. Results

Taken as a group, our speakers show the standard North American pattern, with significantly darker /l/s in word final position, in both phrases and compounds.

Figure 1 below shows F2-F1 values in initial and final position within phrases (compound data is not illustrated for reasons of space). Within-subjects t-tests show a significant effect of final vs. initial position with $p<0.001$ for both the compound and phrase data.

Figure 1

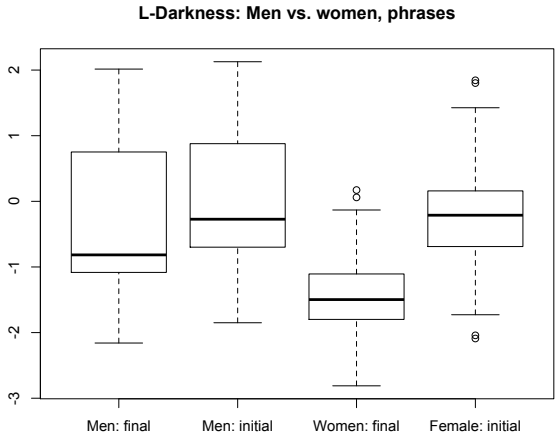


There is, however, significant variation among speakers with 8 of 22 speakers failing to show a significant distinction in the phrase data and 11 failing to show a distinction in the compound data.

With respect to social factors, we found a significant effect of sex with women showing a greater distinction between initial and final position. Figure 2 includes data for men and women in phrasal contexts.

Both men and women show a significant effect of final versus initial condition (men, $p=0.013$, women, $p<0.001$). There was a significant effect of sex with women having significantly darker /l/s than men in both final ($p<0.001$) and initial position ($p=0.025$).

Figure 2



Linear regression showed no significant effect of age on F2-F1 values.

3.3. Summary of acoustic results

The acoustic results show a significant difference between /l/s in initial and final position with word-final /l/s being darker under both compound and phrasal stress. Patterns of individual speakers vary widely with some speakers failing to show an initial-final distinction.

The gender difference is consistent with sociolinguistic patterns in which men retain more local variants, such as light /l/ in coda, while women adopt more standard patterns [18].

4. ARTICULATION STUDY

4.1. Methodology

Using ultrasound tongue imaging, we were able to examine both lowering and retraction of the tongue body, two gestural properties significant in the production of /l/ [16].

The procedures for data collection and analysis broadly follow those of other studies [11]. A Sonosite Titan C11/8-5 MHz ultrasound transducer is secured below the speaker's chin with a Manfrotto 244 variable Magic Arm. Speakers are seated in an

ear, nose, and throat chair with an adjustable headrest to minimize head movement. While speakers read the stimuli, video of the ultrasound image is digitized using a Canopus ADVC-55 and saved at a rate of 30 fps to an AVI file using Adobe Premiere Elements video editing software. Individual video frames showing the point at which the tongue body was most retracted were extracted as a JPG image and submitted to EdgeTrak [12] where the tongue contour was modeled and converted to a series of x-y coordinates. This enabled us to quantify the position of the tongue in a 2D cartesian space, with height represented on the y axis and retraction on the x axis. These x-y contour data, or splines, were then statistically examined to assess the degree of similarity in the lingual shapes of /l/ in word final vs. word initial position using the Smoothing Spline ANOVA test [7] in R [15].

For each speaker, two productions of word-final and word-initial inter-vocalic /l/ were included in the SSANOVA test for each item. This yielded 168 pairwise comparisons (90 in the *compound* comparison and 78 in the *phrase* comparison). Data are reported for only 16 speakers due to poor image quality for the remaining speakers.

4.2. Results

Considering both tongue body height and tongue body retraction, 64% of the pairwise comparisons showed a statistically significant difference between the spline of the word-initial /l/ and that of the final /l/, as shown in Table 2. These results indicate that our sample shows articulatorily distinct patterns across word-initial and word-final positions. Two participants, speakers 21 and 23, showed a significant difference in either tongue body height or tongue body retraction in every pairwise comparison. For the majority of speakers, however, the distinctions are not obligatory – rather, they are realized at different rates.

The output of the SSANOVA tests also served as the dependent variable in a logistic regression analysis to calculate the likelihood of obtaining significant articulatory differences between initial and final /l/ and to determine what social factors influence allophonic variation in lingual activity.

The logistic regression analysis was conducted using Rbrul [9] which assessed the effect of several external factors on the articulation of /l/ in word-initial and word-final positions. We considered age, gender, and region of origin of the speaker and tested data from both phrase and compound contexts together. Speakers who categorically showed a distinction were not included in the test.

Table 2: pairwise comparisons distinct in TBR or TBH or both[1]

Speaker #	% Distinct	# Compared
18	33	6
11	36	11
5	36	11
7	40	10
2	55	11
24	58	12
16	60	10
19	61	18
12	64	11
10	67	6
13	67	12
17	70	10
3	82	11
20	90	10
21	100	11
23	100	8

Table 3 presents the significant results of the logistic regression model. Results reveal that gender has a significant influence on articulatory distinctions across word-initial and word-final positions. Specifically, male speakers are more likely than females to exhibit differences. The significant effect of age on positional variation reveals that older speakers are more likely to show allophonic variation at the level of articulation.

Table 3: Logistic Regression; social factors

	Log odds	%	#	Factor Weight
Gender (p=0.008)				
Male	0.586	73%	80	0.642
Female	-0.586	56%	88	0.358
Age (p=0.014)				
+1	0.071			

4.3. Summary of Articulatory Analysis

While some speakers exhibit categorical differences in the articulation of /l/ across word-final and word-initial position, our analysis shows that most speakers are highly variable (with the lowest rate of differences at 33% of pairwise comparisons). Articulation of inter-vocalic /l/ ranges from being categorically distinct across word-initial and -final positions towards no-distinctions at all, though no speaker showed categorically similar lingual

articulations. Given these results, we report an absence of light /l/ like the type described by Clarke [6] in our sample of Newfoundland English speakers. On the other hand, not everyone shows the standard Canadian English pattern, namely articulatorily distinct /l/s in these two positions. This points to a variable situation in NL that may be due to first, the historical presence of coda light /l/ and second, the levelling of this traditional Newfoundland English feature. What is interesting is that the loss of light /l/, it seems, is gradual and not replaced in all cases simultaneously.

5. DISCUSSION OF ACOUSTIC AND ARTICULATORY RESULTS

At a very general level, the acoustic and articulatory results tell a similar story. The speakers as a group show a distinction between word-final and word-initial /l/, with significant differences in the F2-F1 values in both phrasal and compound contexts; 64% of pairwise comparisons show significant articulatory differences in either tongue body height, tongue body retraction, or both. The articulatory and acoustic data also both show significant variability between speakers, with some speakers failing to demonstrate any significant difference in F2-F1 values. There is also a difference in the rate at which speakers show distinctions in the articulatory measures, with rates ranging from 33% of comparisons to 100%.

When the data are considered more closely, however, we find significant discrepancies between the articulatory and acoustic findings. Of the two speakers who exhibited a categorical distinction between final and initial /l/s in the articulatory data, with compound and phrasal contexts considered as a group, one showed a significant difference in F2-F1 values between initial and final position in both the compound and the phrasal data whereas the other failed to show an acoustic distinction in either context.

Furthermore, when the social factors are considered, the relation between the articulatory and acoustic data is even more remote. In the acoustic data, women showed a greater distinction between the word initial and word final conditions and, in particular, had darker /l/s in final position than did the male speakers. However, in the articulatory data, men showed a significant distinction in tongue body height or tongue body retraction in a greater number of comparisons than the women. The acoustic data therefore suggest that women are making a greater distinction between initial and final /l/ whereas the articulatory data suggest that women make less of a distinction, or, at least, make a distinction less consistently.

The finding of some discrepancy between the acoustic and articulatory results is not surprising, given that they are not based on measures from identical time points in articulation of the /l/. The acoustic values are taken from the midpoint of the /l/ whereas articulatory measures are taken from the point at which the tongue is most retracted. A perfect temporal alignment between acoustic and articulatory measures is not possible given the relatively slow frame-rate of the ultrasound (30 fps). It is plausible that speakers may realize a dark/light distinction at different points in the articulation of the /l/, resulting in some discrepancy between the articulatory and acoustic measures reported here. Speakers who show high rate of distinction in the articulatory data but fail to show significant distinction in the acoustic measures may be realizing the distinction at a time other than the temporal midpoint.

Previous research suggests, however, that not all differences between the acoustic and articulatory measures result from differences in the temporal point which is being measured. In Ying et al.'s [19] study of acoustic and articulatory measures of /l/, F2 lowering did not correlate with tongue body retraction and they suggest that lateralization may affect formant values independent of tongue body retraction or lowering. Turton [17] also finds evidence of articulatory distinctions in /l/ realization that are not reflected in acoustic measures.

6. CONCLUSION

Both our acoustic and articulatory findings show that speakers of Newfoundland English have significant differences in the articulation of final versus initial /l/s when considered as a group. The acoustic and articulatory data also show significant variation between individuals with some speakers failing to make the final-initial distinction in /l/ darkness characteristic of standard North American English.

The acoustic data show women making a greater difference between initial and final /l/ and we tentatively interpret this finding as indicating that men are retaining more local and traditional variants at a greater rate than women. The fact that this pattern does not appear to be reflected in the articulatory data, however, leaves this interpretation open to question. Our future work will involve a greater number of speakers, evenly distributed across gender and region in addition to further investigation of the relation between articulatory and acoustic measures of /l/.

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