ACOUSTIC AND ARTICULATORY VARIATION IN BRITISH ASIAN ENGLISH LIQUIDS

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ABSTRACT

Previous auditory and acoustic research reports variation in /l/ between 'Asian' and 'Anglo' speakers of British English, with Asian speakers producing 'clearer' realisations of /l/ than Anglo speakers from the same geographical region [8, 11, 22]. Whilst research on /r/ in British Asian English suggests variable rhoticity [8, 9], less work has documented /r/ variation in this community in non-coda contexts. Additionally, no study to date has examined the articulatory realisation of liquids in British Asian English. This paper reports a study of liquid variation between Anglo and Asian speakers of Bradford English, a dialect of British English. We report acoustic and midsagittal B-mode ultrasound data on the realisation of /l/ and /r/ in word-initial and word-medial position. We find differences between Anglo and Asian speakers that support previous studies, but also find individual differences in articulation. We discuss our results with reference to language contact and sociophonetic variation in liquids.

Keywords: Ultrasound tongue imaging; liquids; acoustics; articulation; British Asian English

1. INTRODUCTION

British Asian English is a native contact variety of British English that is spoken by many second- and third-generation immigrant communities of South Asian origin [8, 10, 13, 20]. Typical features of British Asian English include retroflex realisations of coronal stops [1, 10, 13, 20], higher and fronter monophthongal FACE and GOAT vowels [8, 19, 22, 25, 26], and 'clearer' allophones of /l/ [8, 11, 22], all of which are hypothesised to represent influence from Panjabi, which many British Asians speak as a heritage language.

This paper investigates acoustic and articulatory variation in liquid production between Anglo and Asian speakers of Bradford English, a dialect of English spoken in the city of Bradford, UK. Bradford is located in West Yorkshire, England and, according to the 2011 UK Census, has a 26.83% Asian (Indian and Pakistani) population and 5% Panjabi main language population. As such, it has one of the highest concentrations of British Asians in the United Kingdom, making it an ideal site for studying this variety. The typical pattern for /l/ in Yorkshire English, the county in which Bradford is located, is 'dark' /l/s in all prosodic contexts, which may be indicated by lower F2 values [6, 11] and a more retracted tongue dorsum [21]. We hypothesise that British Asian speakers will produce /l/ with higher F2 values and a more anterior constriction than British Anglo speakers. There are no clear predictions for British Asian /r/ in the literature in syllable-initial contexts, so whilst we expect differences between groups we make no predictions regarding their directionality.

2. METHODS

Data were collected from five Asian (Pakistani) and three Anglo (White British) speakers of Bradford English, aged 21–36 years old. All speakers were female, native speakers of English, and had lived in Bradford since birth. All Asian speakers were bilingual in English and (Mirpuri) Panjabi, and all Anglo speakers were monolingual in English.

The stimuli comprised twenty-eight words containing /l/ or /r/ in word-initial (e.g. *lead*), word-medial pre-accentual (e.g. *believe*), word-medial post-accentual (e.g. *belly*), morpheme boundary (e.g. *filing*), and word-final contexts (e.g. *peel*), as well as fifty-four distractor words. Each word was repeated three times per speaker. In this paper, we focus only on a subset of these data: a word-initial minimal pair (*lead, reed*) and a word-medial minimal pair (*belly, berry*).

Data signals were acquired using AAA software [3] in a quiet room at a community centre in Bradford. Acoustic data were recorded to a laptop computer using a Beyerdynamic Opus 55 headset microphone into a Grace m101 pre-amplifier and Sound Devices USBPre2 audio interface. B-mode ultrasound images were generated using a Mindray DP-2200 ultrasound scanner, with 5 MHz frequency

and 8.62 cm depth, and acquired at ~30 fps (~60fps deinterlaced) via a ADlink PCIe video capture card. Synchronisation was achieved using a software-generated tone that superimposed a flash on the corner of the video image, and the tone and the flash were aligned during post-processing. The ultrasound probe was stabilised using an Articulate Instruments headset [17] and a palate trace and bite plate were recorded for each speaker at the beginning of the experiment.

The acoustic data were labelled in Praat for the liquid steady-state [6, 15]. F1, F2 and F3 values were estimated from LPC spectra at the time of the closest ultrasound frame to the temporal midpoint of the liquid steady-state. There were consistent formant estimation errors for the Asian speakers' word-initial /r/ tokens, which were corrected by hand. We note that these estimation errors may be a consequence of a partially devoiced onset for initial /r/ in this group. Linear mixed-effects models were fitted to the F1, F2 and F3 values, with ethnicity, position and ethnicity*position as predictor variables, and speaker as a random intercept.

Tongue splines were fitted using a semi-automatic algorithm in AAA, and then automatically extracted from the frame closest to the temporal midpoint of the labelled liquid steady-state. All splines were rotated to the occlusal plane in order to enhance comparability between speakers [16]. The tongue spline data were analysed using local polynomial regression fitting in R and model fits were plotted with 95% confidence intervals in order to assess whether lingual shape for each liquid significantly differs between speakers.

3. ACOUSTIC RESULTS

Figures 1–3 show F1–F3 values at the liquid midpoint for each position/word in each group.

There are significant effects of ethnicity and position for F1 in /l/, with Asian speakers producing lower values [β = -88.97, SE = 22.55, p = .008] and medial tokens having higher F1 values than initial tokens [β = 94.93, SE = 12.34, p < .001]. Medial tokens also have higher F1 in /r/ [β = 67.54, SE = 11.55, p < .001], but there are no significant differences between ethnic groups for F1 in /r/. There are also no significant interactions between ethnicity and position.

There is a significant effect of ethnicity for F2 in /l/, with Asian speakers producing considerably higher values than Anglo speakers [β = 923.28, SE = 73.42, p < .001], but there is no effect of position. The same holds true for /r/, with Asian speakers producing higher F2 values than Anglo speakers [β = 388.60, SE = 101.54, p = .009]. There is also an effect of position, with medial /r/s having higher F2 values than initial /r/s [β = 144.48, SE = 63.01, p = .027], but this effect only seems to be robust amongst the Anglo speakers, despite no significant interaction between ethnicity and position (see Figure 2).

Figure 1: F1 values (Hertz) at liquid midpoint by position*group.

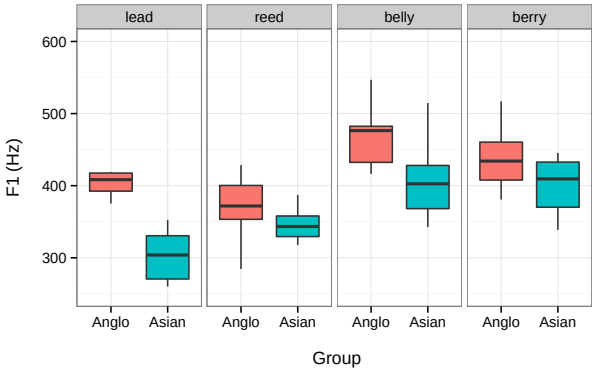


Figure 2: F2 values (Hertz) at liquid midpoint by position*group.

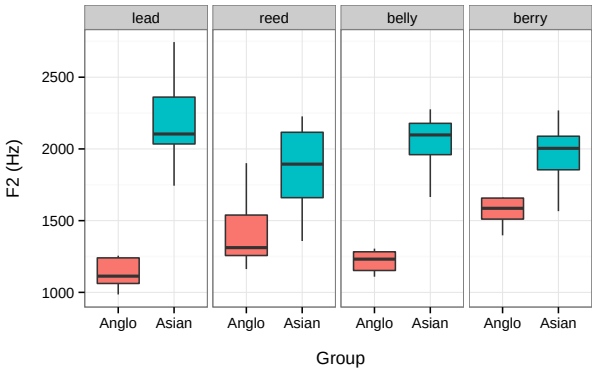
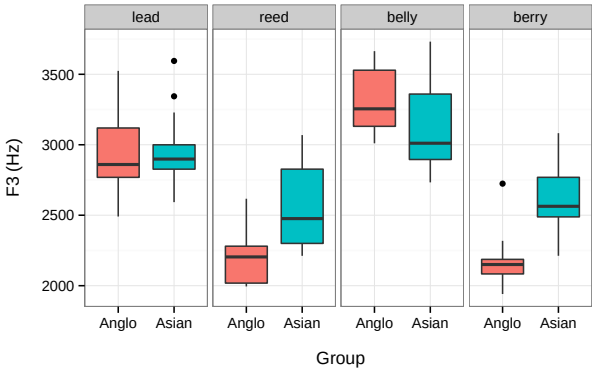


Figure 3: F3 values (Hertz) at liquid midpoint by position*group.



Medial tokens of /l/ have higher F3 than initial tokens [β = 247.74, SE = 61.09, p < .001] and there is no effect of ethnicity for F3 in /l/. However, Asian

speakers do have higher F3 in /r/ than Anglo speakers [β = 389.33, SE = 105.11, p = .01], but there is no effect of position.

Overall, the acoustic results show significant effects of ethnicity for F1 in /l/ (Asian speakers lower), for F2 in /l/ and /r/ (Asian speakers higher), and for F3 in /r/ (Asian speakers lower). If we treat F2 as an indicator of clearness/darkness [6], this suggests that Asian speakers have 'clearer' realisations of /l/ and /r/ than the Anglo speakers. We discuss relationships between acoustic measures and the articulatory results below.

4. ARTICULATORY RESULTS

4.1. Midsagittal tongue shape: Laterals

Figure 4 shows midsagittal tongue splines for all eight speakers at the mid-point of word-initial /l/ in *lead*. The red (Anglo) and blue (Asian) lines indicate speaker means for that word and the grey areas represent 95% confidence intervals, with non-overlapping areas indicating a significant difference between speakers. All of the Asian speakers produce some kind of anterior constriction with the tongue tip or front. Patterns amongst the Anglo speakers are more varied, with one speaker showing a more retracted tongue dorsum and lowered tongue tip, one speaker producing a more anterior constriction like the Asian speakers, and one speaker showing a higher tongue position and retracted tongue dorsum.

Figure 4: Midsagittal tongue shape for word-initial /l/ in *lead*.

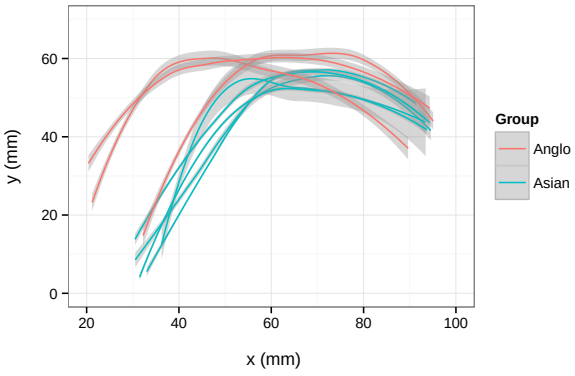
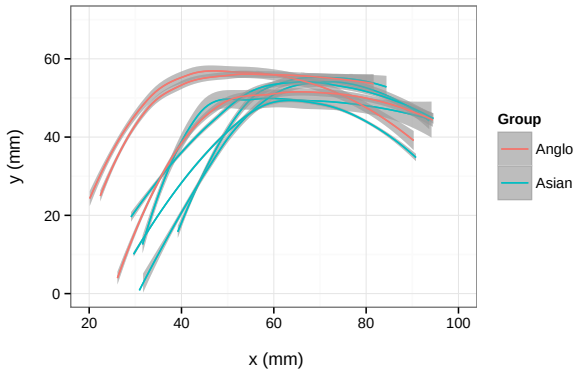


Figure 5 shows midsagittal tongue splines for all eight speakers at the mid-point of word-medial /l/ in *belly*. The results are largely the same as the word-initial lateral, with most of the Asian speakers speakers producing a relatively anterior constriction. Two of the Anglo speakers produce /l/ with a more retracted tongue dorsum, whilst the third Anglo speaker patterns closely with the Asian speakers, but with a slightly more retracted tongue dorsum.

Figure 5: Midsagittal tongue shape for word-medial /l/ in *belly*.



The results suggest that the high F2 and low F1 in Asian speakers' /l/ may be related to a more palatal constriction with the anterior part of the tongue. However, there is variation within groups: one Anglo speaker consistently produces a more anterior constriction, whereas one Asian speaker produces a slightly more posterior constriction than the other Asian speakers, but not as retracted as the Anglo speakers. Generally speaking, our prediction that Asian speakers will produce a more anterior constriction holds for /l/.

4.2. Midsagittal tongue shape: Rhotics

Figure 6 shows midsagittal tongue splines for all eight speakers at the mid-point of word-initial /r/ in *reed*. Four Asian speakers produce a more anterior constriction with tongue tip downwards, whereas one speaker's tongue is lower and more retracted. Two Anglo speakers have a more retracted and raised tongue dorsum, one of which has a much shorter tongue spline due to this speaker's tongue tip imaging very poorly on the ultrasound display for all tokens of /r/. The third Anglo speaker produces the Asian-like pattern with a more anterior constriction.

Figure 6: Midsagittal tongue shape for word-initial /r/ in *reed*.

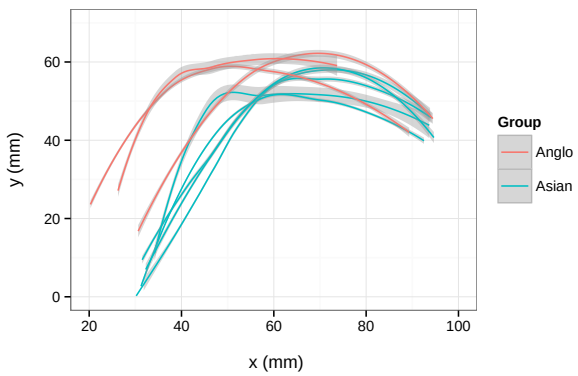
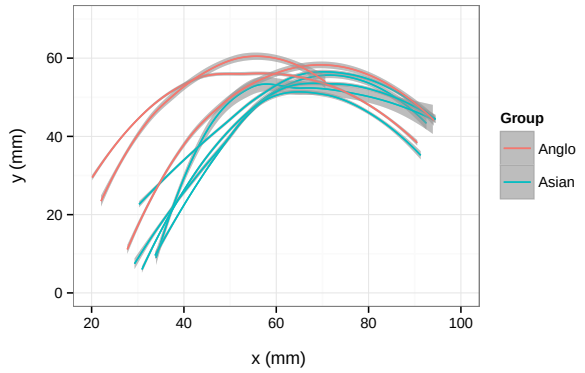


Figure 7 shows midsagittal tongue splines for the eight speakers at the mid-point of word-medial /r/ in *berry*. All speakers produce word-medial /r/ with a downwards tongue tip, with the main axis of difference being a more anterior constriction for Asian speakers and a more retracted tongue dorsum for Anglo speakers. Within-group variation is largely the same as for the other contexts, with one Asian speaker showing a slightly more retracted tongue dorsum and one Anglo speaker showing a more anterior constriction that is similar to the Asian speakers.

Figure 7: Midsagittal tongue shape for word-medial /r/ in *berry*.



For /r/ the results are similar to those observed for /l/. Asian speakers show a more anterior tongue tip constriction, whilst Anglo speakers generally produce a higher and more posterior constriction with a retracted tongue dorsum. These results also pattern with the acoustic data, with the Asian speakers' higher F2 and F3 values in /r/ correlating with a smaller front cavity volume due to the more anterior constriction [2, 7].

5. DISCUSSION

Asian speakers typically produce /l/ and /r/ with an anterior constriction with the tongue front or tip, whereas Anglo speakers typically produce /l/ and /r/ with a more posterior constriction with a retracted tongue dorsum. However, there is considerable within-group variation, particularly for the Anglo speakers. We expect that this is partly explained through our focus on midsagittal tongue shape alone and that labial gestures, as well as lingual articulations away from the midline of the vocal tract, may also contribute towards differences between groups [4, 5]. In addition to this, the relative timing of gestures is important and it is plausible that the choice of a non-articulatory-based timepoint in our analysis has captured non-equivalent stages of the intergestural timing relationship in liquids. To this end, future work will investigate the timing of coronal and dorsal constrictions in these data, as well as probing the extent to which such timing patterns are categorical or gradient across different prosodic contexts (e.g. [14, 21, 23]).

These results support previous acoustic studies that report higher F2 values for /l/ in Asian speakers compared to Anglo speakers from the same geographical region [22]. One interpretation of these results is that the Asian speakers' productions represent phonetic influence from their heritage language, Panjabi. Panjabi is typically described as having 'clear' /l/s in all syllable positions [18] and corresponding L2 varieties of Pakistani/Indian English are also described as having clearer /l/s [8, 24].

Whilst bilingual interference may explain the existence of this variation, [20] find that various bilingualism usage indicators do not predict variation in their study of /t/ in British Asian English (see also [1, 11, 12]). Instead, we propose that the variation evidenced here is likely to represent the acquisition of a contact variety of English, which has received considerable input from Panjabi, but can be acquired within British Asian communities, even by those who are not proficient in Panjabi. Whilst we did not collect any information on our speakers beyond basic demographic characteristics, [27] reports a detailed study of phonetic variation in the Bradford Asian community, which includes attitudinal and ethnographic information from a very similar group of speakers, and the results suggest that variation within the Bradford Asian community may be related to socio-indexical factors.

6. CONCLUSION

This study reports acoustic and articulatory variation in /l/ and /r/ between British Asian and British Anglo speakers of Bradford English. The acoustic results show that Asian speakers produce /l/ with lower F1 and higher F2 than Anglo speakers, and that Asian speakers also produce /r/ with higher F2 and F3 than Anglo speakers. Accordingly, Asian speakers generally produce /l/ and /r/ with a more anterior constriction, whereas some Anglo speakers produce /l/ and /r/ with a more retracted tongue dorsum. However, there is also individual variation in articulation, particularly in the Anglo group. We suggest that this variation is the result of Asian speakers acquiring a contact variety of English and not a straightforward effect of bilingual interference.

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