

Revealing covert articulation in *s*-retraction

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In this paper we use both ultrasound and acoustic data to investigate *s*-retraction in the clusters /stɪ/ and /stj/ in Manchester English (McE). Our results uncover inter-speaker variation, not only with respect to the categoricity and gradience of retraction, but also the precise articulatory means employed to achieve the same, or similar, acoustic outputs.

The phenomenon of *s*-retraction is somewhat under-studied in British English and work has been based solely on acoustic data (e.g. Altendorf 2003, Bass 2009, Sollgan 2013). Collecting ultrasound data enables us to ascertain a direct articulatory picture and is especially important given that it is known that the same acoustic signal can be achieved through different articulatory means (e.g. Mielke et al. 2016 on covert articulation of /ɹ/).

In American English (AmE), *s*-retraction is relatively well-studied (e.g. Durian 2007, Gylfadottir 2015, Wilbanks 2017). It has been argued that retraction in AmE is triggered directly and non-locally by /ɹ/ (e.g. Shapiro 1995), though this has been rejected by others (e.g. Lawrence 2000, Rutter 2011) who claim that it is indirect, with retraction of /s/ coming from the affrication of /t/ by a following /ɹ/. In any case, such studies have also principally relied on acoustic data, with the notable exceptions of ultrasound studies by Mielke et al. (2010) and Baker et al. (2011).

Our results suggest that, in McE, /ɹ/ is not the direct cause of retraction, nor is it the only indirect source as we see comparable behaviour in /stj/, a cluster notably absent in AmE (in the contexts under study). Although we find inter-speaker variation with respect to the gradience or categoricity of retraction, /stɪ/ and /stj/ pattern together.

Articulatory data were collected using midsagittal ultrasound tongue imaging alongside simultaneous, synchronised audio recordings. Five repetitions of each target word were elicited in the carrier sentence ‘I know *x* is a word’, with a different randomised order used for each participant. The stimuli were all monosyllabic with target segments in word-initial position and were balanced for the following vowel (/i: u: ɒ/), with the exception of /stj/, which only occurs before /u:/ and for which two target words were disyllabic (*student*, *stupid*, *stew*). Distractor items began with /s/, /ʃ/, /st/, /tʃ/, /tj/, /tɪ/ and /ɹ/. The /s/- and /ʃ/-initial words were used to gauge the degree of retraction in target clusters. Additionally, the /tʃ/-, /tj/- and /tɪ/-initial items were used in comparisons of *t*-affrication. All test items elicited had a score of between 2.8–5.6 on the Zipf-scale. The ultrasound data were analysed using generalised additive mixed models (GAMMs; Sóskuthy 2017) and the acoustic data were analysed using linear mixed-effects models.

Taking into account both the acoustic and articulatory data, results from 7 subjects (2M, 5F; aged 18–26; mean age 21.4) reveal inter-speaker variation. In terms of articulation, there are three groups of speakers (as can be seen in Figures 1 and 2): those with categorical retraction, those with gradient retraction and those with no apparent (or statistically significant) lingual difference between all contexts (even underlying /s/ and /ʃ/). Crucially we see that all speakers show an acoustic difference between /s/ and /ʃ/, even those with no visible differentiation in tongue shape. Furthermore, for 3 speakers, we see categorical acoustic “retraction” and, for 4 speakers, we find (varying degrees of) gradient acoustic “retraction”. For all speakers, regardless of their individual patterns, /stɪ/ and /stj/ behave similarly.

In addition to varying degrees of *s*-retraction, *t*-affrication is found in all speakers. For most speakers, the fricated portions of pre-*ɹ*/ affricated /t/ and instances of /tj/-coalescence are identical both to each other and to underlying /tʃ/.

The fact that all speakers, whether gradient or categorical, produce retraction for /stɪ/ and /stj/ shows that certain explanations for *s*-retraction in AmE are not applicable to McrE. That is, rather than /ɪ/ being the direct trigger (see Baker et al. 2011), we instead suggest that both /ɪ/ and /j/ trigger affrication of the preceding /t/, which in turn causes retraction of /s/ (cf. Lawrence 2000, Rutter 2011 *inter alia*; contra Magloughlin & Wilbanks 2016). Furthermore, the results suggest that speakers are hitting an acoustic rather than articulatory target in order to produce acoustic “retraction”. That is, speakers resort to different articulatory means to achieve the same or similar acoustic signals on the /s/-/ʃ/ continuum, such as lip-rounding, tongue grooving or finely-controlled tongue tip movement (see Rutter 2011:31). In future work, we hope to be able to provide direct articulatory evidence of these mechanisms.

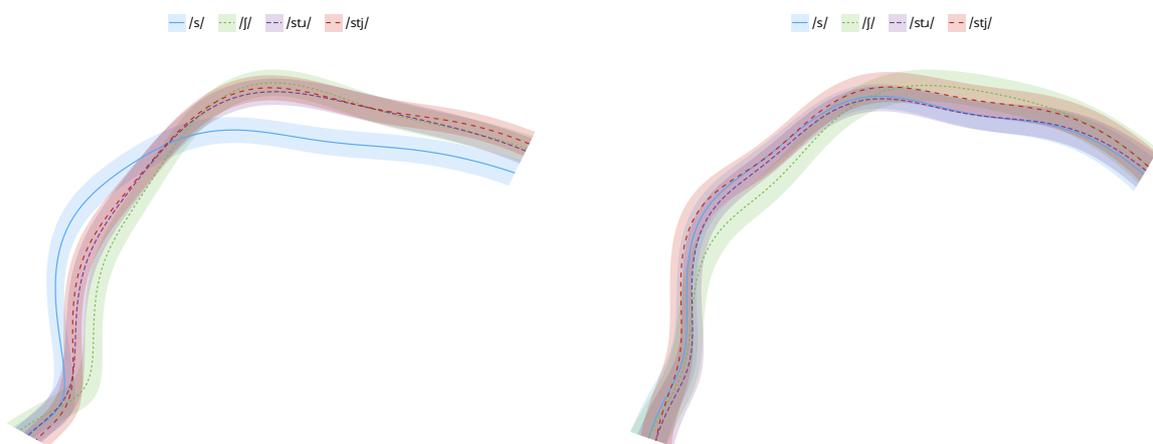


Figure 1: GAMM plots for M01 (left) and F01 (right). Tongue root on left, tongue tip on right.

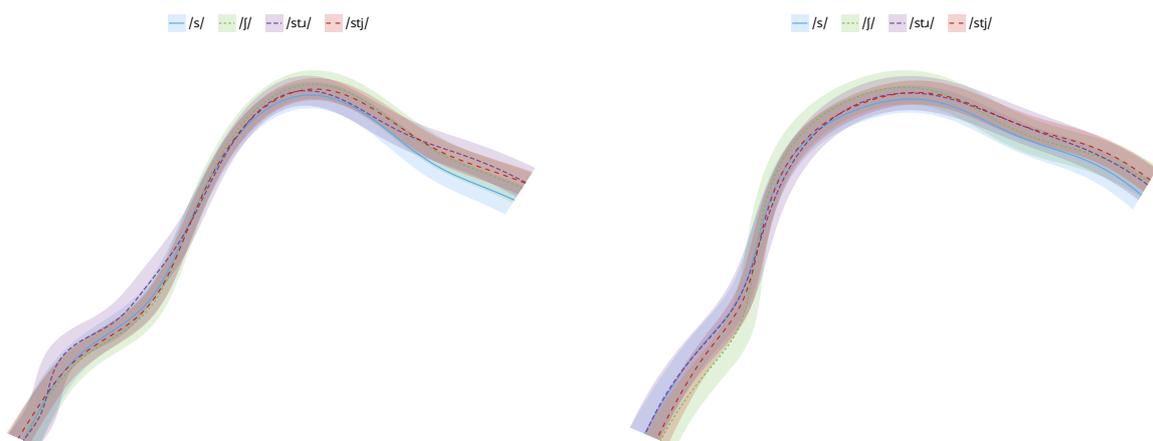


Figure 2: GAMM plots for F06 (left) and F08 (right). Tongue root on left, tongue tip on right.