

**Towards systematic exploration of variation in gestural timing.  
/l/ vocalisation in Southern British English**

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Certain aspects of speech dynamics are highly individual, as evidenced by forensic research on speaker identification (McDougall, 2005). At the same time, however, there is accumulating evidence that acoustic dynamics can also be predictive of sociophonetic factors such as speaker age and social class (Haddican et al., 2013; Hughes & Foulkes, 2015), or dialect (Williams & Escudero, 2014). Recent articulatory work suggests that a similar kind of continuum from individual to sociophonetic information is encoded in articulatory dynamics (Lawson et al., 2016; Mielke et al., 2016). This study provides further evidence in this respect, by presenting a case of systematic variation in articulatory timing which appears sociolinguistically relevant, since it lines up with the direction of ongoing sound change.

Our case study concerns ongoing /l/-vocalisation in Southern British English (SBE). Previous accounts characterise /l/-vocalisation as a reductive sound change, in which the tongue tip (TT) gesture is reduced and/or delayed (Gick 1999 and references therein). Gestural delay and reduction have both been evidenced by articulatory studies of /l/-vocalisation in different accents of English (Scobbie et al., 2007; Lin et al., 2014). However, it is currently unclear whether the two are always correlated, or whether they are two different articulatory strategies for achieving the acoustic effect of vocalisation. Our own results (see below) suggest the latter, although there is a continuum of variation along both parameters.

Our research is based on a previously collected corpus of time-aligned ultrasound and audio data from 20 speakers of SBE (Strycharczuk & Scobbie, 2015). 10 younger (20-28, median=22.5) and 10 older (45-66, median=55) speakers were recorded. The speakers' tongue movements were captured using a high-speed ultrasound system, at the rate of 121 frames per second. Head-stabilisation was used throughout the recordings to minimise the movement of the ultrasound probe. For the current study, we selected 864 tokens of /l/. The preceding vowels were always /u:/ and /ʊ/, and non-lingual consonants were preferred in the initial position. /l/ occurred in three contexts: i) word-final pre-consonantal (*fool#five*, *pull#five*); ii) word-final pre-vocalic (*fool#it*, *pull#it*); and iii) word-medial (*fooling*, *pulling*). All these tokens came from a subset of 12 speakers (7 younger and 5 older), selected based on the relatively good quality of their ultrasound image, which is essential for the dynamic analysis,

For all the /l/ tokens, we identified the point of maximum tongue tip raising (TT gesture), and measured the time lag between TT gesture and the acoustic offset of /l/ (the offset of voicing, or the beginning of the following segment, depending on context). In addition, for all three contexts, we measured the degree of aperture, following a method based on Lin et al. (2014). Specifically, we measured the distance from the highest point of the tongue blade we could consistently image to the hard palate, along a line crossing the centre of the probe (a fan line). We also measured the first two formants towards the end of /l/ (at 90% of Vowel+/l/ sequence), since previous studies cite decreased F1-F2 distance as a primary acoustic correlate of /l/-darkening and /l/-vocalisation (Carter, 2002; Lin et al., 2014).

In our speaker group, there were two advanced vocalisers: YF4 and YF6. YF4 consistently produced TT gestures that were, however, considerably reduced and delayed beyond the offset of voicing (by 54 ms on average). YF6 did not produce identifiable TT gestures in the *fool#five* context. For her, TT raising blended with the transition into the following segment.

The remaining 10 speakers typically produced clearly identifiable and audible TT gestures that

differed, however, in timing and magnitude. We used data from these speakers to analyse delay and reduction in incipient /l/-vocalisation, based on two linear mixed-effects regression models. We used comparisons of nested models to establish whether individual main predictors made a significant improvement to model fit. Based on this method, we established that gestural lag is a significant predictor for reduction: reduced gestures are typically also quite late. We also find that there is more TT reduction in word-final /l/ compared to word-medial or word-final pre-vocalic. Increased reduction is correlated with decreased F1-F2 distance. The timing of the TT gesture is best explained by segmental duration: the shorter the /u:l/ sequence, the closer the TT gesture to the offset of voicing. Reduction, on the other hand, is not a significant predictor of gestural delay, which suggests that the TT gesture may occur relatively late, yet be fully realised.

In summary, we find that reduced TT gestures are also typically delayed, but the reverse is not true: TT gestures may be delayed without being reduced. Our findings indicate that gestural delay may be an independent mechanism in the actuation and propagation of /l/-vocalisation, similar to what has been proposed for Glasgow English derhoticisation (Lawson et al., 2016). According to Lawson et al., the relative timing of the apical consonantal gesture in Glasgow /r/ varies, depending on social class. Specifically, the tongue tip gesture may occur relatively late for working class speakers, creating the auditory percept of /r/-loss. In our case, we do not have direct evidence that the variation is sociolinguistically systematic, since the sample was not appropriately stratified. However, we expect that some aspects of the articulatory variation are indeed sociolinguistically relevant, since we find the same delay and reduction patterns, albeit more advanced, in the two categorical vocalisers, who are in further stages of the sound change. An emerging question for future variationist studies concern the conditioning of delay only and delay+reduction patterns: are the two in free variation, or do they vary according to social and/or linguistic factors? Meanwhile, our findings highlight the benefit of integrating acoustic and articulatory methods in such further exploration, as well as in other variationist research, since the small adjustments in articulatory timing we observe are not directly measurable from the acoustics.

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