A corpus and articulatory study of covert articulatory variation and its phonological consequences in Raleigh, NC English

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We are investigating the relationship between covert articulatory variation and phonetically conditioned variation and change. Covert articulatory variation occurs when talkers use different articulatory strategies to produce sounds that are not easily distinguished acoustically or auditorily. A classic example of covert articulatory variation is the range of tongue shapes used to produce English /ɹ/. Delattre and Freeman (1968) described several tongue postures, often grouped into categories such as bunched, blade-up, and retroflex, that are used to produce sounds that are effectively indistinguishable by listeners. We take the position that the actuation of sound change (that is the emergence of an innovative variant) is likely to occur during primary language acquisition, before large social networks develop. That is, a child picks up the ambient language in their home and small social environment, from caregivers and peers (e.g., siblings, day care), hypothesizing phonological targets for each sound from the acoustics of the language, which are not necessarily the same targets as those of their parents or peers. Then the child must solve the problem of how to form articulations that reach these acoustic targets. There are multiple ways to solve this problem for each sound and sound grouping. Some solutions can lead to exaggeration of an existing low-level variant pronunciation (for example, as [tʰɹ] developed into [tʃɹ], and we hypothesize that [s̠r] could develop into [ʃɹ]). Multiple children will have come up with the same variant solution, which will then be shared with peers, and it will either catch on or or it won't, and here is where social factors can boost or repel a possible sound change, but each new generation of talkers undeniably brings their own phonology to the marketplace.

An important implication of covert articulatory variation is that the coarticulatory effects of distinct articulatory gestures should differ from each other, with potentially important consequences, especially for the many consonants and vowels that are involved in phonetic or phonological patterns that are conditioned by covertly variable sounds. Any sound pattern that is sensitive to the range of hyper- to hypo-articulated speech (Lindblom, 1990) will be sensitive to differences in the articulation of its trigger.

Prototypical covert articulatory variables are not related to any social factors that might be useful for describing a speech community. This means that the communities involved in the inception and spread of a sound change are necessarily heterogenous with respect to covert articulatory differences that may be directly relevant to the phonetic motivation for a change or to the interpretation of innovative variants.

We hypothesize that covert articulatory variation predisposes certain individuals to produce sounds in a way that may be treated by other individuals as innovative, potentially leading to community patterns. Individual articulatory differences are therefore a potential source of variation even in groups of talkers who are doing their best to talk the same way as each other. We hypothesize that the phonetic consequences of covert articulatory variation are particularly challenging for listeners to compensate for, because the relationship between coarticulatory cause and effect is unclear to a listener who has no way to estimate the talker's coarticulatory motivation. As long as the covert articulatory variable remains relevant for a sound change as it progresses, it will continue to enable incrementation (or regression) of the change. Furthermore, since talkers with different covert variants may have different degrees of phonetic motivation for a particular sound pattern, covert articulatory differences provide a way to distinguish between the direct influence of articulatory factors (which apply to individuals) and emerging community-level speech norms.

Following Baker et al. (2011) and De Decker and Nycz (2012), we predict that articulatory variation is more likely to lead to sound change if it is covert. However, we think it is probably premature to predict a typology of covertly-motivated sound changes, because our knowledge of covert variables is limited to a small number of well-known patterns, and a search for previously unknown covert variables has (to our knowledge) not been conducted.

Ohala (2011) has argued that the most obvious active role taken by speaker-listeners is to *maintain* accepted norms, and studies of variation and change have repeatedly revealed striking uniformity even in changes in progress and stable variation, and in the internal factors governing changes (Guy, 1980; Labov, 2009; Forrest, 2014). Ohala (1989, 175) emphasizes the importance of "hidden" variation, i.e., that "speakers exhibit variations in their pronunciation which they and listeners usually do not recognize as variation." By definition, covert articulatory variables are linguistically relevant facts that cannot be determined by the community. If the cause of coarticulation is covert, perceptual compensation for it is a more challenging task for the listener (Beddor, 2009), and interaction between individuals with different degrees of coarticulation are particularly likely to result in the exaggeration of coarticulation that is necessary for articulatorily-driven sound change.

We are examining several sound patterns related to covert articulatory variables in a 135-talker sample of the Raleigh Corpus (Dodsworth and Kohn, 2012) and a corpus of ultrasound and video articulatory data from a demographically overlapping group of 29 talkers. The articulatory variables under investigation are posterior constriction location in /l/ and back vowels, and the aforementioned /ɹ/ variable, which is the focus of this abstract.

Research on /ɹ/ in North American English shows that about half of all talkers produce only bunched /ɹ/ and half produce retroflex /ɹ/ in at least some phonological contexts (Mielke et al., 2016). The acoustic difference between these /ɹ/ types is believed to be limited to F4 and F5 (Zhou et al., 2008), and therefore it is difficult or impossible to identify an /ɹ/ just by listening. The choice of /ɹ/ variant (or variants) used by a talker appear to be idiosyncratic, with twins even being observed to use different tongue shapes (Magloughlin, 2016).

Several phonetically motivated English sound patterns appear to be triggered by /ɹ/. Affrication in /tɹ/ and /dɹ/ clusters is increasing in apparent time in Raleigh (Magloughlin, 2017), and /stɹ/ retraction is increasing among some talkers (Wilbanks, 2016). Both are contexts where /ɹ/ is overwhelmingly produced as bunched, but Baker et al. (2011) found that variation between bunched tongue shapes could account for differences in the degree of retraction. /s z/ retraction is also observed where these sounds meet /ɹ/s across word boundaries. This does not appear to be a change in progress in Raleigh. While male Raleigh talkers' /s z/ productions appear to be generally less retracted over time (Wilbanks, 2016), some talkers, male and female, still appear to have a consistently retracted /s/ when followed by /ɹ/, as evidenced by a relatively stable center of gravity as opposed to a dynamic center of gravity for purely coarticulatory effects. This is similar to the way that many English speakers have a consistently palatalized /s/ when followed by /j/ (Zsiga, 1995). We hypothesize that /ɹ/ bunchers are likely to be the first speakers to develop robust enough retraction in /s z/ that tongue retroflexers are more likely to perceive them as similar to /ʃ ʒ/. If they adopt these variants, then, using an entirely different tongue posture, for these talkers, the change will be phonologized, with an even more retracted target.

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