Listeners compensate for asymmetric sound change distribution of /s/-retraction in American English

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Introduction: Researchers have proposed that perceptual compensation may be linked to sound change actuation, as a change begins when listeners do not compensate for extreme coarticulatory information (e.g. Ohala 1993). Instead, listeners encode a new speech target, which may influence later productions, even in environments where coarticulatory triggers are not present. Less work, however, has examined the role perceptual compensation plays in on-going sound changes. Notable exceptions, like Harrington et al. (2008), have focused on vowel shifts, finding apparent time support for Ohala's hypothesis: as the sound change progresses to environments without coarticulatory triggers, younger listeners compensate less for coarticulatory effects.

The present study examines perceptual compensation for /s/-retraction, an American English sound change in progress in which /s/ approaches [ʃ] in /stɹ/ clusters (Shapiro 1995), but rarely in /s{p, k}ɹ/ clusters. Accounts of /s/-retraction propose that /ɹ/ exerts a coarticulatory influence on /s/ across the intervening /t/. However, while /t/ is shown to have a slight dampening effect on /s/ in /st/ clusters, and while /s{p, k}ɹ/ show some coarticulatory effects (Baker et al. 2011), there does not appear to be a definitive coarticulatory explanation for the asymmetric distribution of the phenomenon. Furthermore, for some individuals, the change appears to be phonologized, where /stɹ/ clusters can be said to be reanalyzed as /ʃtɹ/ clusters, but this is never observed for /s{p, k}ɹ/ clusters. Finally, it it crucial to note that English phonotactics do not permit /ʃ/ preconsonantally, potentially encouraging more extreme coarticulation without the need to maintain a phonological contrast. This study seeks to examine listeners perception of /s/ and /ʃ/ in these environments to better understand the nature of this asymmetric distribution.

Methods: Due to the lack of contrast /s/ and /ʃ/ preconsonantally, this study utilizes nonce words to identify listeners' phoneme category boundaries. Two model talkers (males, ages 19 and 21) recorded the nonce words *s{p,t,c}rimble* /s{p,t,k}ɹɪmbəl/ as well as the prevocalic equivalents *simble* /sɪmbəl/ and *shimble* /ʃɪmbəl/. The onsets from the prevocalic contexts were extracted and digitally mixed, using a script modified from Darwin (2005), to create a seven-step continuum from /s/ to /ʃ/. Each step was cross-spliced onto the preconsonantal target word, creating a continuum from /s{p,t,k}ɹɪmbəl/ to /ʃ{p,t,k}ɹɪmbəl/.

Thirty-one participants completed a forced choice (non-)lexical decision task in a sound attenuated booth. Participants were presented with the orthographic nonce word choices and responded with a key selection. Each step was played a total of four times for both speakers.

Results/Discussion: Listeners' responses (/s/ or /ʃ/) were modeled using a logistic mixed effects regression with TARGET (STR, SKR, SPR), STEP (1–7, scaled), and SPEAKER as independent variables. Additionally, random intercepts for listener and by-listener random slopes for TARGET, improved model likelihood, suggesting significant individual variability.

The results of the model find that /stɹ/ clusters are significantly more likely to receive an /s/ response at higher steps than /spɹ/ and skɹ/

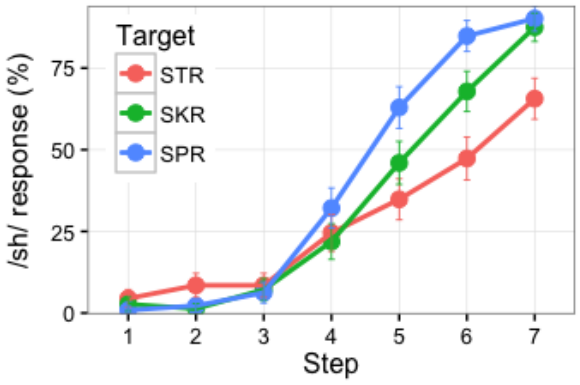

Figure 1: Percentage of /ʃ/ responses (y-axis) as a function of increased /ʃ/ mixing ratio (x-axis) by target cluster (COLOR: red = /stɹ/, green = /skɹ/, blue = /spɹ/).

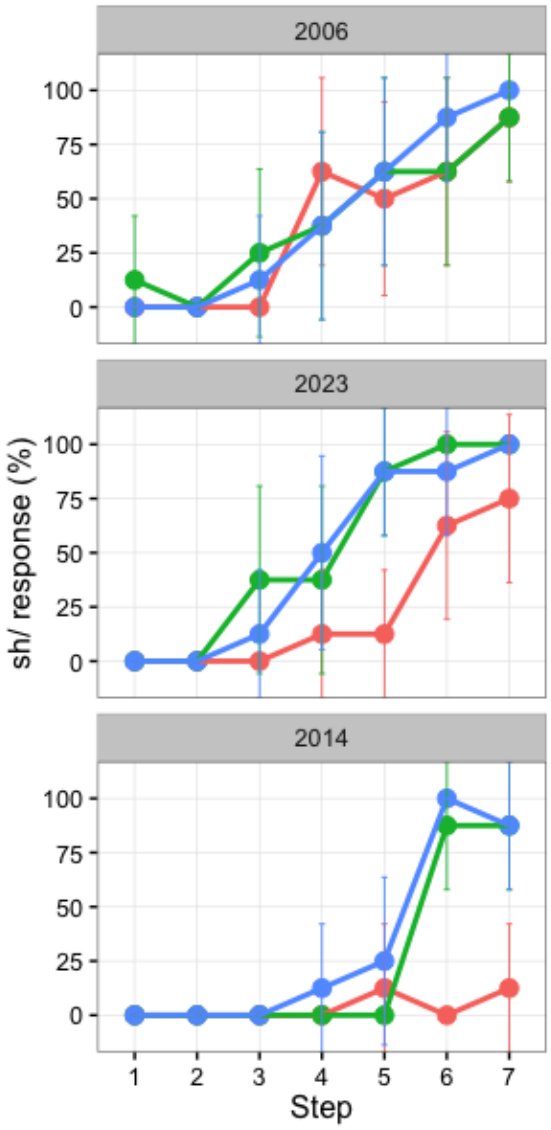

Figure 2: Individual variation (panels) in percentage of /ʃ/ responses (y-axis) as a function of increased /ʃ/ mixing ratio (x-axis) by target cluster (COLOR: red = /stɹ/, green = /skɹ/, blue = /spɹ/).

clusters ($p < 0.001$). Because /ʃCɹ/ clusters are phonotactically illicit in English, a bias toward /s/ may be expected in all clusters, but no difference is predicted between /stɹ/ and /s{p, k}ɹ/ clusters on phonotactic grounds alone. Rather, these results provide empirical evidence for perceptual compensation of /s/-retraction, as individuals continue to perceive the onset as /s/ due to coarticulatory influences in /stɹ/ clusters, despite the fact that retraction is plausible, but not observed, in /s{p, k}ɹ/ clusters. Additionally, it is crucial to note that perceptual compensation here manifests not simply as a shift in the response curve, but rather as a dampening in /ʃ/ responses in the second half of the continuum, shown in Figure 1. This finding is best explained to the lack of phonological contrast preconsonantally, allowing listeners to perceive what may be unambiguously perceived as /ʃ/ without context, as /s/ in /stɹ/ clusters due to perceived extreme coarticulation, but not in /s{p, k}ɹ/ clusters, where listeners do not expect coarticulation.

The model also suggests a high degree of individual variability, illustrated in Figure 2. Some individuals (2006: top panel) exhibit no effect of cluster, showing no evidence for perceptual compensation for coarticulation. Others (2023: middle panel) mirror the population-level pattern, exhibiting compensation for coarticulation in /stɹ/ clusters. And some individuals (2014: bottom panel) give no /ʃ/ responses at all in /stɹ/ clusters. The individual differences in perception strategies may encode meaningful information about individuals' experiences and phonologies. Individuals who exhibit no perceptual compensation for /stɹ/ clusters may be speakers from communities where /s/-retraction is not yet common, and thus /stɹ/ clusters only exhibit nominally more coarticulatory effects than /s{p, k}ɹ/ clusters. Similarly, speakers who exhibit compensation to the point of never perceiving /ʃ/ preceding /tɹ/ clusters, may be speakers from communities that have advanced or phonologized retraction, not yet consciously represented as /ʃ/ due to English orthography. Taken together, these different perception strategies for a sound change in progress demonstrate how one's experiences shape their phonology, which in turn can influence their perception and future production, actuating and propagating novel sound changes.

Selected references • Baker, A., D. Archangeli & J. Mielke. 2011. Variability in American English s-retraction suggests a solution to the actuation problem. *LVC* 23. 347–374. • Darwin, C. 2005. *Digital mixing script*. University of Sussex. • Harrington, J., F. Kleber & U. Reubold. 2008. Compensation for coarticulation, /u/-fronting, and sound change in standard southern British: an acoustic and perceptual study. *JASA* 123(5). 2825–2835. • Ohala, J. 1993. The phonetics of sound change. In C. Jones (ed.), *Historical linguistics: Problems and perspectives*, 237–278. London: Longman. • Shapiro, M. 1995. A case of distant assimilation: /str/ → /ʃtr/. *AS* 70(1). 101–107.