

Word on the Shtreet

Palatalization in /str/ Clusters in Young Western American Speakers

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This study investigates the presence of palatalization in the initial fricative of /str/ clusters in the speech of young adult speakers of Western American English. A total of 1,200 observations were gathered from thirty speakers, including samples of the /str/ variable as well as /st/ and /ft/ controls. The level of palatalization in each sample was quantified using acoustic analysis of the sound's center of gravity. Statistical analysis revealed a significant difference in the pronunciation of the sampled /str/ clusters compared to both the /st/ and /ft/ controls.

The focus of this paper is the phenomenon of retraction, or palatalization, of the initial /s/ fricative in the English /str/ cluster. This cluster can be found word-initially in words such as *strength* and *street* as well as word-medially, as in *Australian* and *construct*. When retraction occurs, articulation of the /s/ fricative shifts from an alveolar to post-alveolar locus, with the potential to be realized as the post-alveolar [ʃ]. Thus, the word *street* would be pronounced as [ʃt.ɹi:t] rather than [st.ɹi:t].

Literature Review and Predictions

Smith, Mielke, Magloughlin, and Wilbanks note that the mechanism most commonly cited as being responsible for this change is the long-distance assimilation with the cluster's final /ɹ/ sound and highlight the similar, although less widely studied phenomenon through which /dɹ/ and /tɹ/ become affricated in pronunciations such as *dream* [dʒ.ɹim] and *tree* [tʃ.ɹi] (2019). Retraction in the /str/ cluster has been documented in speakers from Britain, New Zealand, and the United States (Rutter, 2014). Durian suggests that the feature was strongly associated with urban speakers in the Columbus, Ohio, region, although growing in prevalence among all groups studied, and also suggested the existence of intermediate forms between [s] and [ʃ] (2007). Shapiro suggests that this instance of language change is “neither dialectal nor regional” and noted the feature in the speech of public figures from around the country (1995). Rutter was surprised to find the [ʃt.ɹi] variant in the read speech of only three out of eight mothers participating in a study on language acquisition in Oklahoma City despite the “perceived prevalence” of the feature in the area, although a greater number of the women were seen to use the variant in natural conversation (2014). It was also noted that the form may be used in some words containing the cluster and not others (Rutter, 2014). The collection of data on this topic for the purpose of acoustic analysis has proved successful when centered around the use of spectral analysis and comparison with instances of /s/ and /ʃ/ gathered from speech outside of the cluster (Rutter, 2011). This is supported by the more general observation that the place of articulation of English fricatives can be classified through the use of various acoustic cues, including spectral peak analysis (Jongman et al., 2000).

Notably, little of the work done concerning this change in American English has centered on speakers in the American West. The research outlined above suggests that the prerequisite influence for the change, namely the qualities of the English /ɪ/, are in place in the region, and the phenomenon is broadly observed enough that its occurrence in the West is likely, although it may prove to be variable. This article attempts to fill that gap by investigating the presence of /str/ retraction in young adult speakers in the American West. It seeks to determine through acoustic analysis whether the initial fricative in /str/ differs significantly from occurrences of /s/ and /ʃ/ outside of the /str/ cluster context. My hypothesis is that the overall data will suggest a significant difference between /str/ and /s/. If this occurs, the /str/ fricative may have begun to resemble /ʃ/. Whether this hypothesis will be supported or rejected depends on whether the average center of gravity of the /str/ fricative, determined through spectral analysis, closely resembles or differs from the average centers of gravity of /s/ and /ʃ/ determined by similar means from speech from the same speaker. I expect that the /str/ average will differ significantly from at least one of the controls. The remainder of this article discusses the methods used to gather data, the analysis conducted, and the conclusions that can be drawn from the results.

Methods

Data for this project was gathered through solicited recordings from speakers fitting the general demographic description of young adults from the Western United States. Participants were asked to read a word list of eighty words, with forty being filler words and twenty, ten, and ten meant to target the /str/ cluster and /st/ and /ʃt/ controls, respectively. The words selected to represent both /str/ and /st/ were split evenly between word-initial and word-medial occurrences, while only one word-initial /ʃt/ word was used due to the rarity of the cluster in that position in the standard English lexicon. The mix of positions and vowels used in the selected words should mean that they are sufficient to represent the majority of environments in which the phenomenon of retraction may or may not occur. Notably, the use of read speech may result in fewer observations of the phenomenon than would occur in conversational speech, as noted in previous research. The words, sorted by category, have been included below.

Speakers were selected using convenience sampling methods; all were current students located through their residence in on-campus housing at Brigham Young University. This has notable demographic implications, as the pool drawn from is disproportionately white, active in the Church of Jesus Christ of Latter-day Saints (LDS), and middle-class or higher when compared with young adults in the Western United States generally. This may mean that the data gathered reflects the prevalence of the feature in relation to one or more of those sociolinguistic categories rather than to the target group as a whole. Speakers ranged from eighteen to twenty-four years of age, with sixteen females and fourteen males. Speakers self-identified as being from their specified Western American state. The final count included two speakers from Colorado, four from California, two from New Mexico, six from Washington, eight from Utah, five from Arizona, and one each from Idaho and Oregon. Notably, not all states in the West were represented. Although small compared to the represented population, the sample size of forty words from thirty speakers—1,200 individual observations—should be sufficiently large to observe overall trends, including statistically significant differences between the /str/ fricative and the controls, as well as variance between speakers.

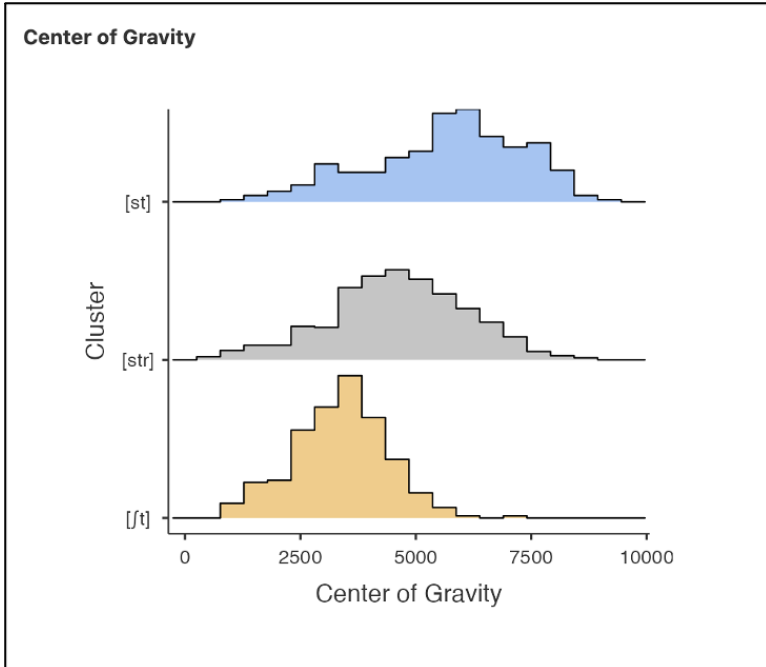
After the recordings had been gathered from each speaker, the targeted fricative in the /str/, /st/, or /ft/ cluster was located. A spectral slice was then taken from a selection of the fricative roughly 0.05 seconds in length, and the center of gravity, or average frequency of the sound, was taken from that selection. These center of gravity measurements were used in the statistical comparison of /str/, /st/ and /ft/.

Results

The mean center of gravity measurements for the three groups are as follows: /st/ 5,655, /ft/ 3,365, /str/ 4,609. The median measurements are quite similar: /st/ 5,866, /ft/ 3,391, /str/ 4,606. The spread of center of gravity measurements in Hz for the words in each category can be seen in Figure 1 below. There is a significant trend in which the /st/ measurements cluster towards a higher average measurement than either /str/ or /ft/, with /str/ displaying a higher average than /ft/. This suggests that, as expected, the average center of gravity of the /str/ fricative is measurably distinct from the fricative in either control category.

Of the three groups, /ʃt/ seems to have the least variance in measurements. This may be due in part to the difference in the acoustics of word-initial and word-medial fricatives, which will be discussed in greater detail below.

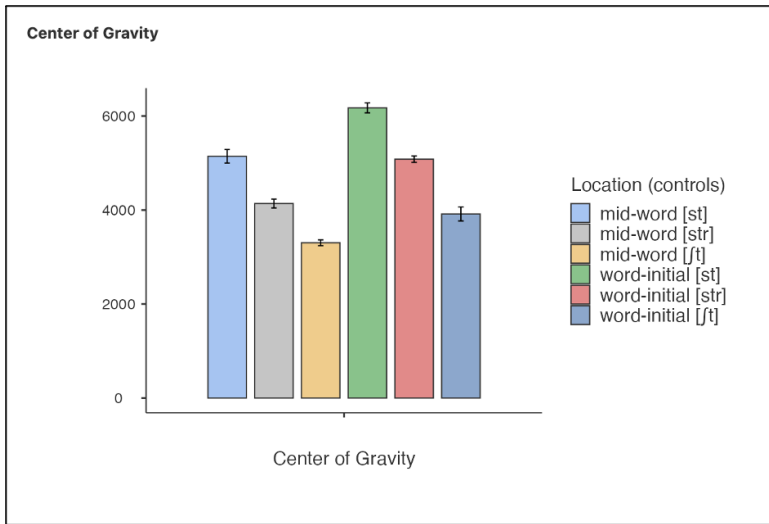
Figure 1



Further statistical analysis was needed to confirm the significance of these initial findings. The test run was a One-Way Kruskal-Wallis ANOVA (assumptions of normality were not met), which showed that there was a significant difference across the group: $\chi^2 = 304$, $df=2$, $p < .001$. To determine where exactly these differences lay, a post-hoc DSCF pairwise comparison was conducted. The results confirm that there is a significant difference between every combination of cluster pairs. For /st/ and /str/, $W = -13.1$, $p < .001$. For /str/ and /ʃt/, $W = -22.1$, $p < .001$. The difference between /st/ and /ʃt/ was also statistically significant, $W = -18.0$ and $p < .001$, although this was to be expected in the presence or absence of /str/ palatalization due to the documented acoustic differences of the two fricatives.

As mentioned previously, the /ʃt/ fricatives seem to have the least variance in center of gravity measurements of the three groups. This is supported by a closer look at the numbers. The standard deviation for the /ʃt/ group was 1013 Hz, compared to 1631 Hz and 1498 Hz for the /st/ and /str/ fricatives, respectively. This may be because the /ʃt/ words selected for the word list were mostly word-medial, whereas the words representing the other clusters were split evenly between word-initial and word-medial occurrences. Figure 2 displays the general trend surrounding the effect of the position of the cluster on the average center of gravity. Each word-initial average is noticeably higher than the average for its word-medial counterpart. The lack of word-initial representation may have resulted in an artificially low and artificially homogenous collection of measurements for the /ʃt/ fricative group compared to the other classes of fricatives. This may mean that the distance between the /str/ and /ʃt/ groups was increased due to the word-medial /ʃt/ sampling bias.

Figure 2



The fact that the center of gravity of the /str/ differs significantly from both the /ʃt/ and the /st/ groups has two basic potential explanations. The first would be that the majority of the speakers produce a fricative in /str/ that is somewhere between the traditional [ʃ] and [s] sounds used in the control groups. The second would be that no significant intermediate form is used, and the middle of the road average of the /str/ fricative is attributable to

the fact that some speakers use palatalization in their speech, producing an [ʃ]-like sound, and others do not, producing a consistently [s]-like sound. An alternate version of this explanation could be that the cluster is prone to palatalization in certain words and not others. A closer look at the speech of individual speakers as well as the acoustics of individual words may help to determine which explanation is more likely.

The various speakers' pronunciations of the word *strength* may be taken as a case study to look more closely at the differing levels of retraction employed in a single word. *Strength* was chosen because it had the highest average standard deviation of the word-initial /str/ cluster group. The word-initial group is preferred here over the word-medial group due to the decreased chance of influence from a preceding sound. The minimum center of gravity measurement for *strength* was 2319 Hz, which falls below the average center of gravity for even the /t/ cluster fricatives. The maximum center of gravity measurement for *strength* was 8723 Hz, a figure well above the average for /st/ cluster control words. The maximum measurement was taken from the recording of speaker 7, and the minimum measurement was taken from the recording of speaker 26. Figure 3 displays the sound wave produced by each speaker during their pronunciation of the word, while Figure 4 displays the spectrogram and intensity contour associated with the same section of speech. Note that speaker 7, with the most [s]-like center of gravity, is the top image in each

Figure 3

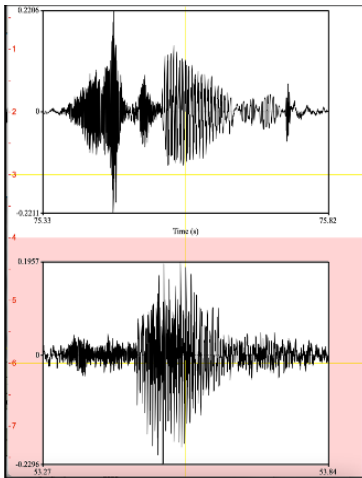
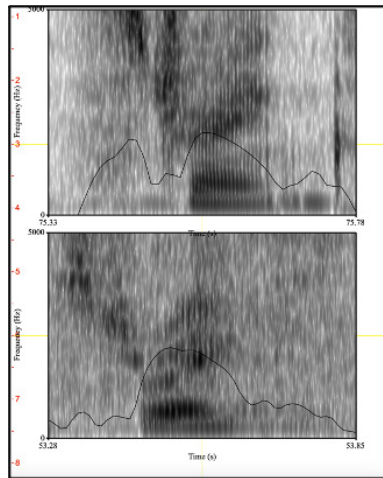


Figure 4



figure, while speaker 26, with the most [ʃ]-like center of gravity, is the bottom image.

Speaker 7's [s]-like pronunciation clearly displays a spike in intensity around the initial fricative that speaker 26's [ʃ]-like pronunciation does not. Speaker 7's spectrogram also shows activity concentrated in a much higher area than is apparent on speaker 26's spectrogram. To a listener, speaker 7's fricative more clearly gives the impression of an [s] sound, while speaker 26's is more distinctly an [ʃ]. This observation was supported by the judgment of a few lay listeners with no training in linguistics.

A similar phenomenon can be observed within the speech of a single speaker. Speaker 18, for example, produced /str/ cluster fricatives with variable centers of gravity. The highest of the word-initial /str/ group was *strength*, with a center of gravity of 6742 Hz, once again above the average for the /st/ control. The lowest was *straight*, with a center of gravity of 2571 Hz, below the average for the /ʃt/ control. Figures 5 and 6 provide visuals for each word, with *strength* included above and *straight* below. Similar observations can be made about the intensity of each fricative as in the comparison between speakers 7 and 26.

Although only two examples of many, the comparison of the same word across two speakers and of two productions of a cluster by the same speaker suggest that the distinct average of the fricative in the /str/ cluster when compared with the /st/ and /ʃt/ fricatives is due at least in part to the variable presence

Figure 5

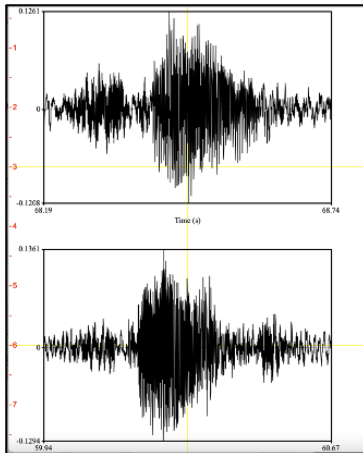
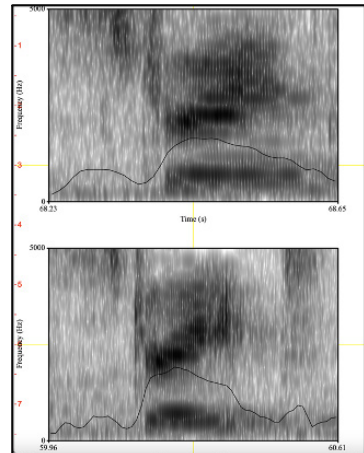


Figure 6



of palatalization in the group studied. This does not, however, rule out the possibility of intermediate fricative forms in the /str/ cluster that are consistently distinct from the fricatives in the /st/ and /jt/ clusters in the speech of individual participants. Further analysis could reveal that these forms are also partially responsible for the /str/ cluster's distinct center of gravity.

Conclusion

The most significant aspect of my findings is the statistically significant difference between the center of gravity measurements for the fricatives in the /st/ and /str/ clusters. This difference supports my hypothesis and is evidence for the retraction of the /str/ fricative in the speech of speakers in the American West. The presence of this feature and its effect on the acoustic properties of the fricative is in keeping with the methods and expectations set by previous research. Whether /str/ retraction is truly a phenomenon “neither regional nor dialectal” remains a matter open for debate, these findings help confirm the perceived prevalence of the feature in the United States as well as the possibility of continued spread (Shapiro, 1995).

There remains much work to be done on this topic. The speakers in this study were drawn from a large geographical area, with representation from eight states. Further work could target smaller areas to compare the prevalence of the feature across the region. Similarly, as was noted above, the participants in this study were relatively homogenous in terms of race, religion, culture, and socioeconomic background. Many of these factors can be dividing lines for sociolinguistic variance, and further work could examine the prevalence of the feature among a more diverse group and work towards uncovering the factors that correlate most strongly with its presence and spread. This is especially true of age, and as this article focused on the speech of young adults, a comparison with other age groups could yield interesting results concerning the changing prevalence of the feature across generations. The relationship between articulation and the position of the cluster also warrants further investigation, in particular the question as to whether the change in acoustic properties is at all related to a tendency for palatalization to occur in certain positions more than others.

On a broader level, the investigation of the phenomenon of /str/ retraction offers unique insight into language change and its

perception among speakers. Although documented around the world and inconsistent with standard English orthography, the [ʃtɹ] variant frequently goes unnoticed both by speakers who use it and speakers who do not. Unlike other examples of language change, including features associated with young speakers, there seems to be little stigma associated with the phenomenon. Changes that involve assimilation have sometimes been moralized as indicating laziness or carelessness, but this does not seem to be the case for [ʃtɹ] speakers, at least on a conscious level. Is the feature's prevalence across countries, classes, and other typical sociolinguistic boundaries the reason that the change has largely gone unnoticed? Or can the lack of commentary be attributed to some aspect of the English language, whether it be orthographical, acoustic, or otherwise, that dulls the average speaker's awareness of the change? The answer to these questions has the potential to touch on language at many levels, from the social to the neurological. Regardless of the cause, the variability of the phenomenon within a pool of relatively homogenous speakers—and sometimes within the speech of a singular individual—sheds light on how language change can move from the periphery to the standard in a relatively short period of time without gaining the collective awareness of the population of speakers. In this way, the study of /str/ retraction offers a glimpse into a process central to languages across the world.

References

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