(thr)-Flapping in American English: Social factors and articulatory motivations

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Abstract This paper is the first dedicated study on (thr)-flapping, or the insertion of a tap in /θɹ/ clusters in American English. While [ɾ] is often described as an allophone of alveolar stops, it is not normally associated with /ɹ/ in American English speakers. Using data collected from word lists by 85 speakers in Washington and Utah, I show that (thr)-flapping is a significant minority variant, especially in Utah. I propose sociolinguistic factors that account for the difference between these two states and suggest articulatory motivations for flapping in this environment. This paper lays the groundwork for additional research on (thr)-flapping.

1 Tapping and Flapping in English

The tapping or flapping of /t/ and /d/ in American English is a textbook example of a phonological rule (Hooper 1976: 112, Hawkins 1984: 47–48, Nathan 2008: 87–88, Hayes 2011: 32, Odden 2013: 20–21, Kennedy 2017: 28), stating that alveolar stops become taps [ɾ] when they are intervocalic and the following vowel is unstressed. While the exact phonetic realization of these taps varies across speakers and dialects, it is clear that [ɾ] is related to both /t/ and /d/ in American English.

In other varieties of English, [ɾ] can also be an allophone of the rhotic /ɹ/. This is heard in the English West Midlands in intervocalic position as in *merry*, *sorry*, and very and also in consonant clusters as in *bright*, *great*, and *cream*, though there is considerable sociolinguistic variation (Clark 2008: 173). In Scotland, the use of [ɾ] is common and varies in frequency depending on sociolinguistic and phonological factors (Stuart-Smith 2008: 65).

What is less common is a tap or flap being an allophone of /ɹ/ in American English. Dr. Martin Luther King Jr. occasionally used taps post-vocalically in his speeches, as in the phrases *river of life* or *never appear in*, but his usage of [ɾ] was "quite noteworthy" (Wolfram et al. 2016: 282). It may have also been a part of the

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speech in some European American southerners after [θ] as in *three* (Thomas 2008: 106). But [ɾ] is not normally a part of descriptions of American English other than as allophones of /t/ or /d/.

This consonant cluster in particular, /θɹ/, is the focus of this paper. In anecdotal observations from a variety of speakers of American English, I have heard flapped variants of the rhotic after /θ/—a phenomenon I am calling (THR)-FLAPPING. Specifically, it appears that a voiced or voiceless flap is inserted between the fricative and the rhotic ([θɾɹi] 'three'). Articulatorily, flaps after /θ/ are plausible: for speakers with retroflex [ɹ], as the tongue tip moves from interdental position to curled behind the alveolar ridge, there is a small period of transition that is described as r-colored, voiceless frication (Olive et al. 1993: 290–291). For some speakers then, during this movement from the fricative to the rhotic, the tip makes brief contact with the intervening alveolar ridge. Perhaps this gesture, which may have started off accidental, was phonologized by some speakers. For speakers with a bunched [ɹ], there is no clear explanation for flaps in this environment, and it is possible that these speakers would not have flaps.

The purpose of this study is to describe the frequency and social patterns of (thr)-flapping in two Western American communities. Allophonic variation in /θɹ/ has been mentioned briefly in descriptions of other English varieties like Southern American English (Thomas 2008: 106), Scottish English (Stuart-Smith 2008: 63), and Maori English (Warren & Bauer 2008: 81–82), but to my knowledge, this study is the first to specifically focus on (thr)-flapping. An articulatory-based motivation for (thr)-flapping may be a contributing factor, but it cannot be the only reason for flapping in this environment simply because not all speakers use the variant. Based on frequency differences between these two Western communities, I propose that this variant is socially conditioned, perhaps serving as an indicator of careful speech.

As a note on terminology, the term *flap* will be used to describe this particular speech sound in this paper. While the terms *tap* and *flap* are often used interchangeably, Ladefoged & Johnson (2015: 186–187) differentiate the two: a tap is when the tongue engages in an up-down motion (as in *city*) and a flap for a back-to-front gesture (as in *dirty*). In this case, the front-to-back gesture in (thr)-flapping is a different pattern. Instead of splitting hairs, I will simply expand the term *flap* to cover any a horizontal gesture (whether front-to-back or back-to-front) and retain the use of *tap* for vertical movement.

2 Methods

(thr)-flapping is one of several phonological processes in English that occur in relatively few words and its appearances in natural discourse are few and far between. Sociolinguistic variables are easiest to study when they are frequent (Labov 1966) because many tokens are needed for a robust quantitative analysis. However, infrequent phonological variables can still be subject to sociolinguistic variation and can inform linguistic theory. For example, there is a considerable amount of phonological, morphological, lexical, and regional factors in the set of English words with the sequence /ɛg/ (*beg*, *integrity*, *segment*), despite the set being so small (Stanley 2019a,b). Dinkin (2016) shows that /ɑ/ merges with /ɔ/ in upstate New York only when preceded by a coda-/l/; *ie*. words like *doll*, *golf*, and *involve* are realized with the same vowel as *small*, *mall*, and *alcohol*, while others like *solid*, *college*, and *volunteer* do not. Existing mechanisms of phonological merger were inadequate to describe this pattern, so the pattern in this small set of words resulted in what Dinkin (2016) calls "merger by phonological transfer." (thr)-flapping is another case where even though the number of words containing the sequence is small, it can shed light into sociolinguistic and phonological theory.

2.1 Word Selection

To select the words for inclusion for this study, I turn to two large dictionaries that contain searchable phonetic transcriptions[1]. The first is the *Carnegie Mellon Dictionary*, which contains approximately 133,000 entries. A search of this dictionary yielded 224 word forms containing the sequence "TH R", which corresponds to /θɹ/. The second was the *Routledge Dictionary of Pronunciation for Current English* (Upton & Kretzschmar Jr. 2017)[2], which contains over 92,000 entries. Searching for the string "θr" resulted in 296 entries. After combining these two and removing duplicates, there were 504 unique word forms.

Using all 504 words in a study would make for a thorough but tedious task, so most of these words had to be systematically excluded until a reasonable subset remained. To begin, the majority of these words were derived forms from the same lexemes (conjugated verbs, plural nouns, and possessives). Many also shared the

[1] As it turns out, /θɹ/ is only represented orthographically by <thr>, so any searchable dictionary, regardless of whether it has phonetic transcriptions available, could have worked.

[2] I am grateful to Bill Kretzschmar for providing me a searchable text version of this dictionary.

same root word: there are no fewer than 59 words containing the morpheme *anthro-* (*anthropology*, *anthropomorphic*, *misanthrope*, *philanthropy*, *lycanthrope*), 35 from *three* (*3D*, *three-pointer*, *threefold*, *threescore*), and 23 from *throw* (*overthrow*, *throwaway*, *throw-out*). To reduce unexpected morphological effects that may occur in the data (cf. Strycharczuk & Scobbie 2016), polymorphemic words were not used in this study. After excluding those, approximately 100 words remain. Over two-thirds of these remaining words were proper nouns (*Catherine*, *Jethro*, *Heathrow*, *Winthrop*, *Ethridge*) and others are quite infrequent (*clathrate*, *hypethral*, *pyrethrin*, *thremmatology*, *thrips*, *throes*, *thrutch*). To prevent the possibility of speakers not being familiar with a word they are asked to say,these proper nouns and very infrequent words were removed.

With the remaining tokens, the priority was to include as many different vowels following the /θɹ/ as possible to teIst for the effect of following vowel on flapping. Words were excluded if they were less common (*thrice*, *thrush*) or polysyllabic (*threshold*, *throttle*) and where /θɹ/ was word-medial (*arthritis*, *enthrall*), in unstressed position (*urethra*, *anthropology*), or present only via compounding (*bathroom*, *forthright*) until one or two remained for each vowel. In the end, the following 12 words were selected for inclusion: *three*, *thrill*, *thread*, *threaten*[3], *thrash*, *thrive*, *throb*, *throng*, *throw*, *throne*, *through*, *thrust*. All American English vowels are represented except /e/ and /ʊ/ because, to my knowledge, there are no English words containing the sequence /θɹe/[4] or /θɹʊ/.

2.2 Data

The data for this study comes from sociolinguistic interviews in two states, Washington and Utah. The gold standard for sociolinguistic research is to use naturally occurring data, but, as is the case with infrequent phonological variables, there were relatively few tokens from natural discourse alone. In this case, there was also a massive imbalance in what words were represented: 54% of the (thr) tokens in conversation were *three*, another 32% were forms of *through*, and the remaining 14% of the tokens came from 13 other lemmas. Therefore, in order to

[3]This polysyllabic word was included because it also includes unstressed /tən/ could also serve as a token for the MOUNTAIN lexical set. See Stanley & Vanderniet (2018).

[4]The exception to this are words derived from the name of the region known as *Thrace* in Bulgaria, Greece, and Turkey. Such words include *Thracian* and the prefix *Thraco-*. However, these words would have been excluded anyway because they are proper nouns and probably unfamiliar to most people.

achieve a balance across speakers and tokens, this study uses data collected from word lists at the end of the sociolinguistic interviews.

The Washington corpus was collected in the summer of 2016 and represents a portion of the word lists that were read by 33 native English speakers from Cowlitz County in southwest Washington State. There were 29 women and 25 men ranging from 18 to 86 years old. At that time, (thr)-flapping was not a primary research question, so only five words (*thrill*, *thread*, *throb*, *throw*, and *through*) were included, though they were selected because they contain /θɹ/ before a variety of vowels. Ten utterances were excluded because of speech errors and poor audio quality, so there were 155 (thr) tokens in this analysis from Washington.

The Utah corpus was collected in January 2018 and contains speech from 52 native English speakers from Wasatch County, Utah. These 35 women and 20 men represent a wider age range, from 5 to 98 years old. These participants also read a word list which contained four[5] of the five words that the Washingtonians read: *thrill*, *thread*, *throb*, and *through*. However, because of some perceived variation in the Washington data, an additional seven words were included: *thrash*, *threaten*, *three*, *thrive*, *throne*, *throng*, and *thrust*. Some of these tokens were excluded due to bad audio and some participants skipped some of the words, so the total number of (thr) tokens from the Utah corpus was 540.

2.3 Analysis

For the purposes of this paper, the presence or absence of flapping was determined impressionistically and as a binary outcome. While this method is less reliable and more subjective than using some sort of acoustic measure, I chose to code tokens impressionistically for three reasons. First, there are few, if any, definite acoustic correlates with flapping because they are quite variable in American English. There is sometimes a drop in F3 or F4 in intervocalic flaps, but this is not consistent (Espy-Wilson 2004, Warner & Tucker 2017). Furthermore, because the flapping environment in these words was following a voiceless fricative, the flap itself was sometimes voiceless, making formant measurements impossible (see Figure 2 below). The second reason for impressionistic coding was the amount of variation in the realization of (thr), particularly in how the fricative was realized. The precise realization of these variants may be an avenue for future research, especially for

[5]Due to an oversight, *throw* was not included in the Utah word list and is only found in the Washington corpus.

their social conditioning, but the purpose of this paper was simply to describe presence or absence of flapping. The other reason is that there is precedence for an impressionistic coding for tapping (cf. Eddington & Elzinga 2008), and for this cursory study of (thr), I felt that this method was satisfactory.

Therefore, I listened to each of the 695 tokens of (thr) words and decided whether I heard a flap or not, based on auditory cues and aided by an inspection of the spectrogram in Praat. Figures 1, 2, and 3 illustrate some of the variants in this sample. Figure 1 shows the word *thrash* said by Spencer[6], a 27-year-old man from Utah. In this token, the flap is voiced as it is realized after the voicing for [ɹ] begins. In fact, it appears that the [ɾ] is interjected near the midpoint of the [ɹ]. Figure 2 shows the word *through* said by Bonnie, a 70-year-old woman from Utah. This spectrogram shows a voiceless flap that appears to occur during the fricative itself. Finally, Figure 3 shows the word *thread* by Gail, a 64-year-old woman from Utah, which has no indication of flapping auditorily or visually in the spectrogram. The tokens in Figures 1 and 2 were coded as containing flaps while the one in Figure 3 was not. This data was then analyzed using generalized linear mixed-effects models using the lme4 package (Bates et al. 2015) in the statistical software R (R Core Team 2018).

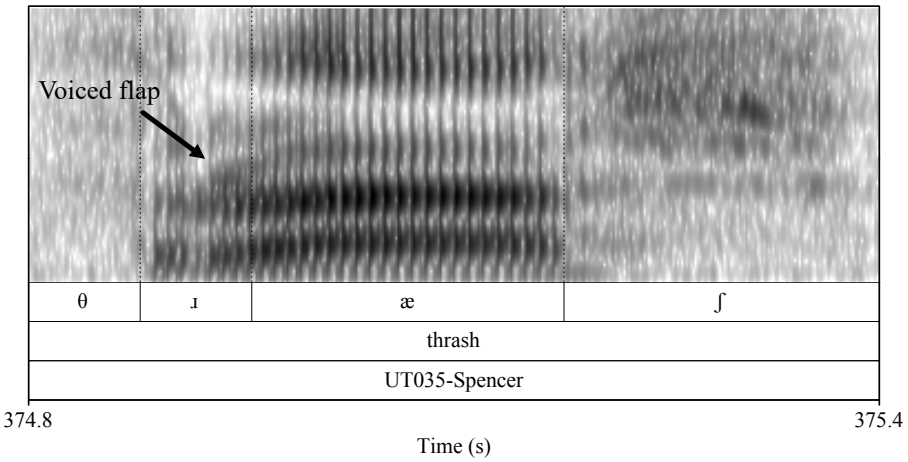

Figure 1 Spectrogram of *thrash*, illustrating a voiced flap.

[6]All names used in this paper are pseudonyms.

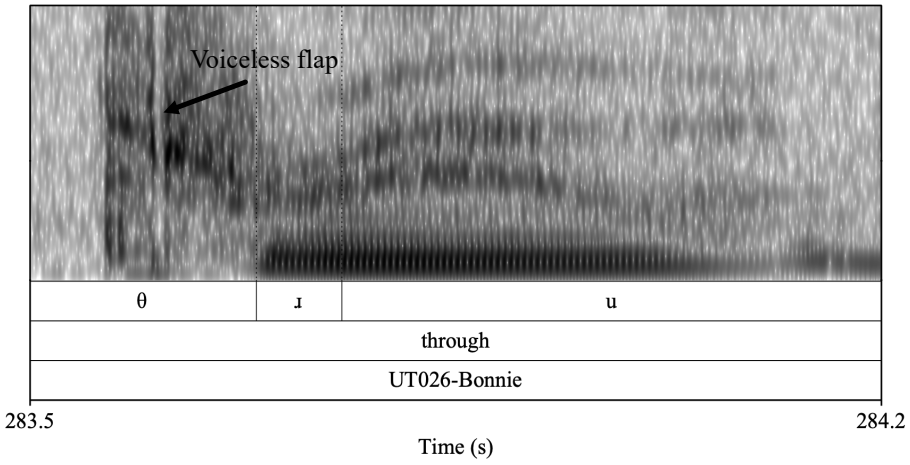

Figure 2 Spectrogram of *through*, illustrating a voiceless flap.

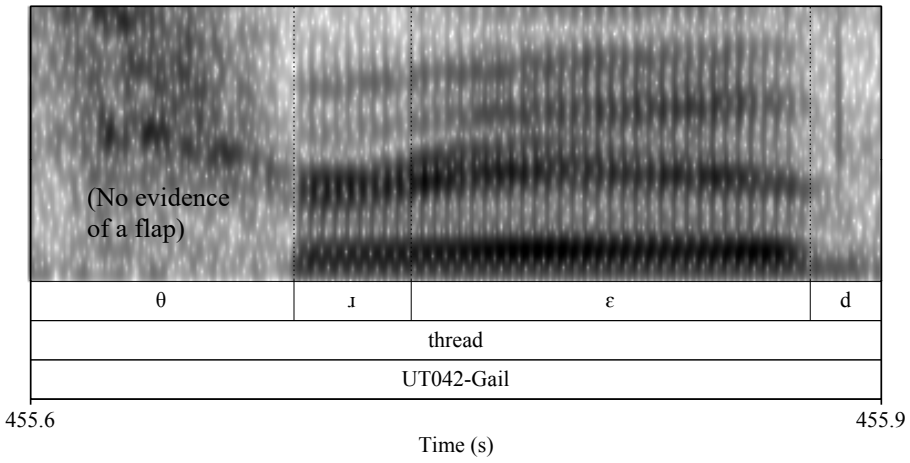

Figure 3 Spectrogram of *thrash*, illustrating /θɹ/ with flapping.

3 Results and discussion

Overall, 121 (17.4%) tokens were realized with flaps. This is a relatively small number but considering that (thr)-flapping is not normally described as a feature of American English phonology, it is a non-negligible minority realization. Most speakers (53 / 85 = 62%) did not use any flapped variants at all (including Gail

from Figure 3). For those that did, the proportion of how many words had flaps varied. Some speakers only used a flap in one word while three speakers (including Spencer from Figure 1 and Bonnie from Figure 2) used flaps in every word.

Because there was variation within speakers, it is useful to consider whether phonological factors may affect the frequency of (thr)-flapping. However, as explained in §2.1, the words selected for this study control for many phonological factors such as stress, position within the word, and syllable boundaries. With the exception of *threaten*, they were all monomorphemic and lexical effects were reduced by excluding proper nouns. By design, these words are controlled for most phonological factors—with the exception of the vowel following the /θɹ/[7].

Therefore, to test whether the following vowel has a significant effect on the realization of /θɹ/, the data was fit to a generalized linear mixed-effects model. Because there are 10 vowels in these 12 words, it made little sense to include vowel as the predictor because it would be difficult to tease apart lexical effects from the effect of the vowel. Instead, the vowels were included in the model based on phonological features: three levels of height (high, mid, and low) and two backness distinctions (front and non-front). These two factors, as well as their interaction, were included as parametric terms in the regression model, with high and front being the reference values.

Similarly, because there is variation across speakers, the model also included some sociolinguistic factors: age, sex (with the reference value being "Female"), and what state the speakers were from (with the reference value being "Utah"). And to account for idiosyncratic speaker-level variation, speaker was included as a random intercept. Table 1, which shows the model summary, suggests that social factors were the strongest predictors and that the effect of the following vowel was small.

Beginning with demographic factors, Table 1 suggests that while the sex of the speaker had very little effect on whether /θɹ/ was realized with a flap, it shows that age is a strong predictor, with older people more likely to use [ɾ]. This is supported somewhat in Figure 4, which shows the effects of age, sex, and state in this data. There are no obvious patterns with respect to sex in Figure 4, supporting the lack of significant differences between the sexes. Regarding age, it is true that several of the oldest Utahns and the oldest Washingtonian all had a high proportion of flaps, but several of the younger people had many flaps as well. This may be a case

[7]These words' codas were also different, but long-distance phonological effects were not considered here.

	Estimate	SE	z-value	p-value	
Intercept	−2.431	0.345	−7.052	< 0.001	***
sex = male	0.002	0.218	−0.009	0.993	
age	0.018	0.004	4.389	< 0.001	***
state =Washington	−1.165	0.336	−3.465	< 0.001	***
backness = non-front	−0.448	0.475	−0.945	0.345	
height = mid	−1.145	0.364	−0.398	0.691	
height = low	0.148	0.454	0.325	0.745	
non-front:mid	1.082	0.576	1.879	0.06	.
non-front:low	1.808	0.645	1.253	0.21	

Table 1 Output of a generalized linear mixed-effects model with vowel height and backness.

where there is a mismatch between data visualization and the statistical model. For now, I am hesitant to conclude that younger people use flap less because it is not supported by the visualization. I leave this for further research when a larger dataset that is more balanced across ages is available.

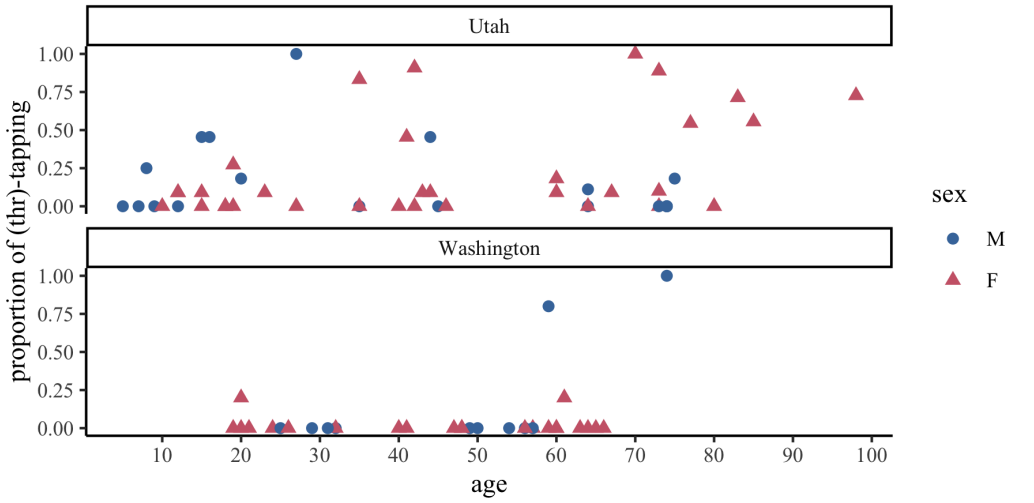

Figure 4 Proportion of (thr)-flapping by age, sex, and state.

Moving on to the effect of state, Table 1 shows that the Washingtonians were far less likely to realize (thr) as [ɾ] than the Utahns. Of the 52 Utahns, 28 (54%) had at least one flapped token, while just 4 (12%) of the 33 Washingtonians did. In fact, while the overall amount of flapping was 17.4%, among Utahns it jumps up to a full 25% (110 of 440 tokens). This is a drastic difference between the two states and is a clear case where there are linguistic differences between geographic areas within the West.

Recent research on other consonantal variables has shown that other nonmainstream variants are in circulation in Utah. Stanley & Vanderniet (2018) find that while Utahns realize words such as mountain or satin (the MOUNTAIN class of words) with a syllabic nasal (*moun*[ʔn̩]) the majority of the time, most speakers used an orally-released glottal stop (*moun*[ʔɪn]; cf. Eddington & Savage 2012) or used a hyperarticulated variant (*moun*[tʰɪn]) at least once. And though no one was a categorical user of these forms, a few speakers preferred using a nonmainstream variant, just as some speakers have (thr)-flapping the majority of the time in this study.

Di Paolo & Johnson (2018) provide a possible explanation for the increased amount of hyperarticulated consonants in Utah. In their study, they find that velar nasals sometimes occur with a following stop (such as talk[ɪŋk] or talk[ɪŋg]). They explain that this may have to do with Utah's large proportion of members of the Church of Jesus Christ of Latter-day Saints. In their worship services, sermons are usually given by regular members of the congregation. In fact, as a part of the children's activities, children begin giving public sermons as young as the age of three. Because public speaking is a relatively common practice for members of this religion and because speakers are usually more carefully enunciated when speaking in public, Di Paolo & Johnson argue that there is some diffusion from this register to other careful registers like reading word lists. Perhaps (thr)-flapping is seen as a more articulated variant, just as stops after velar nasals and aspirated stops in MOUNTAIN are. However, without data on speaker perception of these variants, this remains an open question.

In fact, the speech one of the few Washingtonians who had (thr)-flapping, provides some evidence for (thr)-flapping being used as a more enunciated variant. Rob was born 1942 and has had professional voice training and a background in radio. He is also a categorical user of (thr)-flapping. It is not known whether the use of this variant was a conscious decision or one that was explicitly learned through his training, but given his background it may be that (thr)-flapping is just one of

many strategies he has developed to articulate more clearly. If that is the case, it would provide evidence that flapped variants are perceived as more articulate and enunciated.

Returning to Table 1, the phonological variables included in this model did not appear to have a significant effect on the realization of /θɹ/. The only indication of a pattern is the interaction between height and backness, such that words with mid back vowels (*throne*, *throw*, *throng*, and *thrust*) were flapped more than high front vowels (*three*, *thrill*). This indicates some patterning that may not be fully captured using the existing combination of features. Rather than both height and backness in the same model, the vowel categories were collapsed down to just two: "high or front," which includes *three*, *thrill*, *through*, *thread*, *threaten*, and *thrash*, and "non-high and non-front," which includes *throne*, *throw*, *throng*, *thrust*, *throb*, and *thrive*. This binary distinction classifies the vowel space into two portions that are diagonal to the F1 and F2 dimensions. A second model was fit to the data using this binary variable instead of the height and backness variables, and the summary can be found in Table 2.

As expected, the estimates for state, sex, and age are similar to those found in Table 1, but in this model the phonological effect of following vowel is statistically significant. Table 2 shows that when /θɹ/ is followed by a vowel that is either high or front, the /ɹ/ is less likely to be realized as a flap when compared to words with non-high, non-front vowels. Part of this may be because a simpler model has more statistical power and can find significance where a more complex model cannot, but this division may also be backed up in articulatory gestures.

I propose that the following vowel does have an effect on the realization of /θɹ/ because, as stated in §1, the tongue tip is used in each of these sounds. Olive et al. support this when they show that "there is very little anticipatory coarticulation

	Estimate	SE	z-value	p-value	
Intercept	−1.931	0.271	−7.132	< 0.001	***
sex = male	−0.004	0.218	−0.018	0.986	
age	0.018	0.004	4.398	< 0.001	***
state = Washington	−1.207	0.333	−3.621	< 0.001	***
high or front = yes	−0.594	0.208	−2.860	0.004	**

Table 2 Output of a generalized linear mixed-effects model vowel as a binary variable.

taking place during the utterance of the retroflex /ɹ/" (1993: 218), meaning that the rhotic should block any sort of coarticulatory effect. However, there is some evidence that surrounding vowels can affect taps: when they are followed by high vowels, taps are longer because they "overshoot the target" Zue & Laferriere (1979: 1045). In other words, because the same gesture is used for intervocalic flaps regardless of the previous vowel, if the entire tongue body is higher, that gesture reaches the target sooner and makes contact for a longer period of time than if the tongue were lower. Similarly, if the same gesture that pulls the tongue tip from behind the teeth to a retroflex position is used regardless of the vowel that follows, a lower or backer tongue body brings that gesture nearer to a potential obstacle, the alveolar ridge. Therefore, when the tongue is high or front, it "dodges" the alveolar ridge as it makes the gesture, but if the tongue body is lowering or backing, the tongue makes contact with the alveolar ridge. For speakers that do not normally use a retroflexed /ɹ/, there is no concern of the alveolar ridge intervening between gestures, so it may be that the speakers that do not have (thr)-flapping are simply those that use a bunched /ɹ/. For now, these hypotheses are speculation only, but they can be explicitly tested and verified with articulatory data on (thr)-flapping.

4 Conclusions

In this paper, I have provided evidence to support the hypothesis that some speakers realize /θɹ/ with an intervening flap. Age and sex are not likely to be strong predictors of this variant in this sample, suggesting that this is not an ongoing change in apparent time. However, there were large differences between regions, with Utahns using flapped variants far more than Washingtonians. This is one of several enunciated consonantal variants in Utah, which may have arisen due to frequent public speaking opportunities in the Church of Jesus Christ of Latter-day Saints. Finally, the following vowel is a significant predictor, with flaps occurring in words containing non-high and non-front vowels, which may be supported by articulatory-based motivations.

The purpose of this paper was to explore (thr)-flapping and to show that it is a variant that occurs in some speakers; however, the study is not without its limitations. First, while there are only so many words containing the sequence /θɹ/, this study only explores 12 of them, which were carefully chosen to eliminate as many phonological, morphological, and lexical effects as possible. Future work would expand this list to many more words (and many more tokens of those words)

to fully account for this phenomenon. While there were a relatively large number of speakers represented in this study, there is very little ethnic diversity. Nearly all speakers were Caucasian American, and anecdotally, I have heard this variant used by African Americans and especially Hispanics. A fuller treatment of this study would explore ethnicity as a factor in (thr)-flapping. Methodologically, coding for flaps was subjective and binary, and a more objective and more nuanced approach may be more appropriate. I have proposed social motivations for this variant, particularly in Utah, but to understand these factors, perceptual work is needed to understand how speakers react to the flap, and to see whether it is indeed perceived to be more articulate. Finally, articulatory motivations may explain the existence of the flap, particularly with respect to the following vowel. This study admittedly uses a small dataset and is entirely based on frequency patterns, so a more detailed study with articulatory data from more tokens from each vowel is needed to support or refute these hypotheses.

In conclusion, this paper is the first to study (thr)-flapping, showing that it is a significant minority variant of /θɹ/ in some speakers. This paper has also opened several avenues for future research with specific, testable hypotheses about this phenomenon. Finally, it shows that even infrequent phonological variables can be subject to phonological factors and sociolinguistic variation, further supporting the need to study processes on the margins of English phonology.

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References

Bates, Douglas, Martin Maechler, Ben Bolker & Steve Walker. 2015. Fitting linear mixed-effects models using lme4. *Journal of Statistical Software* 67(1). 1–48. https://doi.org/10.18637/jss.v067.i01.

Clark, Urszula. 2008. The English West Midlands: Phonology. In Bernd Kortmann & Clive Upton (eds.), *Varieties of English 1: The British Isles*, 145–177. Berlin: Mouton De Gruyter.

Di Paolo, Marianna & Lisa Johnson. 2018. Revisiting (NG) in Utah English. Presented at the Annual Meeting of the American Dialect Society, Salt Lake City.

Dinkin, Aaron J. 2016. Phonological transfer as a forerunner of merger in Upstate New York. *Journal of English Linguistics* 44(2). 162–188. https://doi.org/doi:10.1177/0075424216634795.

Eddington, David & Dirk Elzinga. 2008. The phonetic context of American English flapping: Quantitative evidence. *Language and Speech* 51(3). 245–266. https://doi.org/doi:10.1177/0023830908098542.

Eddington, David & Matthew Savage. 2012. Where are the moun[ʔə]ns in Utah? *American Speech* 87(3). 336–349. https://doi.org/doi:10.1215/00031283-1958345.

Espy-Wilson, Carol. 2004. Articulatory strategies, speech acoustics, and variability. *Proceedings of From Sound to Sense* B62–B76.

Hawkins, Peter. 1984. *Introducing phonology*. London: Hutchinson.

Hayes, Bruce. 2011. *Introductory phonology*. Chichester, West Sussex: John Wiley & Sons.

Hooper, Joan B. 1976. *An introduction to natural generative phonology*. New York: Academic Press.

Kennedy, Robert. 2017. *Phonology: A coursebook*. Cambridge: Cambridge University Press.

Labov, William. 1966. The social stratification of English in New York City.

Ladefoged, Peter & Keith Johnson. 2015. *A course in phonetics*. Stamford, CT: Cengage Learning 7th edn.

Nathan, Geoffrey S. 2008. *Phonology: A cognitive grammar introduction*. Amsterdam: John Benjamins Publishing Company.

Odden, David. 2013. *Introducing phonology*. Cambridge: Cambridge University Press 2nd edn.

Olive, Joseph P., Alice Greenwood & John Coleman. 1993. *Acoustics of American English speech: A dynamic approach*. Springer-Verlag.

R Core Team. 2018. *R: A language and environment for statistical computing*. R Foundation for Statistical Computing Vienna, Austria. http://www.R-project.org/.

Stanley, Joseph A. 2019a. Are BEG and BAG-raising distinct? regional patterns in prevelar raising in North American English. Paper presented at the American Dialect Society Annual Meeting, New York City, NY.

Stanley, Joseph A. 2019b. Phonological patterns in BEG-raising. *UGA Working Papers in Linguistics* 4. 69–91.

Stanley, Joseph A. & Kyle Vanderniet. 2018. Consonantal variation in Utah English. *Proceedings of the 4th Annual Linguistics Conference at UGA* http://athenaeum.libs.uga.edu/handle/10724/37876. 50–65.

Strycharczuk, Patrycja & James M. Scobbie. 2016. Gradual or abrupt? the phonetic path to morphologisation. *Journal of Phonetics* 59. 76–91. https://doi.org/doi:10.1016/j.wocn.2016.09.003.

Stuart-Smith, Jane. 2008. Scottish English: Phonology. In Bernd Kortmann & Clive Upton (eds.), *Varieties of English 1: The British Isles*, 48–70. Berlin: Mouton De Gruyter.

Thomas, Erik. 2008. Rural southern white accents. In Bernd Kortmann & Clive Upton (eds.), *Varieties of English 2: The Americas and the Caribbean*, 87–114. Berlin: Mouton De Gruyter.

Upton, Clive & William A. Kretzschmar Jr. 2017. *The Routledge dictionary of pronunciation for Current English*. London; New York: Routledge 2nd edn.

Warner, Natasha & Benjamin V. Tucker. 2017. An effect of flaps on the fourth formant in English. *Journal of the International Phonetic Association* 47(1). 1–15. https://doi.org/doi:10.1017/S0025100316000219.

Warren, Paul & Laurie Bauer. 2008. Maori English: Phonology. In Bernd Kortmann & Clive Upton (eds.), *Varieties of English 3: The Pacific and Australia*, 77–88. Berlin: Mouton De Gruyter.

Wolfram, Walt, Caroline Myrick, Jon Forrest & Michael J. Fox. 2016. The significance of linguistic variation in the speeches of Rev. Dr. Martin Luther King Jr. *American Speech* 91(3). 269–300. https://doi.org/doi:10.1215/00031283-3701015.

Zue, Victor W. & Martha Laferriere. 1979. Acoustic study of medial /t,d/ in american english. *The Journal of the Acoustical Society of America* 66(4). 1039–1050. https://doi.org/doi:10.1121/1.383323.