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The Role of Similarity in Sound Change: Variation and Change in Diné Affricates

Abstract

Studies have often documented an increase in variation and frequency of change in communities undergoing language shift. Segments that are similar across languages appear particularly vulnerable to change through phonemic transfer or subphonemic convergence with a socially-dominant language. However, phonetic documentation of specific changes in minority languages is limited, and what constitutes similarity remains vague. This paper presents a study of incipient sound changes in the Diné bizaad (Navajo) laterally-released alveolar affricates. Variation among proficient speakers points to the relevance of phonetic similarity in these changes, confirmed through acoustic analysis, while the strong correlation with age suggests external pressure, as younger speakers have less exposure to the Diné language and are more likely to substitute English clusters for Diné affricates. Overall, this study shows how multiple motivators can be identified for changes in a threatened language that otherwise appear to be straightforward substitutions from a dominant language.

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The Role of Similarity in Sound Change: Variation and Change in Diné Affricates

Kayla Palakurthy*

1 Introduction

Many studies have documented an increase in variation and frequency of change in speech communities experiencing language shift (Cook 1989, Wolfram 2002, Bird 2008), with changes in minority languages typically attributed to external pressure arising from language contact with a socially dominant language or internal pressure as a result of imperfect language transmission (Campbell and Muntzel 1989). Changes in these contexts may also have multiple motivators (Dorian 1993).

A notable pattern in documented sound changes is that segments that are phonologically similar between languages may be particularly vulnerable to changes. Examples include changes in Northern Paiute, a Uto-Aztecan language spoken in California and Nevada, where the youngest speaker was found to categorically substitute English /s/ for Northern Paiute /ç/, and English /ʃ/ for a palatalized allophone after the vowel /i/ (Babel 2009). Likewise, in Kwak'wala, a Wakashan language spoken in British Columbia, younger speakers substitute the English cluster /gl/ for /t͡ɬ'/ due to pervasive English usage in the community (Goodfellow 2005). Similarity can also lead to subphonemic changes, such as increasing aspiration in Māori voiceless stops due to influence from the similar New Zealand English voiceless stops (Harlow et al. 2009). However, much remains unknown about changes between similar sounds because overall phonetic documentation of changes in endangered languages remains limited, and synchronic patterns of phonetic variation and sound change are especially under-described.

Given this background, this paper analyzes variations: /t͡l/ ~ /kl/ and /t͡ɬ'/ ~ /k͡ɬ'/ in Diné bizaad, a Southern Dene language spoken in the present-day American Southwest. Through acoustic description alongside a statistical analysis of the linguistic and social structure of this variation amongst 51 speakers, this paper presents evidence for incipient sound change in unaspirated /t͡l/ and ejective /t͡ɬ'/. The observed changes are motivated both by internal and external factors, including a high degree of similarity between Diné bizaad /t͡l/ and English /kl/.

2 Background

Contemporary Diné bizaad, or Navajo, is spoken by over 150,000 speakers (Census 2010), mostly in and around the Navajo Nation, which spans Arizona, New Mexico and Utah. Diné bizaad retains a large and active population of middle-aged and older speakers, though like many languages indigenous to North America, it is threatened by intergenerational shift to English (House 2002), and most speakers are bilingual.

The sounds targeted here for analysis are part of the Diné laterally-released affricate series: unaspirated /t͡l/ <dl>, aspirated /t͡ɬ / <tł>, and ejective /t͡ɬ'/ <tł'>. These phonemes have been reconstructed to Proto-Dene and are present throughout the family (McDonough and Wood 2008). Beyond brief descriptions, these segments have not received much scholarly attention, and variable pronunciation has not been documented in work on Diné bizaad. However, variants with velar onsets have been recorded in related Dene languages (Rice 1989, de Reuse 2006), and changes /tl/ > /kl/, along with the reverse, are common cross-linguistically (Blevins and Grawunder 2009). Relatedly, the English cluster /kl/ is a common substitution for /t͡ɬ'/ in loans such as *Beclabito*, the name for a town on the Navajo Nation, from *Bitł'ááh Bito* 'spring underneath' (Young and Morgan 1987: 251).

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Cross-linguistically, variation between /t͡l/ ~ /kl/ has a well-attested phonetic motivation. Extensive research has demonstrated that /tl/ and /kl/ clusters are acoustically similar and easily perceptually confused (Kawasaki 1982, Flemming 2007, Hallé and Best 2007). Speakers of some languages, such as Hebrew, do phonemically and acoustically distinguish between these clusters (Hallé and Best 2007), but the contrast is rare typologically (Bradley 2006, Flemming 2007), and changes /tl/ > /kl/, and /kl/ > /tl/, are typologically widespread (Blevins and Grawunder 2009).

3 Data and Methods

Data for this analysis come from interviews recorded in 2016–2017 with 51 bilingual Diné bizaad/English speakers as part of a broader project investigating sociolinguistic variables and language attitudes (Palakurthy 2019a). The interviews included demographic questions in English, a Diné bizaad word list elicited through oral translation from English, a Pear Film retelling, a personal narrative recounted in Diné bizaad, and a discussion in English about language usage and attitudes. The interviews are available online through the Alaska Native Language Archive (Palakurthy 2019b). In forthcoming examples, citations will refer to the archive identifier and timestamp.

Table 1 presents the distribution of participants by relevant social factors. The category Speaker Background is based on self-reported first language and current language usage: Heritage Speakers are those that grew up hearing and speaking Diné bizaad, but now primarily use English, Simultaneous bilinguals are those who have spoken both languages since birth, L1 Diné bizaad Bilinguals grew up with Diné bizaad as a first language and learned English later, while L1 English Bilinguals first acquired English and later Diné bizaad.

Factors	Levels	Number of Participants
Region	Western (Arizona)	29
	Eastern (New Mexico)	22
Gender	Men	20
	Women	31
Age	Younger speakers (18–38)	14
	Middle-aged speakers (39–58)	22
	Older speakers (59–78)	15
Speaker Background	Heritage Speakers	8
	L1 English Bilinguals	2
	L1 Diné bizaad Bilinguals	37
	Simultaneous Bilinguals	4

Table 1. Background of Participants.

Tokens of unaspirated /t͡l/ (n=209) and ejective /t͡ɬ’/ (n=520) were extracted from the wordlist and connected speech data. The aspirated affricates were not analyzed and will not be discussed due to low token numbers, though the available tokens show similar patterns to the other affricates. After segmenting the affricates in Praat, each token was coded for an audible velar or alveolar onset. A comparison of the acoustic cues of the unaspirated stops /t/ (n=133) and /k/ (n=181) was conducted using wordlist data from the same speakers in order to assess the acoustic effects of the lateral release on cues for place of articulation.

Spectral peak and VOT were targeted as acoustic measurements intended to serve as acoustic correlates to place of articulation (Stevens and Blumstein 1978, Kent and Read 1992).[1] Alveolar stop releases with a short front cavity tend to have higher frequency peaks of energy, while velar stops have a larger front cavity and lower frequency peaks in spectra (Johnson 2003). Spectral measurements follow Sundara 2005 and Chodroff and Wilson 2014 in resampling the audio at 16000 Hz,

[1]While stop burst frequency was intended to serve as an acoustic correlate for place of articulation, the measurements showed a bi-modal distribution with frequencies clustered around 2000Hz and 5000Hz for both velar and alveolar onsets. Therefore, though spectral peak provides information about the spectral shape of these segments, this measurement does not consistently correlate with annotated place of articulation.

pre-emphasized by 6dB above 1000Hz, and high-pass filtered at 200Hz. Praat scripts were used to measure the peak frequency of the highest amplitude peak between 500–6000Hz with the release of the stop as the window of analysis. VOT was measured in Praat from the release of the stop until the onset of voicing of either the following vowel with the ejectives, or of the lateral in the case of the unaspirated stops. It was difficult to consistently distinguish the stop burst from the onset of lateral frication, so VOT was used as a measure of duration instead of duration of the burst alone. For the ejectives, VOT measurements include a long period of silence. There were a number of ejective releases, and one unaspirated release where there was no audible lateral: /t͡ɬ’/ > /t’/. This was indicated by a categorical coding of AUDIBLE LATERAL: YES or NO.

After collecting the acoustic measurements, each token was annotated for the linguistic and social factors shown in Table 2 along with AGE in years. Two logistic regression models were fit to ONSET PLACE using glm and glmer (Bates et al. 2015) in R (R Core Team 2017). Post-hoc contrasts were analyzed using the multcomp package (Hothorn et al. 2008).

Variables	Levels	Unaspirated n	Ejective n
ONSET PLACE	Alveolar	173	305
	Velar	36	215
SOURCE	Wordlist	91	368
	Discourse	118	152
FOLLOWING VOWEL	a	58	45
	e	21	24
	i	27	240
	o	103	211
PHONETIC ENVIRONMENT	Word-initial	9	393
	V_V	82	86
	C_	118	41
AUDIBLE LATERAL	Yes	208	389
	No	1	131
GENDER	Man	86	219
	Woman	123	301
REGION	East (New Mexico)	75	230
	West (Arizona)	134	290
LANGUAGE BACKGROUND	Heritage Speaker	24	64
	L1 Both Bilingual	14	26
	L1 Diné bizaad Bilingual	163	414
	L1 English Bilingual	8	16

Table 2. Annotated Categorical Variables and Levels

4 Results

Across both segments, speakers favor alveolar onsets in 66% of total tokens. The variants are equally common in wordlist and narrative data, suggesting that these forms are not overtly stigmatized. Though not statistically significant, velar onsets are most common across both types of affricates before the vowel /i/. More variation in this phonetic environment is in line with research demonstrating that acoustic differences between velar and alveolar stops are minimal before high front vowels (Plauché 2001). Table 3 presents an overview of the distribution of each variant.

Table 3 shows that speakers strongly favor alveolar onsets at 83% for the unaspirated stops with minimal intraspeaker variation; only four speakers produce tokens of both variants. Most of the unaspirated affricates with velar onsets are produced by young women who realize 63% of their tokens with [kl] versus 21% among young men. The ejective affricates show a more balanced distribution, though alveolar onsets are still favored at 59%. There is also much more intraspeaker variation in the ejective affricates; 38 speakers use both variants.

Place of Onset Articulation	Unaspirated	Ejective	Total
Alveolar	173 (83%)	305 (59%)	478 (66%)
Velar	36 (17%)	215 (41%)	251 (34%)
	n=209	n=520	n=729

Table 3. Distribution of Affricates by Place of Articulation

The onset variation in these sounds is not particularly salient to participants; only Navajo language teachers commented on the variation. For instance, Peggy Manygoats, a Navajo language teacher in Page, Arizona says, “With the consonants, the <tł’>, anything they don’t see as English [is difficult for students]” (18106-14 0:26:09). Mrs. Manygoats ascribes the pronunciation difficulty in the ejective affricates to the vast difference between these Diné sounds and English consonants. Mary Whitehair Frazier, a Navajo language teacher in Albuquerque, echoes a similar sentiment: “And then the younger generation because of the pronunciation, because of the Navajo sounds, especially the glottalized and the digraphs, they’re not hearing it, so like *tł’ízí*, it becomes *kłízí*.” (18106-29 0:29:17).

4.1 Acoustic Results

As shown in figure 1, while the plain stops /t/ and /k/ are well-differentiated from each other in VOT: VOT mean for /k/ is 26ms (sd=10) and for /t/ is 14ms (sd=6), there is much more overlap and no statistically significant difference between the VOT of [t͡l] and [kl] (p=0.53). The lateral release lengthens the plosive onset for both alveolar and velar segments and obscures the contrast. The [t͡l] variant has a mean VOT of 40ms (sd=20) compared with a mean of 32ms (sd=18) for [kl], very similar to the mean VOT of the plain stop /k/. Present VOT values are similar to earlier measurements for /t͡l/ (mean=42, sd=20) (McDonough and Ladefoged 1993). In these segments, the lateral releases of the unaspirated affricates are fully voiced by most speakers; this differs from earlier descriptions that describe the voicing of the lateral as beginning one-third of the way into the lateral.

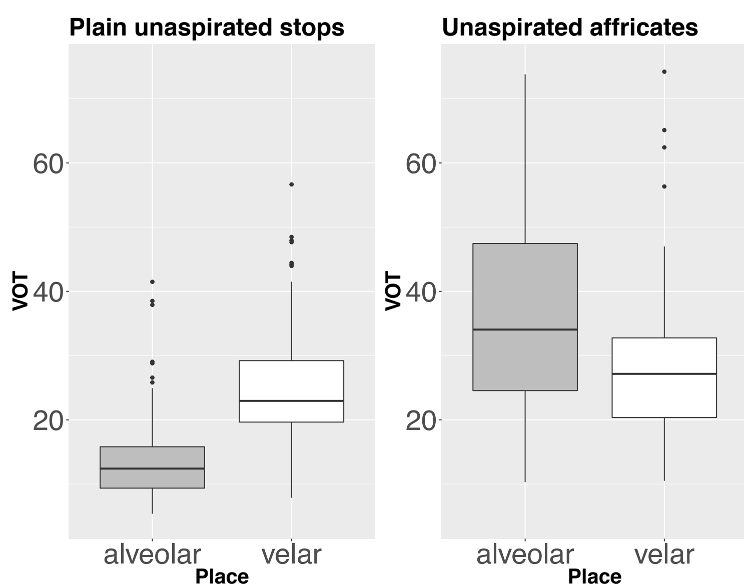

Figure 1. VOT of Unaspirated Stops and Affricates

Figure 2 shows that the plain unaspirated stops are similarly well-differentiated by spectral peak with a mean peak for /t/ of 4072Hz (sd=1578) and a mean peak for /k/ of 1480Hz (sd=866). The variant [kl] likewise has a lower spectral peak than [tl] ($p<0.05$), though as demonstrated by the length of the boxplots, there is substantial variance in these values. Whereas in English the lateral release of medial /dl/ moves the spectral peak closer to the acoustic realization of /g/, in Diné bizaad, the mean spectral peak of /t͡l/ 3980Hz (sd=1451) remains similar to plain /t/ and higher than the mean peak of 3357Hz (sd=1876) for [kl].

A similar comparison with plain ejectives is not available, but an analysis of VOT values by onset place and age group shows that the VOT of ejective affricates with velar onsets is longer than ejective affricates with alveolar onsets: the mean VOT for [k͡ɬ’] is 109ms (sd=39) compared with 100ms (sd=36) for [t͡ɬ’], though this difference is only significant for older speakers (p<0.001). Figure 3 shows VOT by onset place and age group. These VOT values are much shorter than previous measurements reported for /t͡ɬ’/ (mean=157ms; sd=40) (McDonough and Ladefoged 1993: 154).

Spectral peak measurements for the ejective affricates differ significantly by onset place of articulation again only among the older speakers (p<0.001). Overall tokens of [k͡ɬ’] have a mean frequency of 3424Hz (sd=1574) and tokens of [t͡ɬ’] a mean of 3957Hz (sd=1482). Figure 4 presents the observed spectral peak measurements by generational age group and onset place of articulation.

Figure 2. Spectral Peak of Unaspirated Stops and Affricates

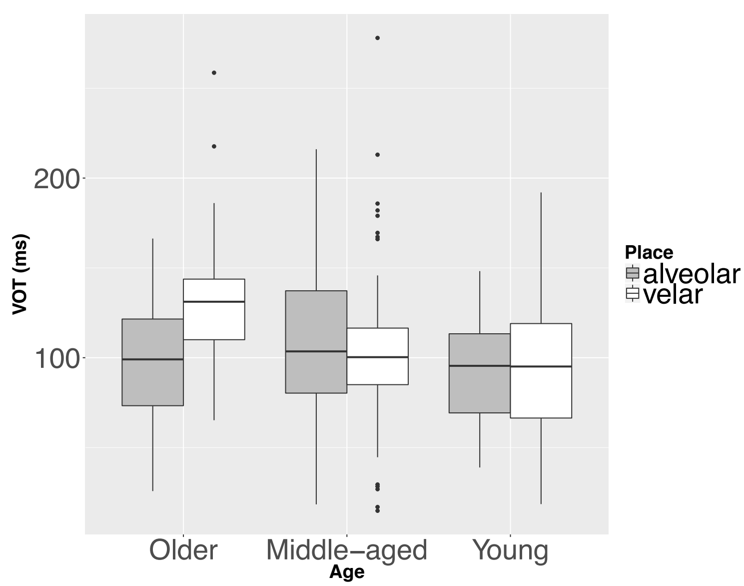

Figure 3. VOT of Ejective Affricates by Age Group

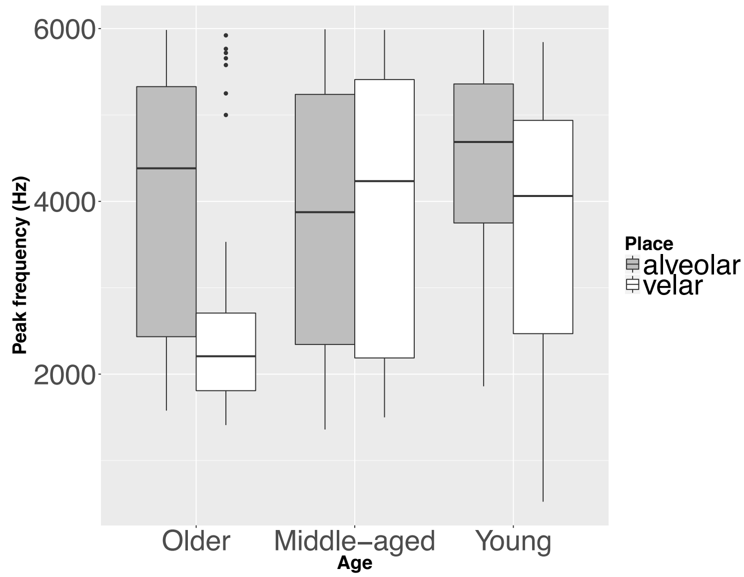

Figure 4. Spectral Peak of Ejective Affricates by Age Group

4.2 Statistical Results

Logistic regression models were fit to ONSET PLACE of articulation for the unaspirated and ejective affricates. For the unaspirated segments, the final model was fit with the glm function and includes only AGE in years, as a numerical predictor.[2] The final model ($\chi^2 = 75.21$, df= 1, p<0.0001) has an R^2 value of 0.57, and a C-value of 0.898. Figure 5 shows the predicted probabilities generated by the effects package (Fox and Weisberg 2019). The predicted probability of a velar onset is presented on the y-axis and AGE is labeled on the x-axis with tick marks indicative of the age of each speaker. This graph shows a sharp increase in predicted velar onsets as age decreases: younger speakers are predicted to favor [kl], while older speakers favor [t͡l]. This distribution shows that the velar variant is predicted to be produced almost entirely by speakers under the age of 50.

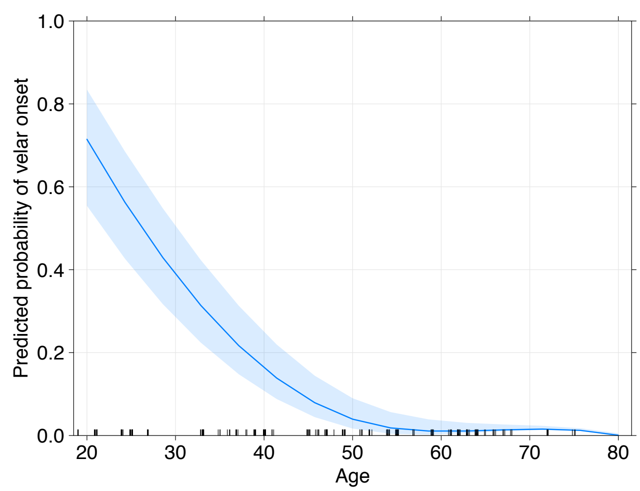

Figure 5. Probability of Velar Onsets in Unaspirated Affricates by Age

[2]Though it is standard to fit a model with SPEAKER and WORD as random effects, due to low token counts, the model for unaspirated affricates did not converge with random effects. When a summary of observations from each speaker was analyzed, AGE was statistically significant, supporting the validity of the glm model output.

Next, a model was fit to ONSET PLACE for the ejective affricates (R^2m= 0.30; R2c=0.53). The final model included SPEAKER as a random effect adjustment to the intercept, while WORD was removed during model selection. Main effects included: AGE, LANGUAGE BACKGROUND, AUDIBLE LATERAL, and PHONETIC ENVIRONMENT. Regarding the latter two effects, speakers are predicted to favor velar onsets word-initially and when there is no audible lateral release.

The AGE variable was again a significant predictor in this model. Figure 6 shows the predicted probability of velar onsets in the ejective affricates on the y-axis and AGE in years on the x-axis. Similar to the results in figure 5, younger speakers are predicted to produce more velar onsets, though the effect is more gradual than for the unaspirated segments. Speakers of all ages show variation between both onsets, with speakers younger than 45 predicted to favor velar onsets, and speakers older than 45 predicted to favor alveolar onsets. The predictor LANGUAGE BACKGROUND is also significant in the model with results displayed in figure 7. Simultaneous Bilinguals (labeled "L1 both bilingual") significantly differ from the other bilinguals here. The model predicts that for simultaneous bilinguals, nearly all (94%) of their tokens will have velar onsets. The other groups of bilinguals vary but are predicted to favor alveolar onsets.[3]

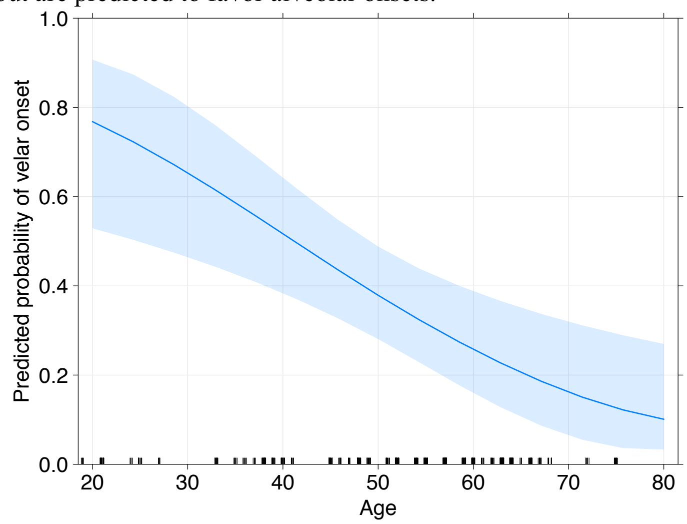

Figure 6. Probability of Velar Onsets in Ejective Affricates by Age

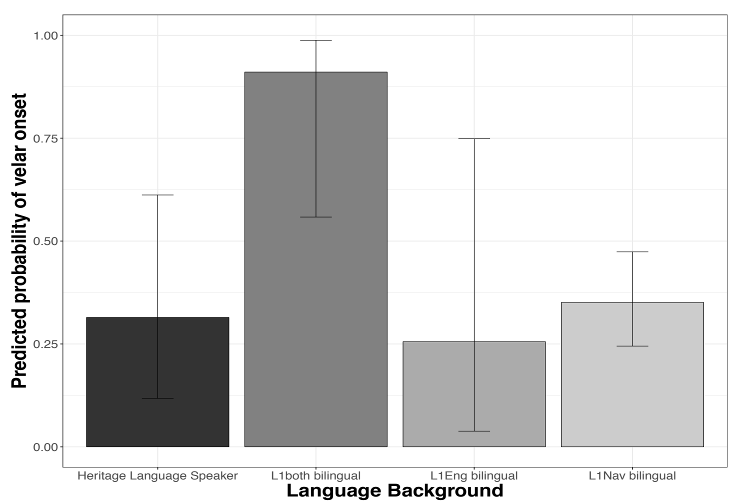

Figure 7. Probability of Velar Onset in Ejective Affricates by Language Background

[3]There are only 4 simultaneous bilinguals with 26 tokens and 2 L1 English Sequential Bilinguals with 16 tokens. Given these low token numbers, results should be interpreted cautiously.

5 Discussion

These results reveal incipient changes in the Diné bizaad lateral affricates: /t͡l/ > /kl/ and /t͡ł’/ > /k͡ł’/. For the unaspirated affricates, though alveolar onsets still occur most often, the high frequency of velar onsets amongst young speakers suggests that /t͡l/> /kl/ is a recent innovation. Results from the acoustic analysis show that while plain stops /t/ and /k/ are distinguished by VOT and spectral peak frequency, in the context of a lateral release these acoustic differences are less robust. There are non-significant spectral differences between [kl] and [tl] variants, but a high degree of variance and overlap remains. Outside of a few Navajo language teachers, who report that they attempt to correct [gl] pronunciations in their classrooms, this change remains below the level of awareness among these speakers. For the ejective affricates, variation between [t͡ł’] ~ [k͡ł’] is present among speakers of all ages, though velar onsets are more common among younger speakers and simultaneous bilinguals raised speaking both languages. Older speakers vary between alveolar and velar onsets, which are significantly differentiated in spectral peak frequency and VOT.

In terms of motivations for these changes, I propose that the variation in the ejective affricates among proficient speakers indicates that /k͡ł’/ is an earlier innovation that has arisen due to phonetic similarity between affricates with velar and alveolar onsets. At the same time, the /k͡ł’/ gap in the Diné inventory increases the likelihood of change due to what has been called language-specific perceptual assimilation (Blevins and Grawunder 2009). Under this view, variation introduced out of phonetic similarity can be tolerated because there is no contrastive /k͡ł’/ in the Diné inventory, and more variability is permitted because of an effect of top-down processing whereby speakers would perceive velar [k͡ł’] as /t͡ł’/ because it is the closest permissible phoneme. Even the acoustically distinct variants produced by the older speakers do not obscure any contrasts.

While phonetic and perceptual similarity motivate this change, the contact with English, which only allows word-initial clusters /gl/ and /kl/, is likely accelerating the change, evidenced by the strong preference for velar onsets among younger speakers. Especially in the case of the unaspirated segments, the strong correlation between age and velar onsets points to externally-motivated convergent change. Due to increasing English usage in many domains of Diné life, younger speakers have less exposure to Diné bizaad and may be substituting English clusters for Diné phones as they categorize them as equivalent. The practice of borrowing Diné names containing /t͡ł’/ into English with /kl/ means that speakers have long been exposed to this conventionalized substitution.

In both proposed changes, younger speakers produce more tokens of the innovative velar onset variant in the observed data, evidence that they are the leaders of these changes, even the younger speakers who use Diné bizaad regularly. These speakers have had sufficient exposure to Diné bizaad to use the language comfortably and regularly, but they also have been exposed, and continue to be exposed, to a great deal of English input, which thus impacts their Diné bizaad pronunciation and results in some convergent changes. Yet, such changes are not necessarily due to partial acquisition or imperfect learning on the part of these younger bilinguals. The correlation between velar onsets and a higher exposure to English accounts for the strong preference amongst the simultaneous bilinguals for velar onsets, but it is surprising that we do not see similar effects amongst the heritage language speakers and L1 English sequential bilinguals, both groups that have similarly received substantial English input. However, due to a highly imbalanced distribution of speakers among the bilingual language background levels, it remains impossible to tease apart the differences between language background and the highly correlated factor of age in this sample. The language background categories are also quite broad and an insufficient proxy for exposure to English over the course of a speaker’s lifetime.

6 Conclusion

To conclude, this paper documents phonetic characteristics of the Diné bizaad unaspirated and ejective laterally-released affricates and proposes incipient changes /t͡l/ > /kl/ and /t͡ł’/ > /k͡ł’/. These changes are not stigmatized, and for most speakers, remain below the level of awareness. The changes are argued to be motivated by phonetic similarity, language-specific perceptual assimilation, and expedited by intense contact with English. Because Diné bizaad has no phoneme /kl/, this change does not neutralize any meaningful contrasts. Statistical analysis further reveals that younger speakers are leading the changes, and in the case of the changes in the ejective affricates, variable patterns are present amongst the simultaneous bilinguals. These findings demonstrate that by phonetically examining variation in speech produced by participants of different backgrounds, multiple motivators can be identified for a change that might at first appear to be just a straightforward substitution of similar sounds from English. Furthermore, the non-neutralizing nature of these changes, as well as their low salience, means that if such changes continue to spread, they would be less disruptive than changes that eliminate phonemic contrasts in the inventory (Babel 2009).

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