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Social Influences on the Degree of Stop Voicing in Inland California

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Abstract

This paper examines social influences on the realization of voiced stops in inland California. We analyzed sociolinguistic interviews with 62 white residents from Redding, Merced, and Bakersfield (which mark the northern, middle, and southern points of California's Central Valley), balanced for sex, class, age, and whether a speaker earns their livelihood off the land. We follow Jaciewicz, Fox, and Lyle (2009) in examining the extent of voicing during stop closures (duration of voicing during closure relative to total duration of closure), and also adopt a novel measure of the magnitude of voicing, which captures the intensity of a stop closure relative to the following vowel. Mixed effects linear regression models were constructed for both voicing measures, with a number of linguistic and social predictors considered in addition to random effects. Results show that the extent of voicing measure was insufficiently sensitive to differentiate speakers, as nearly everyone exhibited voicing throughout the closure. The voicing intensity measure, however, was shown to reveal significant effects of place of articulation, closure duration, and ties to the land. Most importantly, speakers who earn their livelihood off the land exhibit significantly stronger voiced stops than those who do not. We argue that even though strongly voiced stops likely entered California during a large-scale immigration of Southerners during the Dust Bowl (Jaciewicz et al. 2009 report more extensive voicing among women from the South compared to the Midwest), they have since taken on locally significant indexicalities reflecting the values and ideals of land-oriented communities throughout the Central Valley (and do not simply mean "Southern"). Our findings also raise questions about where the linguistic limits of socially structured variation lie, given the systematic social patterning observed here for low-level phonetic details (i.e., voicing intensity) that likely operate far below the level of consciousness.

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1 Introduction

As the number of sociophonetic studies on plosives has increased over the last decade, it is now well established that social factors condition the phonetic realization of stops. Yet little of this work investigates variation in stop closures, focusing instead on dimensions of variation in the transitions into and out of the closure. This paper provides evidence for linguistic and social constraints on the phonetic realization of voiced stop closures in three communities of California's Central Valley. In particular, we show that speakers who earn their livelihood off the land produce more strongly voiced stops than those who do not. We suggest that this pattern finds roots in the Central Valley's settlement history, as all three communities have witnessed large waves of immigration from the Southern United States, where relatively heavy voicing during closures has previously been documented (Jaciewicz, Fox, and Lyle 2009).

Foulkes, Docherty, and Jones (2010) characterize the articulation of stops as comprising three distinct phases: the onset, closure, and release. These phases are exemplified in Figure 1, which shows a wideband spectrogram of [k] in the word *like*. Sociophonetic research has been unequally distributed across these phases, focusing on onsets, where formant transitions provide cues to the presence or absence of an oral gesture (e.g., Milroy, Milroy, Hartley, and Walshaw 1994, Docherty and Foulkes 2005, Foulkes, Docherty, and Watt 2005, Eddington and Taylor 2009), and releases, which can vary both in whether they are observable in the acoustic or auditory signals (e.g., Podesva, Campbell-Kibler, and Roberts 2002, Benor 2004, Docherty and Foulkes 2005, Levon 2006, Drager 2009) and in terms of their strength when present (Podesva 2006). While some work has investigated variation in manner of articulation, with stops alternating with fricative or approximant realizations (Lavoie 2001, Drager 2011), little work has considered the possibility that social factors may condition how the stop closure itself is realized. We might attribute this in part to the fact that closures merely mark silence, but the duration of silence offers important linguistic cues to voicing status and place of articulation. In the case of voiced stops, which have been the subject of relatively few sociophonetic investigations compared to voiceless stops, voicing details like the magnitude of voicing constitute an additional dimension of potential variation.

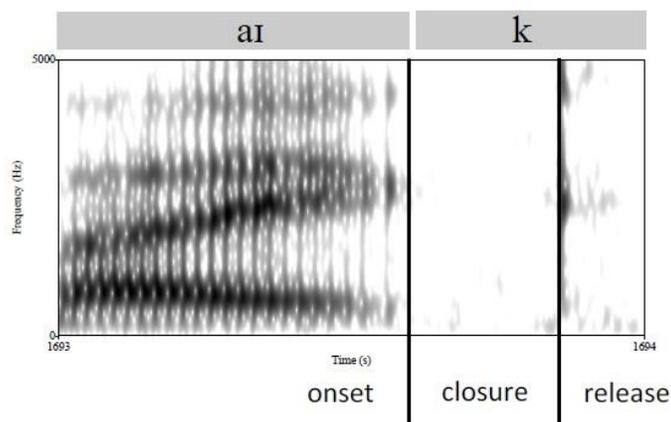


Figure 1: Phases of the stop [k], exemplified in a spectrogram of *like*.

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While few studies consider socially conditioned variation in the extent of closure voicing, Jaciewicz, Fox, and Lyle (2009) is a notable exception. They compared the speech of ten women from North Carolina to the speech of ten women from Wisconsin, focusing on voicing during the closure for the word-initial bilabial voiced stop, /b/. They report that women from North Carolina voice a greater percentage of the closure than do women from Wisconsin, a pattern that holds regardless of how much emphasis is placed on the stop. These findings show that stop closures exhibit systematic social conditioning with respect to dialect region, with Southerners producing more fully voiced /b/. Further evidence for the connection between strong voicing during stops and Southern identity can be found in Podesva, Hilton, Moon, and Szakay's (2013) study on the use of nasality in actors' performances of character types. While their study focused on nasal airflow, an analysis of the degree of voicing (during /g/) in the same data reveals that of the sixteen character types considered, the only one regionalized as Southern—redneck—exhibited the second-highest degree of voicing across the performances of 12 actors.

Although these patterns may appear at first blush to have little to do with California's Central Valley, the region's settlement history suggests otherwise. One of the largest migrations to the region came in the 1930s, when Dust Bowlers from Oklahoma, Texas, Arkansas, and a number of other Southern (and Midland) states came to Bakersfield, at the southernmost point of the Central Valley. Some of these migrants continued up the Central Valley and into Oregon, populating communities all along the way. There have been several linguistic consequences of this migration, such that a number of features found in Southern dialects can be observed in the Central Valley, including the PIN-PEN merger (Labov, Ash, and Boberg 2006, Geenberg 2014), raised DRESS (Geenberg 2014), and retracted /s/ (Podesva and Van Hofwegen 2014).

Though these Southern dialect features are prevalent in California's Central Valley, there is evidence that some speakers in the region use more of these features than others. And one of the primary social factors appearing to influence variation patterns is the extent to which community members engage with or are ideologically connected to the land. This factor has been operationalized differently from one study to the next depending on the community under analysis and the kind of fieldwork conducted, but in all cases speakers who have stronger ties to the land produce more Southern features. Geenberg (2014), based on an ethnographic study of Trinity County, draws a distinction between "outdoorsy" and "indoorsy" community members and reports higher rates of the PIN-PEN merger and raised/fronted DRESS, both features of Southern U.S. English, among the former group. Similarly, speakers oriented to the country in Podesva and Van Hofwegen's (2014) study produce more retracted /s/, another feature associated with the South, than those oriented to the town. Finally, Podesva, D'Onofrio, Van Hofwegen, and Kim (2015) illustrate that country-oriented speakers in Redding exhibit significantly different patterns for a number of vowel features than town-oriented speakers, again with country-oriented speakers producing more Southern patterns. In the present paper, we draw a distinction between community members whose families earn their livelihood off the land and those who do not. The industries that speakers who are tied to the land participate in vary from one field site to another, but include farming, ranching, logging, and oil.

In addition to examining whether speakers' engagement with the land influences their production of voiced stops, we address a number of additional questions not considered in Jaciewicz et al.'s (2009) study. First, do voicing patterns in spontaneous speech resemble those observed in read laboratory speech? Do /d/ and /g/ pattern similarly to /b/, and how do internal factors influence their patterning? Is variation in closure voicing conditioned by sex class (only women were considered in Jaciewicz et al.'s 2009 study) or age (is there evidence for change in apparent time)?

2 Methods

The data under investigation are sociolinguistic interviews conducted by graduate students and faculty at Stanford University as part of the department-wide dialectology project, *Voices of California*. To date, over 500 interviews have been conducted with a representative sample of lifelong residents of four communities (Redding, Sacramento, Merced, and Bakersfield), all in the Central Valley. This paper focuses on Merced (where data were collected in September 2010), Redding (September 2011), and Bakersfield (September 2012). The Central Valley is shown in light green in Figure 2, with Redding, Merced, and Bakersfield marking the northern, central, and southern

points of the Central Valley, respectively.



Figure 2: Field sites: Redding, Merced, and Bakersfield.

In this paper, we investigate the speech of 62 white residents from each of the three communities, as summarized in Table 1. Within each community, the sample includes speakers whose families earn their livelihood off the land and those who do not. For each category of speaker, the sample includes both men and women, across the lifecourse from early adulthood to old age (with the exception of Merced speakers with ties to the land, where speaker age skews old).

62 speakers											
22 Redding				20 Merced				20 Bakersfield			
10 [+land]		12 [-land]		8 [+land]		12 [-land]		8 [+land]		12 [-land]	
5 F	5 M	7 F	5 M	2 F	6 M	7 F	5 M	5 F	3 M	4 F	8 M
19-86 years		19-70 years		52-90 years		19-84 years		22-90 years		22-80 years	

Table 1: Summary of speaker characteristics.

All of the interviews under analysis were orthographically transcribed and force-aligned with FAVE-align (Rosenfelder, Fruehwald, Evanini, and Yuan 2011). For each speaker, 15 tokens each of /b/, /d/, and /g/ were labeled in Praat. To ensure maximum comparability to the findings reported in Jacyewicz et al.'s (2009) study, we limited our analysis to voiced stops in word-initial, stressed, and inter-sonorant contexts. We excluded voiced stops occurring in function words and reported speech/constructed dialogue and included no more than 2 tokens per lemma per speaker, to ensure a variety of lexical items per speaker. Only those tokens that were realized as stops were considered (i.e., tokens exhibiting lenition were excluded). Although we observed variation in manner of articulation, this paper examines phonetic variation within a single manner: stops. For each token meeting these criteria, we hand-corrected alignments and labeled the interval corresponding to the closure, burst, and following vowel; intervals of voicing during all closures were also marked. As shown in Figure 3, the closure and release phases of the stop were annotated on the first tier, the interval of voicing during the closure on the second tier, and the interval of the voiced stop and the following vowel on the third tier. Once annotation was complete, the duration and intensity of each interval were measured via Praat script.

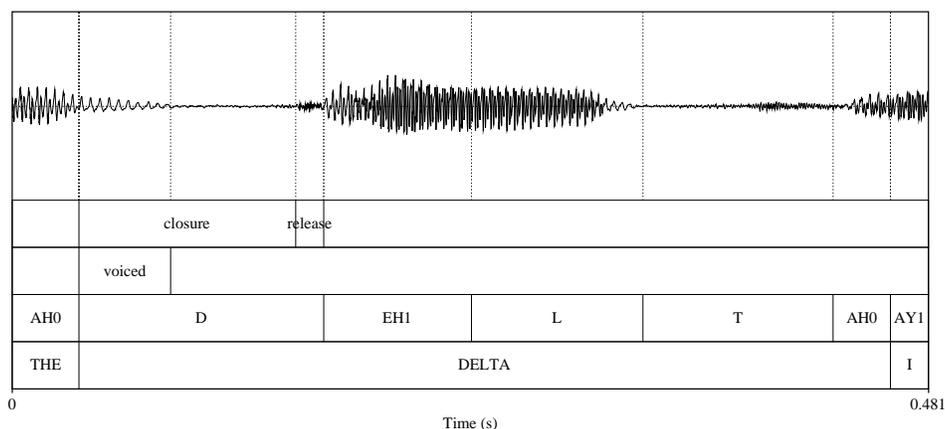


Figure 3: Waveform for a partially voiced closure for [d] in *delta*.

We considered two measures of voicing strength. The first is the *extent* of voicing, as used by Jacewicz et al. (2009). To calculate extent of voicing, the duration of the closure's voicing interval was divided by the duration of the closure (and multiplied by 100 to obtain a percentage). Although this measure nicely captured voicing variation for Jacewicz et al.'s (2009) study, it was not well suited for the spontaneous, conversational speech analyzed here. Tokens exhibiting partial voicing during the closure, like that in Figure 3, accounted for less than 10% of the total number of tokens. More than 90% of the data were fully voiced during the closure, as exemplified by the token of [b] in Figure 4.

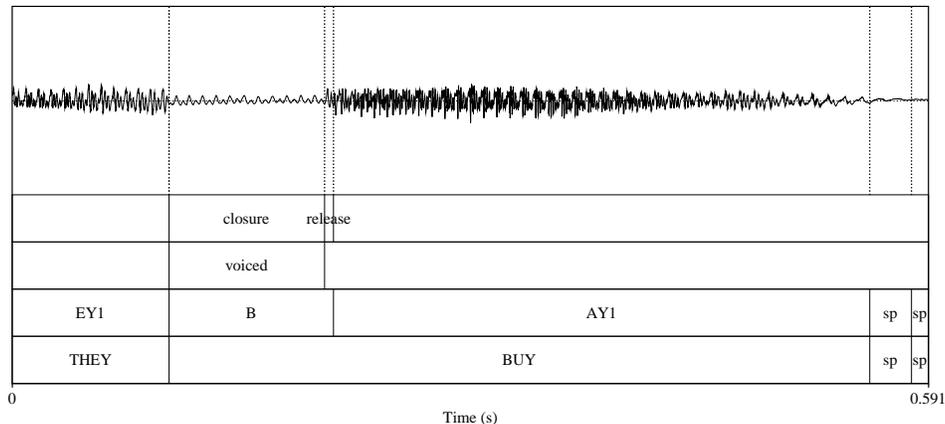


Figure 4: Waveform for a fully voiced closure for [b] in *buy*.

Although the extent of closure voicing was not particularly variable in our data, the *magnitude* of voicing during closures was sufficiently variable for meaningful quantification. We treat the intensity of the closure as a measure of voicing magnitude. Closure intensity corresponds to the magnitude of voicing because supralaryngeal activity is inaudible during the closure, with no acoustic consequences, as the airstream is completely blocked. Any sound that is generated during the closure is produced at the larynx and emanates from the neck. Figure 5 shows an intensity curve for the same token of [b] that appears in Figure 4. Even though the entire closure is voiced (as evident in Figure 4), there is considerable room for variation in the intensity domain. The magnitude of voicing measure is thus able to capture finer-grained distinctions in the production of voiced stops than the extent of voicing measure. As shown in the following section, such fine-grained variation is constrained by at least one social factor.

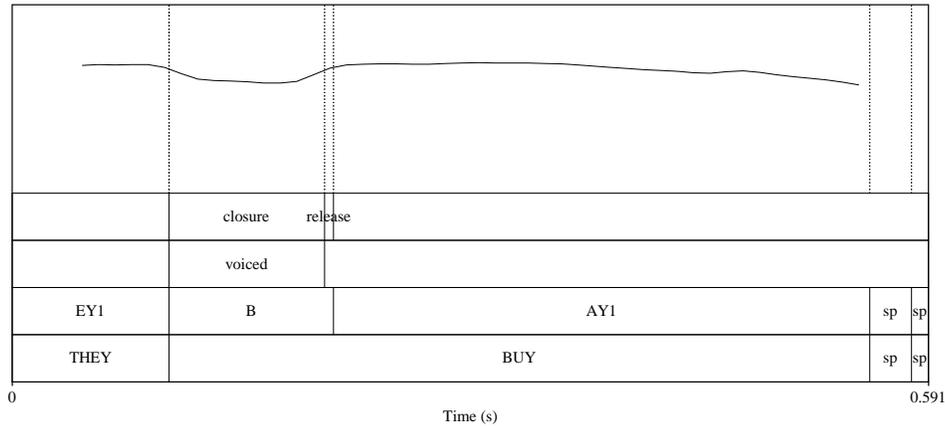


Figure 5: Intensity curve for a fully voiced closure for [b] in *buy*.

Closure intensity was considered relative to the intensity of the following vowel, since intensity levels depend on a number of factors, including how loudly speakers talk and microphone placement, which we assume remain constant during the brief interval of time between the articulation of a voiced stop and the immediately following vowel. Variation in the intensity of the following vowel was controlled to some extent, given that all following vowels carried primary lexical stress (as voiced stops were considered in word-initial, stressed position only). To calculate the vowel-to-closure intensity, the mean intensity of the closure was subtracted from the mean intensity of the vowel. This measure is adapted from phonetic work (Jongman, Blumstein, and Lahiri 1985, Stoel-Gammon, Williams, and Buder 1994) quantifying the intensity of stop bursts (relative to the intensity of following vowels). It is important to note that lower numbers for this measure are indicative of higher-intensity voicing.

Turning to the statistical analysis, a mixed-effects linear regression model was constructed for the response variable of vowel-to-closure intensity for the full dataset (consisting of 2,700 tokens). A number of social factors were considered as predictors, including age, sex class, education level, field site, and whether speakers earned their livelihoods off the land. Effects of linguistic predictors, such as the voiced stop in question (i.e., place of articulation) and log closure duration (closure duration was log-transformed to meet the assumptions of normality for parametric statistical tests) were also considered. Finally, speaker, word, and preceding and following sounds were included as random intercepts.

3 Results

Table 2 summarizes the significant fixed effects in the regression model on vowel-to-closure intensity. Regarding the linguistic factors, both log closure duration and place of articulation both predict voicing strength. The only social factor emerging as significant was whether speakers earned their livelihood off the land. No significant effects were observed for any of the other social factors. We discuss each of the three significant factors in turn.

Term	Estimate	Std Error	DFDen	t Ratio	Prob> t
Intercept	11.226937	0.697831	733.8	16.09	< 0.0001*
log closure duration	0.8356594	0.220667	2466	3.79	0.0002*
segment b (vs. d)	-0.398091	0.128388	209.5	-3.10	0.0022*
segment g (vs. d)	0.6195257	0.143527	228.6	4.32	< 0.0001*
earn livelihood off land [y]	-0.605703	0.284289	56.08	-2.13	0.0375*

Table 2: Summary of fixed effects in regression model on vowel-to-closure intensity.

Beginning with the effect of log closure duration, the regression reveals a positive correlation between log duration and the vowel-to-closure intensity measure. Recall that more strongly voiced closures are indicated by lower values of the vowel-to-closure intensity measure. Thus, the longer the closure, the weaker the voicing. This is an expected pattern, given general principles of voicing aerodynamics. Voicing requires high pressure below the glottis and low pressure above it, a pressure differential that sets the vocal folds into vibration. In the case of stops, the oral cavity is completely closed off, which leads to a rapid increase in pressure in the supraglottal cavity. Speakers can compensate for this suboptimal voicing scenario by shortening the duration of closures when articulating voiced stops. When voiced stop closures are long (i.e., not shortened), it stands to reason that the magnitude of voicing will be diminished, as observed in the data presented here.

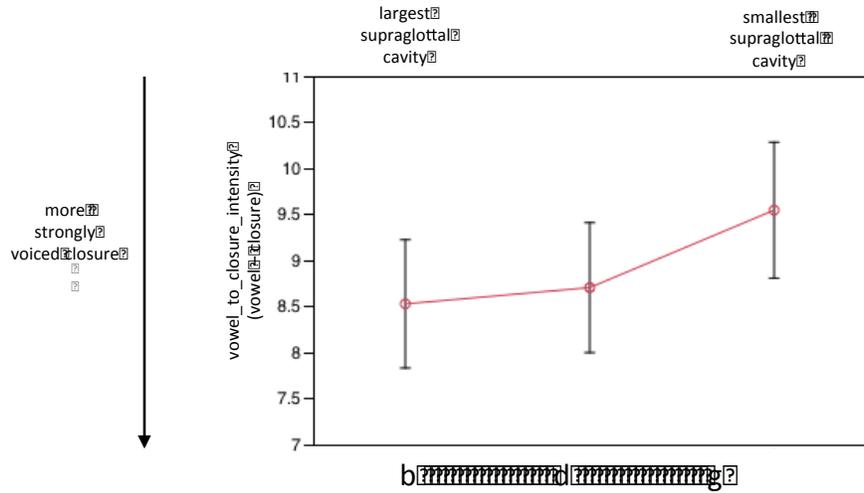


Figure 6: Effect of place of articulation on vowel-to-closure intensity.

Aerodynamics play a similar role in motivating the place of articulation pattern. The regression model reveals that as the constriction moves farther back in the mouth, the strength of voicing diminishes. This pattern is graphically depicted in Figure 6, where the magnitude of voicing is strongest for the most anterior voiced stop, /b/, and weakest for the dorsal voiced stop, /g/. The magnitude of voicing for /d/ is intermediate, as its vowel-to-closure intensity level was significantly greater than that for /b/ and less than that for /g/. This pattern follows if we take into account the size of the supraglottal cavity, shown for all three places of articulation in Figure 7. In the case of

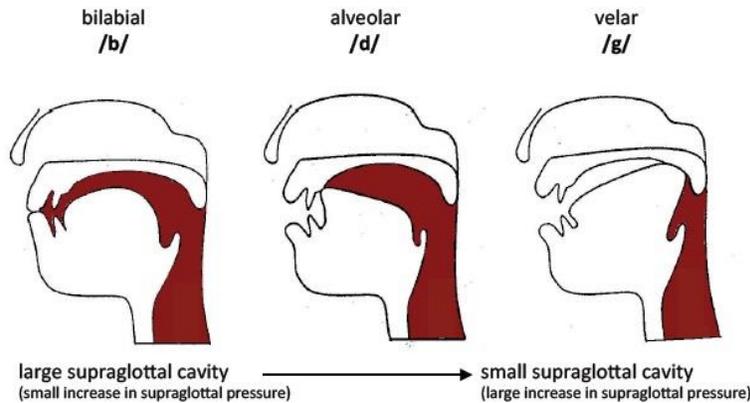


Figure 7: Supraglottal cavity size during stop articulation.

/b/, the supraglottal cavity is relatively large because the constriction is produced at the frontest part of the vocal tract, the lips. The large volume of this cavity staves off the rapid increase in supraglottal pressure, so voicing remains relatively strong. However, as the place of articulation moves farther back, the size of the supraglottal cavity decreases, so supraglottal pressure builds up more quickly. The magnitude of voicing is therefore compromised, yielding our finding that /g/ closures are more weakly voiced than /d/ closures, which are in turn more weakly voiced than /b/ closures.

The final significant effect on the vowel-to-closure intensity measure is that people who earn their livelihood off the land have more strongly voiced closures than those who are not dependent on the land, as shown in Figure 8. Recall that the farming, ranching, logging, and oil industries play an important role in the Central Valley's social and economic vitality, and that the Dust Bowl Migration, from the South, played a pivotal role in the development of these land-based industries. These facts, taken together with Jaciewicz et al.'s (2009) finding that speakers from North Carolina produced more strongly voiced closures than speakers from Wisconsin, beg the question: Does the strong stop voicing characterizing the speech of Central Valley residents who earn their livelihood off the land relate to the status of strong voicing as a regionally Southern feature?

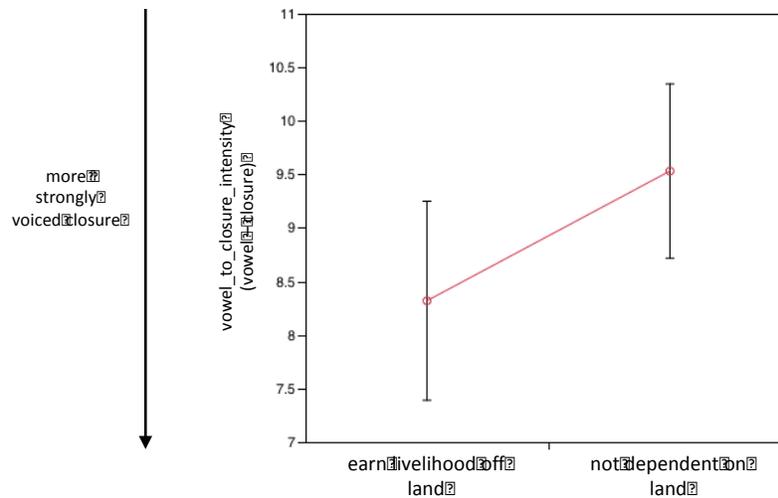


Figure 8: Effect of earning one's livelihood off the land on vowel-to-closure intensity.

4 Discussion

Our discussion centers on the effects of social factors on variation in the magnitude of voicing during stop closures, beginning with the relatively long list of social factors that did not condition the magnitude of stop voicing. First, we did not observe any effects of age, so the possibility of change in apparent time can be ruled out. The variation described here appears to be stable.

There was also no apparent effect of field site. Even though Dust Bowlers first settled in the southern-most part of the Central Valley, in Bakersfield, their somewhat deeper roots there do not appear to have consequences for stop voicing. Whereas differences between field sites have emerged for some variables—for example, Pratt (2015) has found greater fronting of the GOOSE vowel in Merced than Bakersfield—there do not appear to be any differences among Central Valley communities for this low-level phonetic feature.

We also observed no effect of speaker sex class. Cross-linguistically, women have been found to have longer VOT than men, and men have been found to have greater pre-voicing (Koenig 2000, Whiteside, Henry, and Dobbin 2004). A number of physiological explanations have been suggested (Robb, Gilbert, and Lerman 2005, Wadnerkar, Cowell, and Whiteside 2006), but the fact that there are cases where the reverse has been observed, and that no sex differences were found in our study, suggests as Simpson (2009) points out that physiological difference is insufficient to account for the full range of patterns.

Finally, we found no effect of education. Though education has been found to be a rather good (if imperfect) measure of social class in many communities, we hesitate to conclude that class has no bearing on the degree of stop voicing in our data. On the contrary, we believe that the social variable that emerged as a significant predictor of voicing magnitude—whether speakers earn their livelihood off the land—reflects dominant class ideologies in the Central Valley, at least in the three communities under consideration here. For people who earn their living off the land, the majority of whom maintain a politically conservative perspective, class is not about education or income. Included among our land-oriented interviewees is everyone from laborers, to managers, to owners of multi-million dollar ranches, and they interact with, and indeed are friends with, one another. Further, these interviewees often expressed conservative political views on state and federal environmental policy (e.g., water allocation and land conservation), which residents believe ignores the needs of Californians in the Central Valley. These sociopolitical beliefs reflect and reinforce their economic ties to the land, and are additionally linked to belief systems that value egalitarianism and work ethic. We have not conducted a proper network analysis, since we view *Voices of California* primarily as a dialectology project, but our snowball sampling strategy sent us back and forth through the class structure, presumably because networks are so mixed in terms of class. For example, in Redding, Penny Eckert interviewed one of the richest men in town, who then introduced her to someone she characterizes as one of the poorest men in town. Both of these men, and community members in general, frown upon conspicuous consumption. The rich man, for example, explained to us that fancy houses are owned not by true locals, but by “equity pioneers,” or wealthy urban transplants from places like the Bay Area. Class has less to do with money than it has to do with the land, and whether you hold an ideology of egalitarianism.

So in spite of the socioeconomic diversity among people tied to the land, there is uniformity in the magnitude of voicing in their stops. We want to briefly revisit the question of where the strong voiced stops came from. To be clear, we do not claim that these speakers strongly voice their stops because they directly descend from “Okie” or “Arkie” migrants. Rather, Dust Bowlers brought the feature into the Central Valley, and as they participated in industries like agriculture, ranching, logging, and oil, their speech features came to be associated with the values and ideals of land-oriented communities throughout the Central Valley. This analysis is bolstered by Geenberg’s (2014) finding that in Trinity County, which neighbors Redding, the PIN-PEN merger is more prevalent among outdoorsy people, who she describes as “people [who] pride themselves on their ability to farm, fish, hunt, ranch, and generally make it on their own” (p. 113). Crucially, her data show that the PIN-PEN merger was not more advanced among people who descended from Okies. In sum, features that came into the Central Valley as regionally Southern variants have taken on locally significant indexicalities. It is also worth underscoring the unlikelihood that the social meanings of these features were limited to “Southern” when they were introduced to the Central Valley. More likely, it was these features’ other, higher-order indexical meanings that resonated with residents of the community and enabled the features to begin living new semiotic lives.

5 Conclusion

To conclude, we have found that at least one social factor (i.e., whether speakers earn their livelihood off the land) structures variation even for low-level phonetic details operating far below the level of consciousness (i.e., the magnitude of voicing in the closure phase of stops). This raises questions about where the linguistic limits of socially structured variation lie. Also, in looking at spontaneous speech data, we have found that measures of stop voicing that have worked for lab speech are insufficiently fine-grained for capturing the strength of voicing in our data. We therefore adapted a phonetic measure used to capture relative burst intensity (e.g., Jongman et al. 1985, Stoel-Gammon et al. 1994), to quantify relative stop closure intensity, which serves as a viable proxy for magnitude of voicing.

We can identify a number of promising avenues for future research. We have limited our analysis here to the closure phase of stops, but properties of the release phase could also prove illuminating. Preliminary analysis of release duration reveals that speakers who earn their livelihood off the land exhibit shorter release durations than those who do not. This pattern is consistent with the magnitude of closure voicing, assuming that voiced stops are characterized by relatively shorter releases. Our analysis could also be extended by considering variation in manner, as a

number of voiced stops were lenited to approximants, and by investigating voicing strategies among people of color, particularly given Ryalls, Zipprer, and Baldauff (1997) tentative finding that young African Americans used more pre-voicing than white speakers.

Finally, we hope to develop a more complete analysis of how speakers' orientations to the land in the Central Valley relate to their patterns of language use. The current investigation marks the fourth study coming out of the Voices of California project that finds a connection between ties to the land and patterns of variation. It is noteworthy that these patterns emerge in spite of the very different materialities of the land, some of which fosters agriculture and ranching, other parts of which support the growth of forests for logging, and still other parts of which are used to drill for oil. Arriving at a better understanding of the relation between the land and variation will likely require us to think about class in novel ways. We think that traditional approaches to class might work for more urban locales, like Sacramento, but they fall short for "rural cities" like Redding, Merced, and Bakersfield, where class is not stratified in ways that variationists are accustomed to seeing. We hope to have inspired more research on small cities, places that are neither urban, nor rural, but where the urban-rural divide might matter most.

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