**The California Vowel Shift and Fractal Recursivity in an Inland, Non-Urban Community**

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Short Title: THE CVS AND FRACTAL RECURSIVITY

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ABSTRACT

Addressing the dearth of variation research in non-urban, non-coastal regions of California, this study examines the extent to which speakers in Redding, an inland community just north of the Central Valley, participate in the California Vowel Shift (CVS). We acoustically analyze the fronting of the back vowels BOOT and BOAT, the raising of BAN and backing of BAT, and the merger of BOT and BOUGHT, in sociolinguistic interviews with 30 white lifelong residents. Results reveal a change in apparent time for all analyzed variables, indicating the CVS's progression through the community, though not as robust as in urban, coastal areas. This suggests that the shift originated in urban areas and is spreading outward. Additionally, we provide evidence that relative shifted-ness of different vowels is patterned by ideologies about urbanity and rurality. Thus, as the CVS spreads through Redding, speakers utilize particular features of the shift differently, negotiating identities relevant in California's non-urban locales.

INTRODUCTION

Representations of California English have circulated widely in the media for decades, from Moon Zappa's voicing of a "Valley Girl" in a 1982 Frank Zappa song of the same name, to the more recent Saturday Night Live mock-soap opera skits depicting "The Californians," a group of Los Angelenos embroiled in love triangles and traffic talk. These parodies bring to light some popular ideologies about Californians. Namely, people in the coastal Los Angeles Metropolitan Area are often viewed as representative of the entire state, they are people concerned with appearances and driving routes, and they have a distinctive way of speaking.

If the media is guilty of focusing on Los Angeles at the expense of the rest of the state, sociolinguists have not fared much better. Almost all work on Californian varieties of English has been conducted in urban and coastal locations like San Francisco (Eckert, 2008; Hall-Lew, 2009, 2011; Luthin 1987, Mendoza-Denton, 2008; Moonwomon, 1987; Podesva, 2011), Los Angeles (Fought, 1999; Hagiwara, 1997), and Santa Barbara (Kennedy & Grama, 2012). Though California-ness may be associated with these places ideologically, the assumption that these areas are indicative of the entire state leaves vast portions of California underrepresented both in the popular imagination and in linguistic research. Given the social diversity of the state, this assumption of uniformity erases the many areas of California that are neither urban, nor coastal, and which are organized along very different lines socially, politically, and economically, as compared to California's metropolitan areas. It is therefore crucial to investigate the ways that linguistic patterns vary across socially diverse areas of the state.

In this paper, we begin to address the dearth of sociolinguistic work on parts of California that are neither urban nor coastal. Specifically, we examine the participation of a non-coastal, non-urban community in a pattern of sound change found on the California coasts — the California

Vowel Shift (CVS). For speakers born and raised in the city of Redding and its neighboring towns, we investigate three dimensions of the CVS: the fronting of back vowels BOOT[i] and BOAT, the nasal pattern of BAT, in which the vowel raises pre-nasally but lowers and retracts before non-nasals, and the low-back merger of BOT and BOUGHT. Ultimately, it appears that the CVS has indeed spread to this non-urban locale. In this sense, the shift may be aptly named, as it appears to mark Californian identity beyond the urban coast. However, we also find evidence that another vowel system — the Southern Vowel Shift (SVS) — is likely at play in this area, in features of the CVS that are shared with those found in the Southern U.S. Features implicated in the SVS are found to correlate recursively with speakers' orientations toward country identities, while features implicated in the CVS, but not the SVS, correlate with orientation toward the town. We argue that different features index different aspects of California-ness, or country-ness, which speakers in Redding can recruit to negotiate identities made relevant in a non-urban, Californian locale.

*The California Vowel Shift*

Like many other states in the Western United States, California's dialectology has been relatively understudied in comparison with communities in the Northeast, Southeast, and Midwest U.S. While the Atlas of North American English draws detailed divisions among Northeastern cities, it places California together dialectologically with the entire Western half of the U.S., as the "West" (Labov, Ash, & Boberg, 2006). Further, Labov (1991) has posited that California's vowel system fits into a "Third Dialect," third after the Northern Cities Vowel Shift system and the Southern Vowel Shift system. The Third Dialect is said to encompass similar vowel shifts documented in California, Canada, and the United States Midlands. It seems unlikely, however, that these vast and geographically disparate regions pattern in exactly the same way with respect

to sound change, making relevant the need for further research in each of these areas. The body of work on California dialectology in particular has grown over the last few decades, although with a tendency to focus on the prominent urban, coastal communities of Los Angeles and San Francisco.

Previous investigations of urban, coastal California English have identified vowel patterns distinct from other regional varieties. The primary patterns that make up the California Vowel Shift (CVS) are shown in Figure 1. The low back vowels BOT and BOUGHT are merged, a pattern deemed a hallmark of the West (Labov et al., 2006). The back vowels BOOT, BOAT, and BOOK are fronted (Hall-Lew, 2009; Hinton, Moonwomon, Bremner, Luthin, Van Clay, Lerner, & Corcoran, 1987). The front lax vowels BIT, BET, and BAT are lowered and centralized (Eckert, 2008; Hagiwara, 1997; Kennedy & Grama, 2012), with BAT's backing and lowering conditioned by its phonological environment: pre-nasal BAT, what we will call BAN, raises and fronts, while non-pre-nasal BAT backs and lowers (Eckert, 2008), a "nasal split" that distinguishes the California vowel system from the Canadian Vowel Shift.
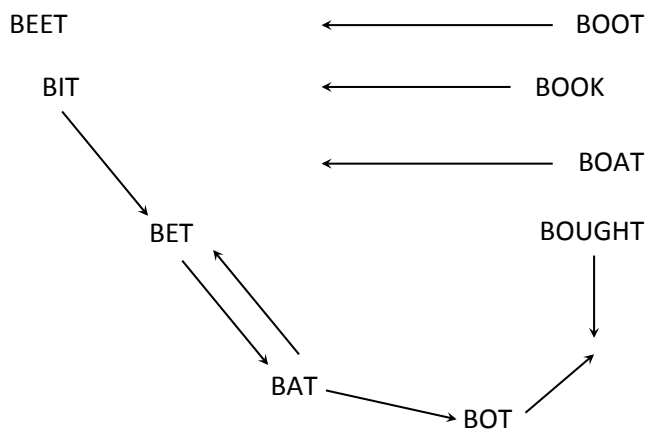


FIGURE 1. The California vowel shift

Though the name of the California Vowel Shift may indicate that this pattern applies uniformly across the state, California's extreme social diversity is reflected in language. While studies of the CVS, like many studies of regional dialects, have privileged the language of white mainstream English speakers as representative of a regional variety, findings indicate that ethnic varieties of African American English and Chicano English within California remain distinct varieties in both Los Angeles (Baugh, 1983; Fought, 1999) and the San Francisco Bay Area (Mendoza-Denton, 2008; Rickford, Ball, Blake, Jackson, & Martin, 1991). It thus appears that this shift most accurately describes the vowel systems of white mainstream American English speakers in California, though of course, much variation has been found in the use of these variables both by white and non-white speakers.

While descriptive work on the California Vowel Shift has elucidated prominent patterns specific to California, the majority of such studies have analyzed vowel systems of speakers from the urban coast. For example, Kennedy and Grama (2012) report on the speech of thirteen speakers, all from the San Francisco Bay Area, the Central Coast (e.g., Santa Barbara) or coastal Southern California (e.g., Los Angeles, San Diego). Very few investigations of the shift have focused on speakers outside these areas, leaving the vast region of inland California unexamined. Further, descriptive studies of the CVS have largely focused on speech gathered in reading or citation tasks (e.g., Hagiwara, 1997; Kennedy & Grama, 2012). As sociolinguists have repeatedly shown, remarkable intra-speaker differences emerge between these types of tasks and interview speech, and reading or citation tasks tend to underrepresent the extent of a speaker's use of local features (cf. Labov, 1966). Questions therefore remain regarding the details of the CVS in more conversational contexts. By focusing solely on informal interview speech of speakers from the Redding area, a non-coastal, non-urban community, this paper enriches the

current understanding of the California Vowel Shift as a statewide phenomenon. Crucially,

focusing on speakers in Redding foregrounds a particular social distinction that is less salient on

the urban coast, and has been shown to influence sociolinguistic patterning: town versus country

identities.

*Country identity and language in California*

Though characterizations of California in popular media tend to take its urban centers as

indicative of the state as a whole, this assumption erases the diversity of the state, including the

patterns of migration that make up California's history. The Dust Bowl of the 1930s brought

migrants west from Oklahoma, Texas, and other Southern states, to California's Central Valley.

Some remained at the Central Valley's southernmost points, settling in communities like

Bakersfield, while others continued north to locales like Redding, at the Valley's northern tip.

The Central Valley remains a prominent agricultural center both for the state and for the nation

as a whole, and it is home to a large number of farmers and ranchers. Country or Okie heritage is

explicitly discussed within these communities, and many orient more readily toward rural or

country lifestyles than to aspects of urban, coastal California identities endemic to stereotypes of

the state.

Inevitably, settlers from the South Midlands brought elements of their regional dialects with

them as they migrated to California. Studies of folk linguistics (e.g., Niedzielski & Preston,

2003; Preston, 1989) indicate that Country Talk is widely recognized as a variety in the U.S.

popular imagination, and this extends to language attitudes within California. Speakers from

outside of California (Preston, 1989) and within California (Fought, 2002) tend to label the state

a locus of "good" or "normal" English. However, when native Californians are asked to divide

the state into smaller regions, ideologies about country speakers emerge. Bucholtz, Bermudez,

Edwards, Fung, and Vargas, (2007) asked over 700 respondents, mostly California natives, to draw social and linguistic divisions within the state. They found that the country-related labels *hicks*, *hillbillies*, and *rednecks* were the most commonly used in the task. These labels (in addition to others like *cowboys, farmers, ranchers, okies, country, rural, white trash*, and *twangy*) predominated in identifications of the Inland and Northern areas of California, just those areas where Dust Bowl migrants created agricultural communities in the state.

While a number of studies have examined Country Talk as a folk linguistic or ideological object, it has not been well understood by linguists as a sociolinguistic style in itself. Hall-Lew and Stephens (2012) begin to address this gap in an investigation of Country Talk's sociolinguistic correlates in the Texoma region of the United States — the Red River valley of Texas and Oklahoma. Through a series of interviews in which descriptions of Country Talk were elicited, Hall-Lew and Stephens (2012) found that speakers name a number of features as country on the levels of discourse, the lexicon (e.g., "howdy," "yonder"), morphosyntax (e.g., "y'all," "ain't"), and phonetics/phonology (e.g., "a drawl," monophthongal /ai/, alveolar ING). They argue that Country Talk is an enregistered variety (Agha, 2003) that indexes particular social meanings associated with both rurality and the Southern region of the United States. For Texoma speakers, Country Talk is associated with particular types of local rural personae that are connected to the land, like farmer and rancher identities. These indexical links in turn reflect a larger scale association between the variety and the agricultural South, particularly as compared to the industrial North.

Research has only just begun to address how historical and present-day country affiliation continues to resonate through the linguistic patterns of communities *outside* of the Southern U.S. Through an ethnographic study, Geenberg (2014) investigated the connection between Country

Talk ideologies and speech patterns in Trinity County, California, just north of the Redding area. Even within this rural, inland county, described by inhabitants as "like Appalachia," an ideological distinction was maintained between more rural "outdoorsy" people, called "hillbillies" by some, and the less rural "indoorsy" people, deemed "flatlanders." Geenberg examined the merger of pre-nasal BIT and BET vowels, or the PIN-PEN merger, which has been found to dominate in the Southern and Midland United States (Labov et al., 2006) and thus may retain associations with Southern or country identities. Within the rural town of Hayfork, Geenberg showed a divergence in outdoorsy versus indoorsy uses of the PIN-PEN merger over time, such that younger indoorsy speakers were most likely to have the PIN-PEN distinction, while younger outdoorsy speakers were most likely to have the PIN-PEN merger. This merger had no correlation with whether or not a speaker had "Okie" heritage, or historical ties to the South itself. Rather than simply serving as a remnant of historical migration patterns, the PIN-PEN merger appears to be an increasingly prominent index of outdoorsy identity in this community. Geenberg found that outdoorsy speakers also showed more raised BET — a component of the Southern Vowel Shift (Labov et al., 2006) — than indoorsy speakers. She proposes that within this community, constructed identities and corresponding linguistic styles have emerged in direct opposition to urban progress. These findings show that country identity plays a strong role in the ideological talk of speakers in inland California. Moreover, these ideologies drive the patterning of phonetic variables as well.

Geenberg also examined one aspect of the CVS in this community — the backing of non-pre-nasal BAT. She found that backing was more common in the less rural town of Weaverville than in more rural Hayfork. Speakers who had spent time outside of the county, typically in areas of urban California, were also more likely to exhibit backed BAT than speakers who had not. This

provides evidence that at least some aspects of the CVS have spread to rural, inland areas of the state.

The present study expands upon Geenberg's findings regarding the CVS in Northern inland California, examining BAT, along with five additional vowels involved in the shift, in the Redding area. Redding provides a unique middle ground between urban cities of the coast and extremely rural Trinity County. Though some inhabitants of Redding are oriented to rural and country ideologies and lifestyles, many are oriented to more urban lifestyles, and speak highly of California's coastal cities. The coexistence of these identities within a single community makes Redding a useful place to investigate the behavior of linguistic patterns associated with California (the CVS) in the context of an area that maintains some ties to country ways of life.

*Social meaning and the California Vowel Shift*

As sociolinguists have become interested in how linguistic variables can be recruited for identity work, the social meanings tied up in the use of linguistic variables have become relevant. A third-wave variationist approach (Eckert, 2012) foregrounds the importance of these social meanings in creating sociolinguistic styles. Some studies in this vein have investigated the CVS, examining ways that speakers recruit features of the shift to index locally significant identities that can be tied to various heterogeneous ethnic and social groups within California. Such studies demonstrate that macro-social regional varieties do not simply mark demographic location of origin. Rather, such features and their regionally-based social meanings can be recruited (or *not* recruited) to index local social meanings or personae. These micro-level sociolinguistic moves often reflect, or themselves create, larger-scale macro-level social meanings, in a system of *fractal recursivity* (Irvine & Gal, 2000), where global oppositions play out on telescoping levels of localness.

Along these lines, a number of studies have complicated the picture of straightforward correlations between California features and macro-social categories. In the realm of ethnicity, for example, Hall-Lew (2009) finds that young Asian Americans in the Sunset neighborhood of San Francisco lead some aspects of the CVS as compared to European Americans of the same age cohort. Rather than drawing the use of the CVS along lines of ethnicity, these speakers use the CVS to index local affiliation with the Sunset, a neighborhood that historically has been comprised of both Asian and European ethnic groups. Similarly, in an examination of the "nasal split" of the BAT vowel in the speech of White and Chicano students at two elementary schools, Eckert (2008) finds that these students recruit the raising and fronting of BAN to index position in the local social order, regardless of ethnicity, in spite of the fact that on a macro-social level, Chicano English speakers tend not to raise and front BAN. In Los Angeles and the Bay Area, respectively, Fought (1999) and Mendoza-Denton (2008) examine the ways that gang affiliation, rather than broader ethnic group, conditions patterning of CVS features. Fought argues that non-fronted BOOT amongst Los Angeles area gang-affiliated Latinos is not simply a lack of assimilation to white speech, but a stylistic resource used to create specifically Chicano identities. Adding to these findings of local, stylistic uses of the CVS that are not simply straightforward macro-social markers, Podesva (2011) finds features of the CVS to be recruited in gay styles, a "partier" persona, for instance. This likely draws upon conventionalized social meanings of California-ness, which often circulate in representations of "cool" or "laidback" personae.

Together, these studies indicate that within urban, coastal California, speakers draw upon or resist the use of CVS features in various styles related to local place identity, social status within a group, or personae. In this paper, we begin to address the ways that such features are recruited

by Californians who may not orient to the state and its urban centers in the same way as speakers from Los Angeles or San Francisco. Fractal oppositions along urban-rural lines emerge in the Redding area — the larger scale opposition between urban coastal cities and the Redding community as a whole is reflected internally between those who orient to the town of Redding and those who are more country oriented. If elements of the CVS are indexical of the urban coasts from where they originated, we hypothesize that within the Redding community, features of the shift will more strongly index town, as opposed to country, orientation, and that country speakers may show entirely different patterns related to country identity. We therefore expect firstly, to see the shift spreading throughout the community in apparent time, and secondly, to see it patterning according to this town-country distinction within the area.

THE STUDY

This study analyzes vocalic data gathered from sociolinguistic interviews collected on site in Redding, California, and its surrounding communities, in the summer of 2011. These interviews were open-ended and semi-structured, conducted by field workers of the Voices of California project out of Stanford University. The project's goal has been to document the linguistic diversity and to broaden the sociolinguistic and dialectological understandings of California beyond its urban, coastal centers. This involves not only gathering data at each field site — 130 or so interviews, word list recordings, and perceptual dialectology map tasks (cf. Preston, 1989) — but also spending quality interpersonal time with residents to learn about the sociocultural features unique to each setting. Because this study investigates the extent to which the California Vowel Shift is evident in Redding, we focus on the following vowels: 1) BOT and BOUGHT and whether there is evidence of merger; 2) BOOT and BOAT, as well as their post-coronal counterparts TOO and TOE,[ii] and whether they show evidence of fronting; 3) BAN and its relative

raising and frontness; and 4) BAT and the extent to which it is retracted (backed). We also investigate the extent to which any of these vowels may be undergoing change via the lens of apparent time.

*Community*

Redding is located in Shasta County, California. Speakers in this study come from Redding (Shasta's county seat) and its surrounding towns. Redding proper, population roughly 90,000 as of the 2010 census, is the largest city in the Shasta-Cascade region of far northern California. Known for its rich natural resources and its fierce independence, this region shares geographic and economic realities more akin to those in southern Oregon than to the rest of California. In fact, several referenda have been held over the years proposing secession from the state to create a new State of Jefferson. While these referenda have not been successful politically, the plight of the State of Jefferson is alive and well in the sociocultural consciousness.

The secession movements stem not only from an acknowledgement of the region's geographic disparity from the rest of the state, but also from feelings of political alienation. Redding residents repeatedly report frustration that their vital interests are not adequately considered in Sacramento, California's capital, which they believe to be overrun by liberal legislators from the Bay Area and Los Angeles. For example, pointing to Sacramento during the map task, one speaker said, "the capital is right there in the middle, but you'd think it was there [pointing to Los Angeles], and that's all I need to say about that." One pivotal historical factor driving sentiments like these is the fact that the economic prosperity of the region was decimated in the 1990s, due to environmental regulations coming out of Sacramento. These regulations greatly restricted the region's number one industry—the logging and milling of timber—to the point where local unemployment levels peaked and most residents were forced to pursue other,

more service-oriented occupations. More recently, feelings of distaste for so-called "Southerners" (i.e., people from California south of Redding) have worsened as citizens from the Bay Area have been moving up to Shasta County and have gotten involved in local politics. These "equity pioneers," as one resident called them, with their liberal politics and their big houses, have not been received favorably by lifelong locals. Thus, given the widespread sentiment that Redding is nothing like the cities to the south, the question of whether the California Vowel Shift is represented in Redding merits further investigation.

*Speakers*

All 130 or so Redding area residents interviewed during field work were sampled via a snowball sampling method, with an effort made to balance for age, sex, and ethnic characteristics. The subjects selected for this study are 30 speakers (15 females; 15 males), ranging in age from 18 through 86. All of the speakers identify as white. While focusing on white speakers does not reflect the aims of the Voices of California project overall, it is nevertheless true that Redding is an overwhelmingly white community — eighty-six percent accordingly to the 2010 census.

Few class-based distinctions were reported by interviewees. Residents of the Redding area seem to value egalitarianism regardless of relative socioeconomic success. However, one important distinction that emerged over the course of fieldwork was between residents who were rurally-oriented (called "Countryfolk" for the purposes of this paper) and those who were oriented toward the town of Redding ("Townies"). Countryfolk were those who lived outside of the Redding town limits, built their livelihood on rural-based industries like farming or ranching, and/or were seriously involved in country-based recreational pursuits like regular horseback riding or hunting. One speaker, a young female rancher, described tasks like "fixing fence," which she associated with "being a country girl," and she cited her love for "the tradition and the

heritage...the small town atmosphere, and not having neighbors," sentiments shared by other Countryfolk.

"Townies" were those individuals who were oriented toward the town of Redding. In contrast to Countryfolk, these residents were involved in non-rural livelihoods and activities based in town life. It is important to note that while Townies are decidedly not rurally-oriented, they are at the same time not necessarily urban-oriented either. That is, many Townies expressed disdain for the big cities down south, as did their Countryfolk counterparts. Because this country-versus-town orientation played such an important role in shaping community dynamics in Redding, and because the concept of "country" has been shown to be significantly reflected in linguistic variation (as discussed above), this distinction was noted for all 30 speakers in the sample. In all, there were 15 Countryfolk (8 female; 7 male) and 15 Townies (7 female; 8 male) in the sample. Table 1 summarizes the sample under study.

TABLE 1. *Summary of speaker characteristics*

| 30 speakers | | | |
|---|---|---|---|
| 15 Countryfolk | | 15 Townies | |
| 8 female | 7 male | 7 female | 8 male |
| ages 19 - 69 | ages 20 - 86 | ages 18 - 73 | ages 18 - 63 |

*Data*

All speech data were recorded in the field on Marantz PMD660, Zoom H2, or Sony PCM-M10 recorders using Audio Technica AT831b or Audio Technica ATPro70 lavalier microphones. Recordings were made at a 44.1 kHz sampling frequency with a bit rate of 16. All resulting WAV files were orthographically transcribed and time aligned in Transcriber (Barras, Geoffrois,

Wu, & Liberman, 2001) and then force-aligned into phone segments using the FAVE software

package (Rosenfelder, Fruehwald, Evanini, & Yuan, 2011). Subsequent extraction and analysis

of tokens was carried out in Praat (Boersma & Weenink, 2006).

For each of the vowels BOT, BOUGHT, TOO, BOOT, TOE, BOAT, BAN, and BAT, 25 tokens per

speaker were hand-selected. Tokens were also extracted for BEET and POOL, anchor vowels used

for normalization and analytical purposes (see below). Several relevant controls were also taken

into consideration. First, to control for potential observer effects, tokens were gathered only after

15 minutes (900 seconds) of the interview had elapsed. All tokens were in contexts carrying

primary stress, and function words were excluded. Segment boundaries identified through forced

alignment were hand-corrected, and only those tokens with durations longer than 75 milliseconds

were considered. Tokens with preceding vowels, glides, or /r/ were excluded, as were those with

following vowels, glides, and liquids, to ensure reliable boundaries between vowels and their

neighboring sounds. Finally, no more than two tokens per lemma were considered. In some

cases, due to a paucity of appropriate tokens given these controls, the token sample was

expanded to include those from the first 15 minutes or a third lemma as needed. In all, about

6,000 tokens were extracted for analysis.

Midpoint $F_1$ and $F_2$ measurements in Hertz were made for each token. Following Hall-Lew

(2009), we took a combination vowel-intrinsic and vowel-extrinsic normalization approach. Such

an approach arguably takes into better account the perceptual/processing salience of relative

differences in speakers' vowel spaces. In doing this, first all Hertz measurements were converted

to Bark using Traunmüller's (1997) formula. Then, these Bark values were normalized via the

NORM vowel normalization suite (Thomas & Kendall, 2007), using the "modified" Watt and

Fabricius $S$-centroid procedure (Fabricius, Watt, & Johnson, 2009). Finally, these normalized

vowel measurements were used to create outcome variables for assessing merger or relative

vowel distances.

The first specific distance measure created for analysis was the Euclidean distance between

each BOT token and the overall BOUGHT mean for each speaker (called *BOT − mBOUGHT*

henceforth). We chose this means of assessing merger because in other work (D'Onofrio, Eckert,

Podesva, Pratt, & Van Hofwegen, in prep.) we have found evidence for BOT's variable

encroachment on a relatively stable BOUGHT-like target (not vice-versa). The second Euclidean

distance measure was between each BAN token and BEET's mean for each speaker (*BAN − mBEET*).

As previous work on this feature (e.g., Eckert, 2008) has shown a raising and fronting target for

BAN in California English (i.e., not uni-dimensional $F_1$ or $F_2$ movement alone), Euclidean

distance with the highest and frontmost anchor vowel BEET is thus an appropriate measure.

Because the other distance measures examined in this paper are primarily in terms of

movement along the $F_2$ axis (i.e., relative fronting/backing, not lowering/raising), they were

calculated in terms of relative normalized $F_2$ distances between each vowel under analysis and

the mean normalized $F_2$ of BEET, for each speaker. BEET was chosen as a reference vowel for

these measures because it is more stable for California speakers than are the backmost anchor

vowels (i.e., POOL, BOWL, BULL, etc.), which may also be undergoing fronting. Thus, relative BAT

retraction was measured in terms of the $F_2$ distance between each BAT token and the mean of

BEET for each speaker (*BAT − mBEET*); relative TOO/BOOT and TOE/BOAT fronting was likewise

assessed in terms of $F_2$ distances with a speaker's BEET mean (*TOO − mBEET, BOOT − mBEET, TOE

− mBEET,* and *BOAT − mBOAT*). Considering these vowels in terms of their relative distances with

BEET provides an additional intra-speaker control, more appropriate than looking at normalized

$F_2$ values alone. Table 2 summarizes the outcome variables utilized in the statistical analysis described below.

TABLE 2. *Summary of outcome variables*

| Variable | Measure | |
| --- | --- | --- |
| | Euclidean distance | Normalized $F_2$ distance |
| BOT-BOUGHT merger | *BOT–mBOUGHT* | |
| BAN raising/fronting | *BAN–mBEET* | |
| BAT retraction | | *BAT–mBEET* |
| TOO fronting | | *TOO–mBEET* |
| BOOT fronting | | *BOOT–mBEET* |
| TOE fronting | | *TOE–mBEET* |
| BOAT fronting | | *BOAT–mBEET* |

These outcome variables were then incorporated into linear mixed-effect models. Random and fixed effect coefficients were estimated in *R*, using the *lmer* function of the *lme4* package. *P*-values were obtained using *R*'s *lmerTest* package. In each model, we included fixed effects of speaker *age* (continuous), *sex* (binary, male or female), and *orientation* (binary, country or town), with random effects of *speaker*, *word*, *preceding environment*, and *following environment*. By *environment* we mean those phonological segments immediately preceding or following the vowel in question. Continuous variables were centered, while discrete variables were coded using sum contrasts, so that lower-order coefficients would refer to the grand mean of the variables when higher-order coefficients were included in the model. A separate model was fit for each outcome variable.

RESULTS

In this section we report the results for each of the outcome variables listed in Table 2, beginning with the fronting of the back vowels (BOOT, TOO, BOAT, TOE), continuing with the raising of BAN and backing of BAT, and ending with the BOT-BOUGHT merger. Given the large number of variables considered, our focus here is to identify significant correlations between the linguistic variables and the social variables under consideration (age, sex, town vs. country orientation, and their interactions). Models for each variable, including significance values for each factor, are summarized in the regression tables in the Appendix (Table 3 through Table 9). While we focus on significant correlations between the outcome variables and social factors modeled, it should also be borne in mind that, as detailed in the previous section, linguistic factors were included in the models for each outcome variable.

*BOOT and TOO*

Following previous work on back vowel fronting, we investigated the high back vowels in two phonological environments: following coronals (e.g., TOO), where articulatory constraints encourage fronting, and elsewhere (e.g., BOOT). The statistical models for the outcome variables (*BOOT–mBEET* for BOOT fronting and *TOO–mBEET* for TOO fronting) were remarkably similar: the same factors emerged as significant, with the levels of each factor exhibiting the same trend for *BOOT–mBEET* as for *TOO–mBEET*. The only appreciable differences were that the magnitude of fronting was slightly greater for TOO, as expected, and that a three-way interaction was significant for *TOO–mBEET* but it was just above the alpha level of 0.05 for *BOOT–mBEET*. Given these largely convergent patterns, we discuss here only the results for BOOT, the more general phonological environment. The model for TOO fronting can be found in the Appendix.

For the outcome variable *BOOT–mBEET*, there were main effects of age and orientation. Fronter realizations of BOOT were produced by younger speakers and by country-oriented speakers, with backer realizations by their older and town-oriented counterparts. The two-way interaction between age and gender emerged as significant, while the two-way interaction between age and orientation and three-way interaction between age, gender, and orientation trended toward significance. The details of the model can be found in Table 4 in the Appendix. Figure 2 depicts the interaction among the social factors. All groups show an age effect, with younger speakers fronting to a greater extent than older speakers; note that lower values indicate a shorter distance between BOOT and BEET, hence greater fronting. Among Countryfolk, the effect of age is stronger among male speakers. That is, younger country-oriented males front BOOT more than younger country-oriented females, while older country-oriented males front BOOT less than older country-oriented females. The gender difference with respect to the age pattern does not appear to extend to town-oriented speakers, among whom males and females exhibit similar patterns across the age range.
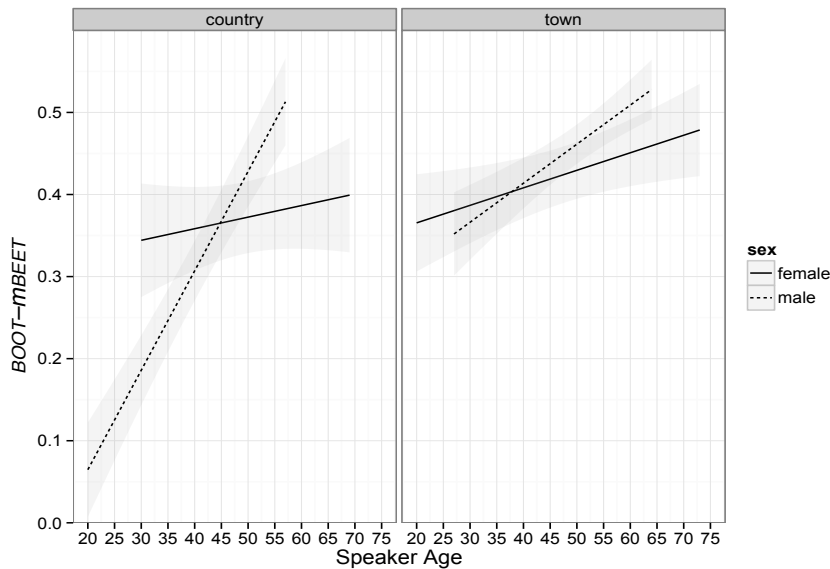
FIGURE 2. Normalized F2 distance between BOOT and BEET (*BOOT–mBEET*) by age, gender, and orientation (lower values indicate greater BOOT fronting)

Although numerous social factors appear to constrain the degree of fronting for BOOT, it is important to note that most speakers in the corpus exhibit some degree of fronting. Figure 3 provides a sense of the range of fronting we observe in the sample. The left panel shows the vowel space for BOOT and TOO for a 20-year-old country-oriented male, the speaker who shows the most fronting. In addition to BOOT and TOO, the plot shows ellipses (indicating two standard deviations from the mean, a representational practice we follow herein) for the vowels at the periphery of the space—BEET, BOT, and POOL—for reference. This speaker exhibits an extreme degree of fronting, such that BOOT and TOO essentially occupy the same position as BEET in the $F_1$-$F_2$ plane (though it is likely that the phonological distinction between front and back vowels is maintained in other acoustic dimensions, particularly $F_3$; BOOT and TOO are rounded, based on auditory inspection of the speaker's vowels). While no other speakers front BOOT and TOO to such a great extent, many speakers exhibit a moderate degree of fronting, even older speakers, such as the 59-year-old country-oriented woman in the right panel in Figure 3. Note that BOOT is

nearly as fronted as TOO for this speaker, in spite of the fact that the phonological environment does not occasion fronting for this vowel class.
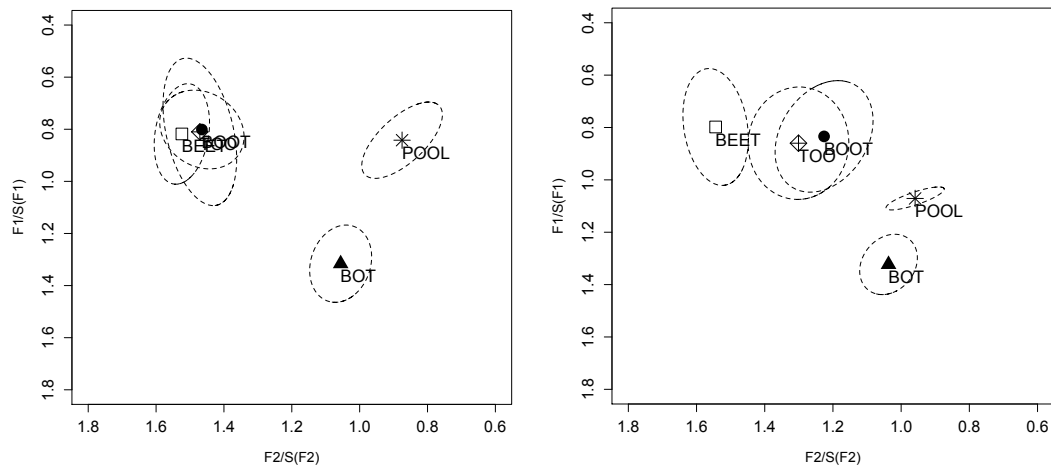


FIGURE 3. Vowel plots for two speakers exhibiting extreme (left, 20-year-old country-oriented male) and moderate (right, 59-year-old country-oriented female) degrees of BOOT and TOO fronting

In summary, the back vowels BOOT and TOO are in the process of fronting in Redding. Nearly all speakers exhibit some degree of fronting, while younger and country-oriented speakers appear to be leading the change. Among the country-oriented speakers, the age effect is more pronounced for males than females. We turn now to the question of whether the mid back vowels exhibit the same degree of uniformity as BOOT and TOO with respect to fronting.

*BOAT and* TOE

In contrast to BOOT and TOO, BOAT and TOE exhibit distinct fronting patterns, so we discuss the results for these two variables separately, beginning with TOE. For the outcome variable *TOE–mBEET* (details of the model are summarized in Table 5 in the Appendix) there were main effects of age and orientation. The degree of TOE fronting decreases with speaker age, and country-oriented speakers front TOE more than town-oriented speakers. The model also shows significant

interactions between age and gender and between age and orientation, and a marginal interaction between age and gender. The three-way interaction between age, gender, and orientation was also marginally significant. As was the case for BOOT and TOO, the interactions reveal that while all groups of speakers display an age effect for TOE fronting, among Countryfolk, the age effect is stronger among men, while there is no gender difference among Townies. These patterns for TOE are, by and large, the same as those for BOOT and TOO.

The patterns begin to diverge for BOAT. The linear regression for the outcome variable *BOAT– mBEET* (summarized in Table 6 in the Appendix) reveals a number of similarities, including main effects of age and orientation (with fronting again more prevalent among younger and country-oriented speakers) and a significant interaction between age and gender. This interaction is shown in Figure 4. While an age effect is evident for both male and female speakers, with the degree of fronting decreasing with speaker age, the age effect is stronger for males. Where BOAT diverges from BOOT, TOO, and TOE is in the total lack of interactions involving orientation. Whether speakers orient to the town or the country does not interact with age, gender, or the combination of the two. Importantly, the age pattern is remarkably similar for Townies and Countryfolk alike.
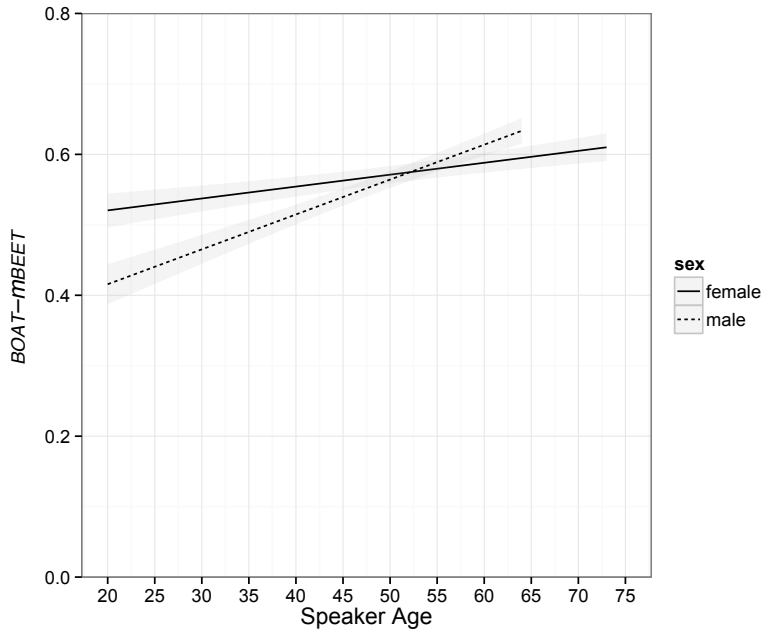
FIGURE 4. Normalized $F_2$ distance between BOAT and BEET (*BOAT–mBEET*) by age and gender (lower values indicate greater BOOT fronting)

Whereas the high back vowels exhibited robust degrees of fronting across the community, the mid back vowels BOAT and TOE show strikingly smaller degrees of fronting. These patterns are evident in Figure 5, which depicts the BOAT and TOE fronting patterns for the most fronted speaker in the sample (on the left), as well as for a speaker who shows only a modest degree of fronting for these vowels (on the right). The speaker in the left panel, the same speaker whose BOOT and TOO tokens are represented on the left panel of Figure 3, fronts only just past the $F_2$ for BOT, which generally sits in the back of the vowel space for speakers in this community, particularly younger speakers such as this one. It is also worth noting that BOAT, which demonstrates social patterning distinct from that of BOOT, TOO, and TOE, shows a much wider range of variation in the $F_2$ dimension, encompassing the backest part of the vowel space and much of the front. Such wide variation may be indicative of its relatively recent introduction into the linguistic repertoire of this speaker. Fronting likely began following coronals (i.e., TOE), an

environment in which the vowel is less dispersed for this speaker, as compared to BOAT. The range of variation for BOAT for older speakers is relatively smaller, as indicated in the panel on the right of Figure 5, which depicts the vowel space of a 68-year-old town-oriented female. It should also be noted that this speaker's BOAT and TOE distributions are settled in the back of the space, indicating only a modest participation in the fronting of the mid back vowels.
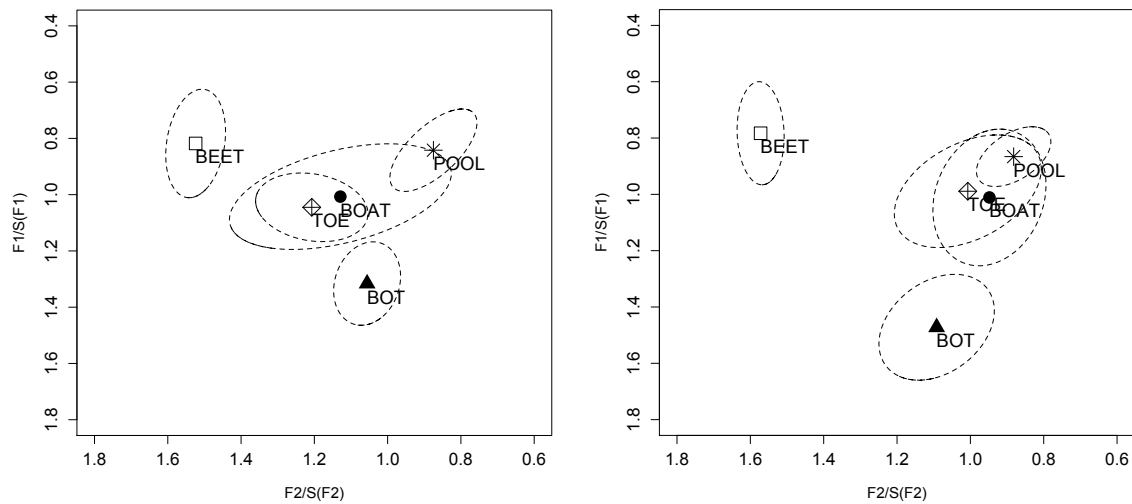


FIGURE 5. Vowel plots for two speakers exhibiting the greatest (left, 20-year-old country-oriented male) and modest (right, 68-year-old town-oriented female) degrees of BOAT and TOE fronting

To summarize the patterns for BOAT and TOE, fronting appears to have begun spreading through Redding, though not to the same extent as it has for the high back vowels. As was the case for high vowel fronting, the fronting of BOAT and TOE is more prevalent among country-oriented speakers than those oriented to the town. In contrast to the high back vowels, BOAT shows distinct social patterning from TOE, in that the effect of orientation is not mediated by the effects of gender or age. Having discussed the fronting of the high and mid back vowels, we turn our attention to the front vowels in the following section.

*BAT and* BAN

As discussed in the introduction above, the realization of BAT (in urban, coastal communities, at least) depends heavily on the following phonological environment, such that fronting and raising occurs prior to nasals, and backing (and some degree of lowering) occurs elsewhere. Accordingly, we treat BAN[iii] as a separate vowel class from BAT, and indeed, the two vowels exhibit strikingly distinct patterns in Redding.

Beginning with BAN, the regression analysis (summarized in Table 7 in the Appendix) on the outcome variable (*BAN–mBEET*) reveals a main effect of age only. As speaker age decreases, the Euclidean distance between BAN and BEET decreases, suggesting that younger speakers are moving BAN in the direction of BEET. There was also a significant interaction between age and orientation, such that the effect of age is stronger among Countryfolk. This interaction is represented in Figure 6, which shows that while there is no across-the-board effect of orientation, younger Countryfolk appear to raise BAN more than younger Townies. No other interactions emerged as significant.
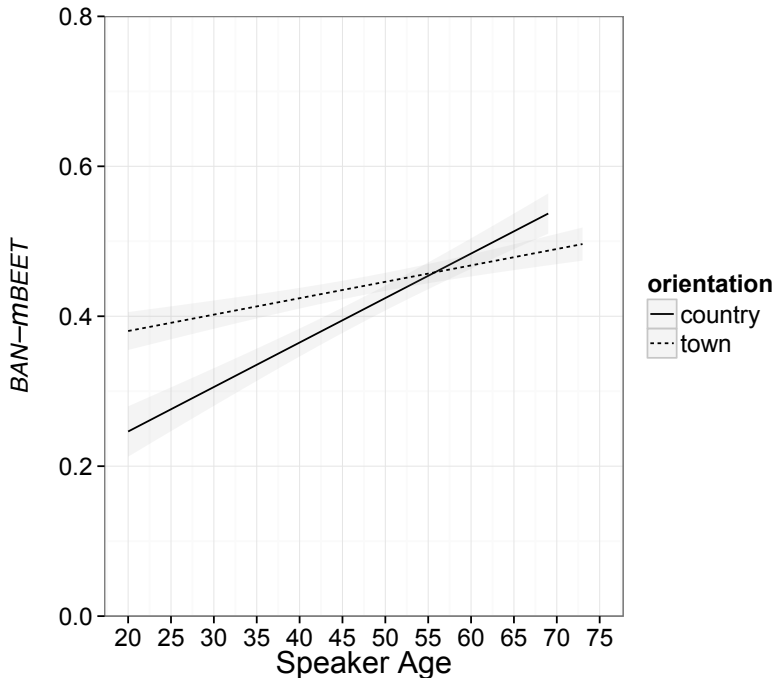
FIGURE 6. Normalized Euclidean distance between BAN and BEET (*BAN–mBEET*) by age and orientation (lower values indicate greater BAN raising)

In stark contrast to the other components of the shift, BAT backing shows no effect of orientation. The regression model for the outcome variable (*BAT–mBEET*), as summarized in Table 8 in the Appendix, shows a main effect of age only. Younger speakers exhibit a longer distance in $F_2$ between BAT and FLEECE, suggesting that they are moving the vowel away from the front of the vowel space (i.e., backing). No interactions, including those with orientation, were significant.

The split between BAT and BAN, achieved by the raising (and slight fronting) of BAN and the backing (and slight lowering) of BAT, is therefore evident in Redding. The vowel plots in Figure 7 give a sense of the magnitude of the split. The left panel shows BAT and BAN for the speaker with the greatest distance between the two vowels, an 18-year-old town-oriented female. As can be seen in her vowel plot, BAT and BAN do not overlap at all, and BAT is rather close to (and

overlaps partly with) BOT, further evidence of BAT retraction. While the BAT-BAN split is evident in Redding, it has not advanced to the degree that it has in urban areas, such as the Bay Area. As Eckert (2008) shows, preadolescents who raise BAN raise the vowel as high as BEET. The vowel plot for a speaker (a 37-year-old town-oriented female), who is now only a few years older than Eckert's preadolescents would be today, appears in the right panel in Figure 7. The plot shows that, while BAN and BAT occupy largely distinct spaces, BAN is scarcely as high as BEET. The same is true even for the speaker on the left, who shows the greatest distance between BAN and BAT in the current sample.
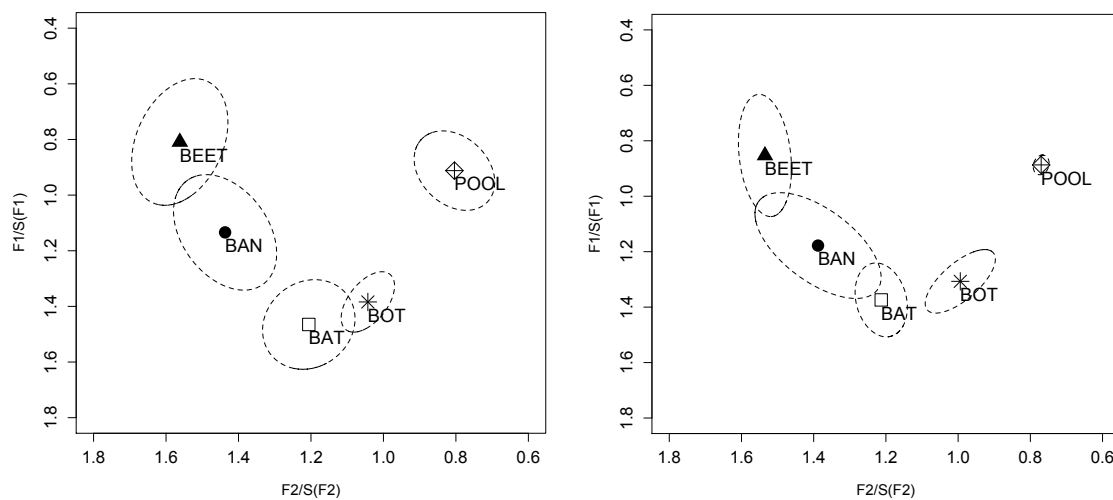


FIGURE 7. Vowel plots for two speakers exhibiting the greatest (left, 18-year-old town-oriented female) and moderate (right, 37-year-old town-oriented female) degrees of the BAT-BAN split

In summary, the BAT-BAN split has spread to Redding, with the raising of BAN and the backing of BAT both significantly more prevalent in the speech of younger speakers. While orientation had an effect on the raising of BAN, such that younger Countryfolk raise BAN to the greatest extent, orientation had no effect on the backing of BAT. For all variables discussed thus far, if orientation influenced the extent to which vowels shifted, it has been country-oriented

speakers who have led the change in apparent time. In the following section, we turn to the final variable under consideration, where town-oriented speakers lead the change.

*BOT and BOUGHT*

We end by discussing the results for the BOT-BOUGHT merger. The regression model on the outcome variable (*BOT–mBOUGHT*), summarized in Table 9 in the Appendix, reveals main effects of age and orientation. As age increases, the Euclidean distance between BOT and BOUGHT increases, suggesting that older speakers maintain a greater distinction between these vowels than younger speakers, who merge them. There was also a main effect of orientation, revealing that speakers oriented to the town exhibited a shorter distance between the vowels, thus indicating greater merger.

The vowel plots in Figure 8 represent the range of patterns in the community. The left panel shows the pattern for a 19-year-old town-oriented female, the speaker who shows the greatest degree of merger according to the outcome variable (*BOT–mBOUGHT*). Here, the means for BOT and BOUGHT are nearly identical, their distributions largely overlapping. This contrasts with the BOT and BOUGHT of the speaker on the right, an 86-year-old country-oriented male. As the figure shows, his BOT and BOUGHT have distinct means, and their distributions overlap to a lesser extent.
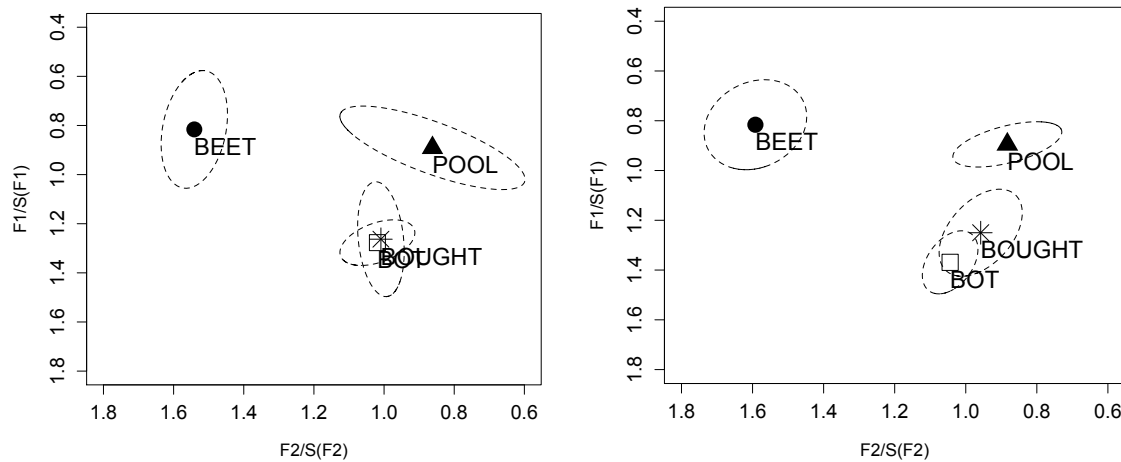
FIGURE 8. Vowel plots for two speakers who merge (left, 19-year-old town-oriented female) and maintain a distinction between (right, 86-year-old country-oriented male) BOT and BOUGHT

To recapitulate, the BOT-BOUGHT merger is well attested in Redding. While a small number of speakers maintain a distinction between BOT and BOUGHT, this pattern is exceedingly rare in the community, even among older speakers; most speakers would be classified as exhibiting a merger. Nevertheless, quantitative differences emerge in the extent to which speakers merge these vowels: younger speakers merge to a greater extent than older speakers, and speakers oriented to the town merge to a greater extent than those oriented to the country.

*Summary of results*

To conclude this section, we summarize the primary findings of our study and highlight some of the most striking trends emerging across the variables. Age serves as a significant predictor for all variables under consideration, with the extent of the shift correlating inversely with speaker age. Age was the only social factor that was significant for all variables.

Speaker orientation to country versus town is a strong predictor of many of the linguistic variables. Townies lead Countryfolk in the BOT-BOUGHT merger, while Countryfolk lead

Townies in the fronting of the back vowels (for all four vowel classes considered). The effect of orientation is not uniform across the sample population, as it significantly interacts with age for TOE fronting and BAN raising, with younger Countryfolk leading in both cases. Orientation and age also interact with gender in the cases of TOO, BOOT (trending), and TOE (trending) fronting. For all three of these variables, younger country-oriented males lead in fronting.

Remarkably, gender did not emerge as a significant predictor for any variables on its own. In addition to its three-way interactions with orientation and age just discussed, gender interacted with age for all fronting variables (TOO, BOOT, TOE, and BOAT). In all four cases, the effects of age are more prevalent among men, with younger men leading in fronting and older men showing the most conservative pattern.

In the following section, we offer explanations for our three primary findings: that younger speakers lead for all components of the CVS considered, that Countryfolk lead for some components of the CVS while Townies lead for others, and that in the few cases where gender structures patterns of variation (and only in interaction with other social factors), it is young, usually country-oriented, men who lead change.

DISCUSSION

Our primary research question is whether people in Redding, an inland, non-urban community in California, participate in the CVS, which has been documented almost exclusively in coastal cities. The fact that all variables are undergoing change in apparent time, with younger speakers more advanced in all cases than older speakers, is strong evidence that the CVS has indeed taken root in Redding. Nearly every speaker in the sample shows evidence of the shift, particularly for TOO and BOOT fronting and the BOT-BOUGHT merger. Other components of the shift, such as the BAT-BAN split and BOAT fronting, appear to be lagging compared to more urban communities.

Further evidence for the recent introduction of BOAT fronting into Redding is evident in the

phonological and social constraints on fronting. If one considers the high back vowels, fronting

occurs regardless of phonological environment (i.e., BOOT and TOO are both heavily fronted), and

BOOT and TOO fronting exhibit the same social constraints. A change that likely began following

coronal consonants (i.e., TOO) has been generalized to other phonological environments. In

contrast, fronting remains phonologically conditioned for the mid back vowel, beginning in the

favored TOE environment, and BOAT fronting shows different social patterning from TOE

fronting. Together, these patterns suggest that the fronting of the high vowels precedes that of the

mid vowels (cf. Hall-Lew, 2009), where fronting has only just begun. In any case, even though

some components of the CVS are more advanced than others, the shift has spread widely through

the community; it is not solely an urban shift.

While the macro-social category of age certainly conditions variation in Redding, the locally

relevant divide between town and country also strongly structures the observed patterns. As

discussed in the introduction, this opposition appears to mimic larger scale contrasts between

urban and non-urban, and between California and non-California (in particular, the Southern

U.S.) locations, in a system of *fractal recursivity* (Irvine & Gal, 2000). Recursivity is the

ideological process that "involves the projection of an opposition, salient at some level of

relationship, onto some other level" (Irvine & Gal, 2000: 38). Given the fractal oppositions

relevant in the Redding area, as schematized in Figure 9, it was hypothesized that features of the

CVS would pattern according to the micro-level opposition between town and country, as it

reproduces the broader opposition (at the level of the coastal metropolis in Figure 9) that

conditions the greater or lesser use of CVS features. Namely, we expected town-oriented

individuals to show greater use of CVS features, with country-oriented individuals showing more

conservative patterns with regard to these vowels. This hypothesis is partially supported by the results, as speakers oriented to the relatively more cosmopolitan town exhibited the BOT-BOUGHT merger to a greater extent than country-oriented speakers.

| Level of Relationship | Opposition |
|---|---|
| UNITED STATES | California ·–––––––––––– The South<br>CVS              SVS<br>↓ |
| COASTAL METROPOLIS | urban ·–––––––––––– non-urban<br>advanced CVS     conservative CVS<br>↓ |
| REDDING | town ·–––––––––––– country |
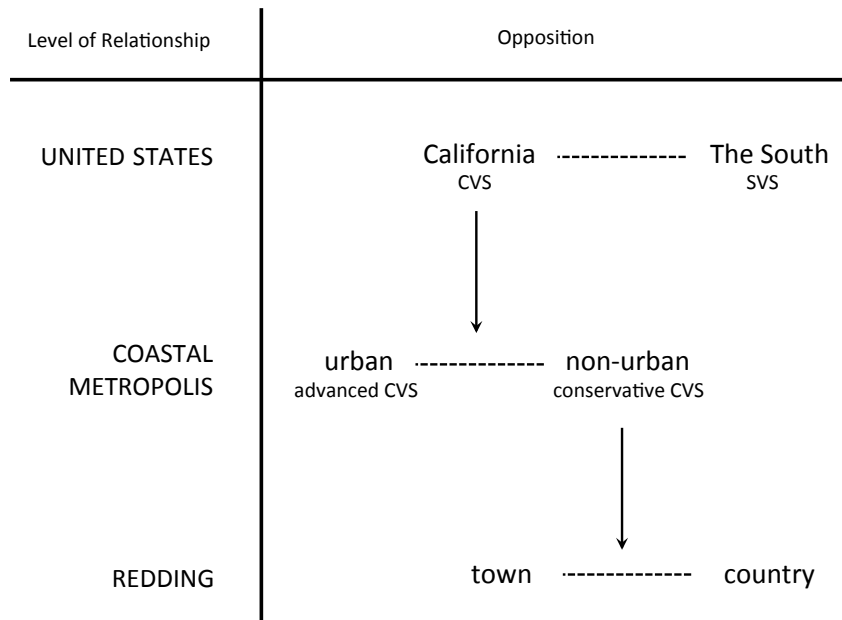
FIGURE 9. Fractal oppositions in Redding

    The social patterning of the BOT-BOUGHT merger notwithstanding, we find that young Countryfolk lead Townies (not the reverse) in the use of a number of other features implicated in the CVS, such as the fronting of the back vowels and the raising of BAN. Although these findings may at first appear to refute the claim that town-oriented speakers use features that index California-ness more prominently, the findings are compatible with our hypothesis if one considers that it is these and only these features that are involved in the Southern Vowel Shift (SVS) in addition to the CVS. While Redding is located at some geographic remove from the American South, the potential influence of the SVS must be taken into account, due to some

community members' association with country identity and the historical migration patterns that led Southern settlers to Redding.

The fronting of back vowels is a well-documented component of the SVS (e.g., Fridland, 2008; Fridland & Bartlett, 2006; Fridland, Barlett, & Kreuz, 2004; Thomas, 1989, 2001), and there is good reason to analyze BAN raising as a Southern feature as well. Bigham (2005) argues that BAN raises to fill the gap left by BET, which itself raises before nasals to achieve the PIN-PEN merger in Southern Illinois. While often characterized as a Southern and Midlands feature, the PIN-PEN merger is attested in California's Central Valley (Labov et al., 2006) and in neighboring regions (Geenberg, 2014). It is therefore a reasonable conjecture that the same forces motivating the raising of BAN in Southern Illinois are at work in Redding, where we have impressionistically observed the merger of PIN-PEN in some speakers.

The finding that country-oriented speakers are leading in the use of SVS features is consonant with Geenberg's (2014) findings in Trinity County for the PIN-PEN merger and BET raising, SVS features that do not occur in the CVS. Geenberg found that "outdoorsy" speakers showed more advanced use of these SVS features — in particular, the greatest difference between "outdoorsy" and "indoorsy" use of these features emerged in the youngest speakers, who Geenberg argues are most concerned with establishing these aspects of their identities. Similarly, we find that younger country-oriented speakers use SVS-implicated features to a greater extent than not only their Townie counterparts, but also older country speakers. It is likely that the divide between town and country is more relevant for younger speakers in the Redding area as well, particularly because the community has undergone urbanization (due to the timber industry shut-down and the in-migration of "equity pioneers") at a time when these younger speakers are entering the workforce. SVS features, due to the fractal opposition between California and the South

(operating at the national level in Figure 9), may enable country-oriented speakers to position themselves in opposition to community members who align more closely with the town.

This interpretation is further supported when features of the CVS that are *not* implicated in the SVS are considered. First, BOT and BOUGHT are significantly more merged for Townies, as compared to Countryfolk. This finding again connects to the fractally recursive California versus U.S. South distinction, as the CVS involves a merger of BOT and BOUGHT, while the SVS maintains a distinction. As we initially expected, the relatively more urban-oriented Townies are further advanced in this California (and, notably, *not* Southern U.S.) feature. Second, BAT in non-pre-nasal contexts shows backing throughout the community, but no town versus country orientation effect was observed. Movement of BAT is not implicated in the SVS in either direction, so it is unlikely to serve as an index of country orientation. This change is thus occurring in a more socially uniform fashion over time in Redding, correlating only with age.

Strikingly, gender did not have a significant main effect on variation patterns for any of the seven features under investigation. At the very least, this indicates that gender is less important than more locally significant dimensions of social distinction, such as orientation to the country. We do not intend to dismiss gender outright, however, since the interaction of gender with age and orientation proved a significant predictor of TOO fronting (and a trending predictor of BOOT and TOE fronting). Younger country-oriented men lead in the fronting of this variable, despite the common finding in other communities that women typically lead in change from below. If the fronting of back vowels indexes a country orientation, as we argue above, then the fact that it is men who lead in fronting is less surprising, given that the country is experienced as a masculine space in this community. As Podesva and Van Hofwegen (2015) report, country-oriented men in the same community lead in the retraction of /s/, another feature linked to country and Southern

identity (Campbell-Kibler, 2011). Similar patterns are evident in neighboring Trinity County, where men (and "outdoorsy" speakers) lead in BET raising (Geenberg, 2014), a hallmark feature of the SVS. How and why the country in inland Northern California has come to be viewed as a masculine space is a question lying beyond the scope of the present paper, though work in rural geography suggests that this ideology originated in the necessity for male physical strength to "'tame' the forces of nature to maximize production" in agricultural settings (Little, 2002: 666). While physical strength is no longer necessary to thrive in agricultural communities, as technology has more or less neutralized differences in physical strength, rural technology is marketed in a way that maintains the ideology of the country as masculine (Brandth, 1995).

CONCLUSION

In summary, we have found that the CVS is well represented in Redding, an inland, non-urban community in Northern California, though it is not as far advanced as in the state's coastal cities studied in the previous literature. Features of the CVS, as well as those of the SVS, serve as resources with which speakers can position themselves with respect to a locally relevant ideological divide between the town and the country. This pattern is reminiscent of findings for Martha's Vineyard reported in Labov (1963), wherein locals used centralized nuclei of the diphthongs (ay) and (aw) to index an oppositional stance to the encroachment of mainland tourists. Where Redding diverges from Martha's Vineyard is in the diversity of dialects through which speakers can demonstrate their affiliation with the country versus the town. Speakers can align with a country ethos not only by resisting the CVS, but also by embracing the SVS. In this particular situation of dialect contact, the CVS and SVS move in tandem for some vowels and in opposite directions for others, to say nothing of the case where a vowel is moving in one dialect and stable in the other. Future work will need to uncover how linguistic pressures and social

ideologies shape the struggle between the CVS and SVS. While this paper has focused on components of the CVS, it is imperative that the same level of attention be devoted to the SVS in this community. It will also likely prove worthwhile to consider the dynamics of formant movement, particularly given Koops's (2010) finding that BOOT fronting is more monophthongal for Houston speakers who participate in other dimensions of the SVS. It is possible that in Redding, speakers can affiliate with the country not only by using fronter variants of the back vowels (as we have seen here), but by using more monophthongal front variants of these vowels (as Koops has observed in Houston).

The coexistence of the CVS and SVS in inland California within different social groups provides striking evidence for dialect diversity within California, not to mention the Western United States. While the West is typically treated as a monolithic dialect region (Labov, 1991; Labov et al., 2006), it is populated by myriad communities, with distinct settlement histories, local industries, and economic circumstances. The divergent social trajectories among Western communities plausibly give rise to distinct dialects. These dialects should be documented, and their development studied.

In all, we suggest that the development of the dialect in Redding has been determined in part by the way community members orient toward or away from larger cities in the state and what these cities represent to them. That the CVS is more advanced in cities may not be unique when compared to other large-scale sound changes (e.g., the Northern Cities Vowel Shift). But, the characterization of California cities by California residents, along with ideologies about cities in general, seems to determine the extent to which speakers participate in language change. In light of these findings, we promote a view of language change where vowel shifts, and enregistered speech varieties more generally, are ideologically associated with the particular qualities of the

places from which they originate. Each city has a different perceived character, and the emergence of this character as distinctive enables the speech styles of the city to become indices of it. A crucial step in understanding the trajectory of language variation and change, especially as we turn our gaze outside of cities, is understanding the qualities that cities and their characteristic dialects represent, and how people outside of them orient to those qualities, which may, in turn, condition their language use.

NOTES

[i]    We refer to vowel classes as orthographic words in small caps, corresponding to the string /bVt/ (e.g., BAT refers to /æ/). We depart from Wells (1982) in order to refer to specific phonological environments that could systematically influence the vowel's phonetic realization (e.g., BAN refers to the vowel in BAT when it is followed by a nasal). Where words do not conform to the general convention of BVT they indicate one of these specific phonological contexts; we specify this context at the first mentions of such words.

[ii]    The fronting effect of a preceding coronal place of articulation on its following vowel has been well established in phonology (cf. Flemming 2003) and for California speech (cf. Hall-Lew 2009). Accordingly, the post-coronal tokens from the BOOT and BOAT vowel classes (i.e., TOO and TOE) were analyzed separately from the non-post-coronal tokens here.

[iii]    Phonologists and phoneticians have long noted that the raising of front vowels before nasal consonants in many English varieties is conditioned by the identity of the nasal consonant, such that vowels before velar nasals are significantly more raised and/or tensed than before /n/ and /m/ (e.g., Ladefoged and Johnson 2014). In the California context, Guenter, Lewis, and Urban (1999) find that Bay Area speakers phonologically classify pre-/ŋ/ vowels as raised and tensed, not lax (i.e., that the vowels in 'sing' and 'bank' are /i/ and /e/, respectively). If this is the case for Redding speakers as well, we may hypothesize that BANG would be significantly more raised than BAN or BAM. However, we do not split our pre-nasal tokens into different groups, because all of our models include phonological following environment, among other things, as a random factor. Our results on BAN-raising therefore are not simply driven by tokens of BANG.

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APPENDIX

TABLE 3. *Summary of fixed factor effects on TOO-mBEET (TOO fronting)*

|  | Estimate | Std. Error | t value | Pr(>\|t\|) | |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.2369476 | 0.0235456 | 10.063 | 3.37e-09 | *** |
| age | 0.0021408 | 0.0004188 | 5.112 | 4.83e-05 | *** |
| sexfemale | 0.0047668 | 0.0084024 | 0.567 | 0.57665 | |
| orientationcountry | -0.0220105 | 0.0084408 | -2.608 | 0.01648 | * |
| age:sexfemale | -0.0013406 | 0.0004155 | -3.227 | 0.00423 | ** |
| age:orientationcountry | 0.0008204 | 0.0004158 | 1.973 | 0.06241 | . |
| sexfemale:orientationcountry | 0.0020026 | 0.0083878 | 0.239 | 0.81368 | |
| age:sexfemale:orientationcountry | -0.0016557 | 0.0004161 | -3.979 | 0.00073 | *** |

TABLE 4. *Summary of fixed factor effects on BOOT-mBEET (BOOT fronting)*

|  | Estimate | Std. Error | t value | Pr(>\|t\|) | |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.4129309 | 0.0242331 | 17.040 | 8.93e-10 | *** |
| age | 0.0039044 | 0.0006360 | 6.139 | 4.97e-06 | *** |
| sexfemale | -0.0014731 | 0.0127678 | -0.115 | 0.90927 | |
| orientationcountry | -0.0414522 | 0.0127591 | -3.249 | 0.00395 | ** |
| age:sexfemale | -0.0020675 | 0.0006409 | -3.226 | 0.00407 | ** |
| age:orientationcountry | 0.0013029 | 0.0006382 | 2.041 | 0.05421 | . |
| sexfemale:orientationcountry | 0.0087421 | 0.0127963 | 0.683 | 0.50214 | |
| age:sexfemale:orientationcountry | -0.0013113 | 0.0006343 | -2.067 | 0.05177 | . |

TABLE 5. *Summary of fixed factor effects on TOE-mBEET (TOE fronting)*

|  | Estimate | Std. Error | t value | Pr(>\|t\|) | |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.4888123 | 0.0156960 | 31.143 | 4.97e-14 | *** |
| age | 0.0026341 | 0.0003460 | 7.612 | 1.02e-07 | *** |
| sexfemale | -0.0036506 | 0.0069358 | -0.526 | 0.60372 | |
| orientationcountry | -0.0209926 | 0.0069045 | -3.040 | 0.00592 | ** |
| age:sexfemale | -0.0008511 | 0.0003451 | -2.467 | 0.02165 | * |
| age:orientationcountry | 0.0009652 | 0.0003452 | 2.796 | 0.01034 | * |
| sexfemale:orientationcountry | 0.0120054 | 0.0069202 | 1.735 | 0.09637 | . |
| age:sexfemale:orientationcountry | -0.0006555 | 0.0003446 | -1.902 | 0.07000 | . |

TABLE 6. *Summary of fixed factor effects on BOAT-mBEET (BOAT fronting)*

|  | Estimate | Std. Error | t value | Pr(>\|t\|) | |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.5629760 | 0.0199263 | 28.253 | < 2e-16 | *** |
| age | 0.0027521 | 0.0004200 | 6.552 | 1.22e-06 | *** |
| sexfemale | -0.0006945 | 0.0083269 | -0.083 | 0.93427 | |
| orientationcountry | -0.0247097 | 0.0083928 | -2.944 | 0.00745 | ** |
| age:sexfemale | -0.0010586 | 0.0004136 | -2.560 | 0.01762 | * |
| age:orientationcountry | 0.0004300 | 0.0004203 | 1.023 | 0.31713 | |
| sexfemale:orientationcountry | 0.0072543 | 0.0084245 | 0.861 | 0.39833 | |

TABLE 7. *Summary of fixed factor effects on BAN-mBEET (BAN raising)*

|  | Estimate | Std. Error | t value | Pr(>|t|) |  |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.4078658 | 0.0246605 | 16.539 | 3e-07 | *** |
| age | 0.0030916 | 0.0007002 | 4.416 | 0.000198 | *** |
| sexfemale | -0.0179472 | 0.0138689 | -1.294 | 0.208451 |  |
| orientationcountry | -0.0213688 | 0.0140227 | -1.524 | 0.141177 |  |
| age:sexfemale | 0.0009406 | 0.0006886 | 1.366 | 0.185070 |  |
| age:orientationcountry | 0.0015904 | 0.0007000 | 2.272 | 0.032744 | * |
| sexfemale:orientationcountry | 0.0159239 | 0.0140636 | 1.132 | 0.269158 |  |

TABLE 8. *Summary of fixed factor effects on BAT-mBEET (BAT backing)*

|  | Estimate | Std. Error | t value | Pr(>|t|) |  |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.2697669 | 0.0093954 | 28.713 | <2e-16 | *** |
| age | -0.0012655 | 0.0003479 | -3.637 | 0.0012 | ** |
| sexfemale | 0.0052802 | 0.0068222 | 0.774 | 0.4459 |  |
| orientationcountry | -0.0109769 | 0.0071594 | -1.533 | 0.1373 |  |

TABLE 9. *Summary of fixed factor effects on BOT-mBOUGHT (BOT-BOUGHT merger)*

|  | Estimate | Std. Error | t value | Pr(>|t|) |  |
| --- | --- | --- | --- | --- | --- |
| (Intercept) | 0.0974275 | 0.0063269 | 15.399 | 9.98e-09 | *** |
| age | 0.0006193 | 0.0002720 | 2.277 | 0.0312 | * |
| sexfemale | -0.0012513 | 0.0053193 | -0.235 | 0.8159 |  |
| orientationcountry | 0.0123223 | 0.0055771 | 2.209 | 0.0362 | * |