A PHONETIC EXAMINATION OF CALIFORNIA[*]

Angela Aiello
MA Thesis

University of California, Santa Cruz

Abstract:

The mass of land making up the West is a large and undifferentiated area in terms of dialect identification. In order to reclassify this, smaller scale and more detailed studies of the states within the area need to be conducted. This study focuses on California by exploring the current status of its inhabitants' vowels in the context of a potential North and South division as well as in comparison to previous conclusions made about the state. Through an experiment in which the spectral qualities and durations of the vowels /i/, /ɪ/, /ɛ/, /æ/, /ɑ/, /ɔ/, /ʊ/, /u/ /ʌ/, /ɹ/, /eɪ/, /aɪ/, /aʊ/, /oʊ/, and /oɪ/ of 10 Northern California and 11 Southern California speakers were examined, it was determined that, phonologically, the state makes up a single dialect. However, the two areas do seem to show divergence in the phonetic realization of gender through duration differences. Furthermore, the current study brings into question former assertions of shift originating in Northern California (Eckert, 2008).

1. Introduction

Classifying a dialect of a language can be based on a variety of linguistic features ranging from lexical items and syntactic patterns, to phonological and phonetic aspects. Current dialect classification of the English spoken in the United States has mostly been based on the latter. Thus, those geographic areas with similar speech sound production and/or those areas exhibiting a particular sound change are grouped as a single cohesive

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dialect area.[1] Under this approach, the United States has customarily been divided into 6 dialect regions: New England, the North, Mid-Atlantic, Midland, the South, and the West. While what can be considered the eastern half of the US encompasses the New England, North, Mid-Atlantic, Midland and Southern dialects, the western portion simply houses the Western dialect. Consequently, such a division groups the states of Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming as one dialectically undifferentiated area. This may be due, in part, to the fact that most studies have simply concentrated on delineating the language variation of the East, which, in turn, is in response to the large waves of immigration to the Eastern United States. The eastern coast, as the first area settled by the British and the gateway to much European immigration, not only has a longer history of the English language, but also a more extensive exposure to a variety of other languages. These factors can facilitate the creation of dialects and thus language change. As the East grew, settlers, along with the English language, slowly moved westward, only reaching the West Coast in the mid 1800's (Wolfram & Schilling-Estes, 1998). This diffusion and integration of English speakers into the West undoubtedly dissolved a majority of the language differences that these inhabitants had brought with them. With this history in mind, the eastern United States may indeed be more dialectically diverse than the West. However, this should not imply that the latter has no diversity. It would be surprising to find that presently this expanse of land does not exhibit a variance that comes close to that seen in the other half of the country.

In addition to the settlement history of the US, the lack of representation of more specific demarcations of dialect variation in the West is likely a reflection of the lack of in-depth acoustic research in its individual states. The large-scale impressionistic studies establishing the 6 dialect zones, such as Labov (1991; -- et al. 2006), are not fine-grained enough to detect the differences that might in fact be present. These studies often use just a few informants from multiple states to draw conclusions about the area as a whole. Furthermore, in such classifications there is a tendency to investigate only phonemic attributes, such as the position of vowels within their space, in order to outline a dialect's characteristics. Albeit a fundamental part of acoustic analysis, resonance frequencies are just one part of the speech signal. In fact, it has been shown that languages may differ in other properties such as fundamental frequency (Van Bezooijen, 1995). That said, a more thorough look at the speech signal could aid in finding differences between a seemingly homogenous dialect area. In order to offer evidence in favor of reanalyzing the blanket term "West", not only are more studies

[1] For example, Labov (1991; --- et al, 2006) considers there to be 3 major dialect areas within the US- the North, the South, and the West based on three different changing patterns in vowel spaces: The Northern Cities Shift, the Southern Shift, and the Low-Back Merger.

focusing on geographic areas within the aforementioned designation necessary, but so are studies that incorporate a more detailed phonetic investigation. These would accordingly provide inventories of data for eventual reference and comparison. The current study aims to contribute to the satisfaction of this need by focusing attention to the state of California as a whole. Previous work in the coastal state has centered on the North and the South individually, but none to my knowledge has unified them in a single study. Before the possibility of comparing California speech to other parts of the West, this complete picture of the state must first be rendered. An aim of the present research is to offer such an image.

2. Previous Studies

Studies considering vowel production in particular Western areas such as Utah (Reeves, 2009), Seattle (Foster & Hoffman, 1966), and California (DeCamp, 1953; Moonwomon, 1991; Hinton et al., 1987; Hagiwara, 1995, 1997; Eckert, 2008; Hall-Lew, 2009; Grama & Kennedy, 2009) have initiated the investigation of the dialects within the West and as a result have begun to offer an idea of the region's rich dialectal diversity. However, the majority of these examinations, particularly with regard to California, has been in the socio-linguistic realm with a concentration on the ethnic and social factors in dialect variation. For this reason, these inquiries often involve data from specific urban centers or particular groups of speakers within an urban center.

For example, Eckert (2008 and website) has done extensive sociolinguistic work in Northern California centered on the vowel production of adolescents in Palo Alto. Based on this, she has concluded that there is a vowel shift occurring in California that she has deemed the Northern California Vowel Shift. This change is characterized by a counterclockwise rotation of the front and low vowels, /ɪ/ is moving into the space occupied by /ɛ/, /ɛ/ is moving towards /æ/ while /æ/ is backing and becoming more like /ɑ/. A second characterization of the shift is a fronting of the mid-high back and high back vowels. This latter point is slightly deviant from what is indicated in the Atlas of North American English (henceforth ANAE) (Labov et al., 2006) for the West, which states that, although /u/ is fronting, /oʊ/ is not. Of the high back vowels, /ʊ/ also seems to be lowering, becoming more like /ʌ/. Finally, Eckert asserts that the merged back vowels /a/ and /ɔ/ are raising into the space of /ɔ/ while /ʌ/ is moving towards /ɛ/.[2]

[2] In order to speak about a shifting from one locus in a vowel space to another, a point of departure needs to be established. Presumably, Eckert is comparing her findings to that of "General American". There is also a possibility that she has based them on her own perception of the sounds. She does not, however, identify this relation. For these reasons it is hard to justify any change at all.

In another study focused on San Francisco, Hall-Lew (2009) finds similar results to those presented by Eckert (2008). Although the aim of Hall-Lew's (2009) dissertation was to consider back vowel production of Asian Americans in comparison to their European American co-inhabitants, she was able to shed light on the state of the back vowels in the city as a whole. She concludes that the Low-Back Merger is a change in progress in the area that is near completion in younger generations, confirming the prior conclusion made by Moonwomon (1991). This is contrary, however, to what is reported in the ANAE (Labov et al., 2006): that San Francisco represents a city in the West where the distinction is still actively maintained.

Although these findings within specific cities may in fact be illustrative of the particular processes happening in California, they are too specific to extend to the State as a whole without a broader scale study for comparison. Moreover, the documentation has widely been based on informal fieldwork interviews, which introduce the possibility of less-controlled conditions in the gathering and processing of data. Soliciting vowel productions in a consistent and controlled setting, on the other hand, can eliminate this risk and provide more reliable documentation of the current state of affairs of vowels in a certain area. One of the first researchers to work on California vowels from this standpoint was Hagiwara (1995; 1997). In his acoustic analysis of Southern California English vowels as produced by native speakers of the area, Hagiwara (1997) sought two main objectives: to show that "American English" is an inaccessible reference, and to encourage other researchers to pursue phonetic research in understudied areas. In addition to these goals, Hagiwara succeeded in providing solid phonetic data for Southern California English.

By looking at static formant frequencies, Hagiwara (1997) showed that the Southern California English vowel space differs largely from the vowel spaces considered "General American" examined in previous studies by Peterson & Barney (1952) and the more recent Hillenbrand et al. (1995), thus affirming that this term is broadly inappropriate.[3] The back vowels of the Southern California speakers included in the study had much higher F_2 frequencies than those reported in Hillenbrand et al. (1995). This fronting of back vowels coupled with a centralization of the front mid vowels resulted in a vowel space more similar to a parallelogram as opposed to the more conventional trapezoid shape as found in the other two studies.[4] Such deviation underscores the need to reconsider the current classification of US dialects. Based on

[3] Peterson & Barney (1952) collected productions from women and children from the Mid-Atlantic area. The majority of the male speakers were from a broader regional area and "spoke General American". The participants in Hillenbrand et al. (1995) were Northern Mid-Westerners.

[4] A more detailed presentation of the formant frequencies determined by Hagiwara will be provided below when discussing the results of the present study.

such a result, Hagiwara also set out to provide a set of testable formant frequencies for speakers of the Southern California area. In doing this, he called upon others in the field to provide similar referents in order to document and compare the current trends in and variations of American English within established dialect areas. Such reasoning has prompted the current study.

3. This study

Through an examination of vowels as produced by native Californians, I investigate differences and similarities between the productions of Southern and Northern California English speakers. In questioning if the state is a cohesive or divergent dialect zone, I will systematically check previous conclusions made about the respective areas against what I have found to be true of the state as a whole. Additionally, I will consider duration, pitch, and jitter as sources of divergence between the North and South.[5] A side product of this approach is a compilation of phonetic data for future use in comparing other Western states. It will be shown that the vowel spaces of the two regions are indeed similar, both exhibiting features of the Northern California Vowel Shift (Eckert, 2008). However, a difference in duration of vowels across gender and region offers a striking and unexpected pattern of dissimilarity.

3.1 Methods

3.1.1 Participants

The participants were 21 native speakers of California English between the ages of 17 and 30 (the median was 19), and, with the exception of one, were UCSC students. Within this group, 11 were from Southern California (5 males and 6 females) and 10 were from Northern California (6 females and 4 males).[6] Northern and Southern California affiliation was defined as having lived in an area classified as such until at least the age of 17. The majority of Northern Californians were from the Greater Bay Area while the majority of Southern Californians were from the Los Angeles and San Diego areas. The specific hometowns and ages of the participants can be viewed in

[5] Jitter is a measure of the regularity of vocal fold vibration. I included this because it can be used to determine the presence of creaky voice. Since Southern California speakers are conventionally characterized as creaky, this was a possible area of divergence for the regions.

[6] Data from 5 Northern Californian male speakers were originally gathered, however for one of these, only 30 tokens were actually recorded. He was thus excluded from the analysis.

Table 1. If any time had been spent in a foreign country it did not exceed a year. All were monolinguals of the California variety of English and fluent in no other language. For those who had exposure to or training in a foreign language, it occurred after the age of 12. None reported hearing or speech impairments. Subjects either received extra-credit for a course taken through the University's Linguistics Department or simply volunteered their time.

Northern California			Southern California		
Hometown	*Age*	*Gender*	*Hometown*	*Age*	*Gender*
Oakland	30	male	Chula Vista	21	female
Boonville	21	male	Oceanside	21	male
Redwood City/Mountain View	20	female	San Diego	20	male
San Jose	20	male	Fullerton	19	female
Kentfield	19	female	Los Angeles	19	male
San Jose	19	female	Manhattan Beach	19	male
San Rafael	19	female	San Diego	19	male
Sebastopol	18	male	Oxnard	18	female
Walnut Creek	18	female	San Luis Obispo	18	female
Walnut Creek/San Ramon	18	female	South Pasadena	18	female
			Encinitas	17	female
Mean age:	20.2			19	

Table 1: Demographic information of the participants used in the current study.

3.1.2 Procedure

Speech recordings of thirty monosyllabic words were collected from the participants. These consisted of the nine monophthongs /i/, /ɪ/, /ɛ/, /æ/, /ɑ/, /ɔ/, /ʊ/, /u/ /ʌ/, the rhotic /ɹ/, and the diphthongs /eɪ/, /aɪ/, /aʊ/, /oʊ/, /oɪ/ in two different contexts, namely /b_t/ and /k_d/. Before beginning the experiment the participants were given a list of the words that would be presented to them during the experiment and were asked to read them aloud for the experimenter. This was done to ensure that each word would be recognizable to the participant during actual recording. If a word was unknown, the experimenter solicited a pronunciation by giving a definition or describing a context in which the word might be used. For nonce words the experimenter defined a word that rhymed with the target word, importantly never pronouncing any of the target words or vowels herself. Instructions for the recording session were given orally and in written form, both on a sheet of paper and on the computer screen. The participants were asked to read in the most natural way possible the word that appeared on the computer screen prompted by the phrase "Please say __".

3.1.3 Design

The experiment was designed using E-Prime 2.0 software (Psychology Software Tools, Pittsburgh, PA) and separated into 6 blocks. The first block was used as training for the subjects to get accustomed to the amount of time between stimuli and was comprised of a random selection of 10 of the 30 monosyllabic words. The design was such that the computer did not actually detect speech. Instead, there was a period of 200 ms from the time a stimulus appeared on the screen until the following one appeared. Recordings from this block were not included in the results. The last five blocks collected the data analyzed in the present study and each consisted of two instances of the 30 randomized stimuli to yield 60 productions per block and thus a total goal of 300 productions for each participant.[7] If desired the participants were offered a break in between each block.

The subjects were recorded individually in a sound-attenuated booth using an AKG-C520 head-mounted condenser microphone placed approximately 2 inches from the speaker's lips and run through a pre-amp into a PC. A test recording was conducted of each subject just prior to the start of the experiment to ensure that a clear and consistent recording was achieved during the actual experiment. Adjustments in volume and in microphone position were made when necessary.

3.1.4 Analysis

A script written for the acoustic analysis software Praat (Boersma & Weenink, 2003) was used to identify the vowel of each token by determining the voiced portion in each sound file and to label it as such in a textgrid. These textgrids were then hand-corrected, ensuring that only one voiced portion was indicated and that it corresponded to only the vowel. At this point any sounds that had been cut short due to speaker delay were thrown out. Only twenty-four such productions were found yielding a grand total of 6,276 and no fewer than 295 tokens per speaker. A second Praat script was then used to automatically extract the acoustic measurements of the vowels using the previously

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[7] Although the purpose of the training block was to acquaint the participants with the amount of time between stimuli, for a small number of tokens during the actual experiment some subjects spoke too late and as a result those tokens were cut short.

labeled textgrids. Specifically, the first three formants were tracked and their averages measured. Additionally, the values at the 25th, 50th, and 75th quartile points of each token were obtained. The average formant frequencies reported for each production was that of the middle third portion. This was done to eliminate any influence from the surrounding consonants on the vowel's quality. As automatic extraction is not without error, some of these formant measurements needed to be hand-corrected.[8] Jitter and F_0 were measured over the middle third of the vowels.

Using the Labonov method via the Vowel Normalization and Plotting Suite, NORM (Kendall & Thomas, 2007), the vowel spaces of each individual were normalized. This process removes any idiosyncratic variations caused by physiological differences that may be present between speakers while preserving the phonetic distinctions of the vowels. This allows for a truer and more controlled comparison of vowel positions across speakers. The plots used in the analysis and included in the discussion are those produced by R (R Development Core Team, 2008). Illustrative examples will be included within the Results and Discussion section.

3.2 Results and Discussion

3.2.1 The Region(s)

As will be shown and discussed, it seems that if a difference in speech is present between the two areas, it does not lie in the spectral quality of the vowels. That is, there is no marked difference between Southern and Northern Californians' vowel spaces. Figures 2 and 3 below represent the normalized mean values of the first and second formants of the monophthongs and diphthongs used in the current study, separated by gender. Female means are on the left and male are on the right. The regions are designated as so: green represents Southern California and blue represents Northern California in both plots. I will continue to use IPA symbols when discussing the Figures and their content. However, modifications were necessary for the plotting process.[9] Therefore the reader is asked to allow the following adjustments to interpret the graphs: [eI]~[eɪ], [I]~[ɪ], [E]~[ɛ], [ae]~[æ], [aU]~[aʊ], [aI]~[aɪ], [a]~[ɑ], [O]~[ɔ], [oU]~[oʊ], [U]~[ʊ], [oI]~[oɪ], [r]~[ɹ], [uh]~[ʌ]. Table 2 contains the average values of F_1 and F_2 in Hertz.

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[8] I was alerted to extraction errors when plotting participants' productions. If the location of an individual token was anomalous as compared to the other tokens of the same vowel, this usually meant the script did not measure a formant correctly. In these cases I re-measured the particular token by hand and used those results in the overall analysis.

[9] All figures were produced in R (R Development Core Team, 2008).

Northern California	F_1		F_2	
Vowel	Women	Men	Women	Men
i	366 (24)	265 (25)	2752 (208)	2241 (83)
ɪ	540 (52)	411 (38)	2157 (168)	1878 (95)
eɪ	446 (44)	404 (32)	2487 (270)	2016 (106)
ɛ	754 (59)	559 (51)	1918 (144)	1698 (94)
æ	931 (60)	709 (69)	1711 (137)	1580 (90)
aɪ	761 (116)	636 (71)	1907 (218)	1540 (145)
aʊ	835 (62)	670 (57)	1466 (121)	1309 (92)
ɑ	806 (63)	636 (61)	1242 (105)	1055 (71)
ɔ	795 (65)	623 (63)	1228 (99)	1022 (75)
oʊ	537 (82)	453 (45)	1284 (143)	1156 (125)
oɪ	510 (51)	435 (35)	1371 (179)	1090 (134)
ʊ	574 (58)	438 (42)	1621 (92)	1359 (134)
u	406 (36)	316 (36)	1560 (222)	1283 (249)
ʌ	730 (69)	560 (47)	1629 (132)	1318 (127)
ɹ	505 (45)	438 (46)	1534 (173)	1364 (118)

Southern California	F_1		F_2	
Vowel	Women	Men	Women	Men
i	341 (36)	279 (25)	2827 (144)	2225 (84)
ɪ	533 (57)	434 (38)	2193 (167)	1850 (95)
eɪ	438 (51)	428 (31)	2551 (177)	2007 (106)
ɛ	709 (90)	571 (51)	1938 (147)	1680 (94)
æ	867 (133)	681 (69)	1724 (153)	1571 (90)
aɪ	742 (116)	624 (71)	1897 (179)	1538 (145)
aʊ	818 (115)	675 (69)	1484 (150)	1335 (98)
ɑ	780 (130)	648 (61)	1238 (118)	1111 (71)
ɔ	776 (126)	649 (63)	1215 (120)	1092 (75)
oʊ	536 (51)	484 (46)	1331 (110)	1191 (153)
oɪ	513 (53)	494 (35)	1419 (152)	1187 (134)
ʊ	551 (71)	467 (42)	1673 (174)	1363 (135)
u	379 (25)	325 (36)	1622 (211)	1308 (250)
ʌ	696 (105)	577 (47)	1620 (134)	1341 (127)
ɹ	497 (56)	457 (46)	1570 (233)	1459 (118)

Table 2: Mean values of the first two formants in Hertz for Northern California speakers (on the left) and Southern California speakers (on the right) of the 15 vowels used in the current study. Standard deviations are given in parentheses to the right of the means.

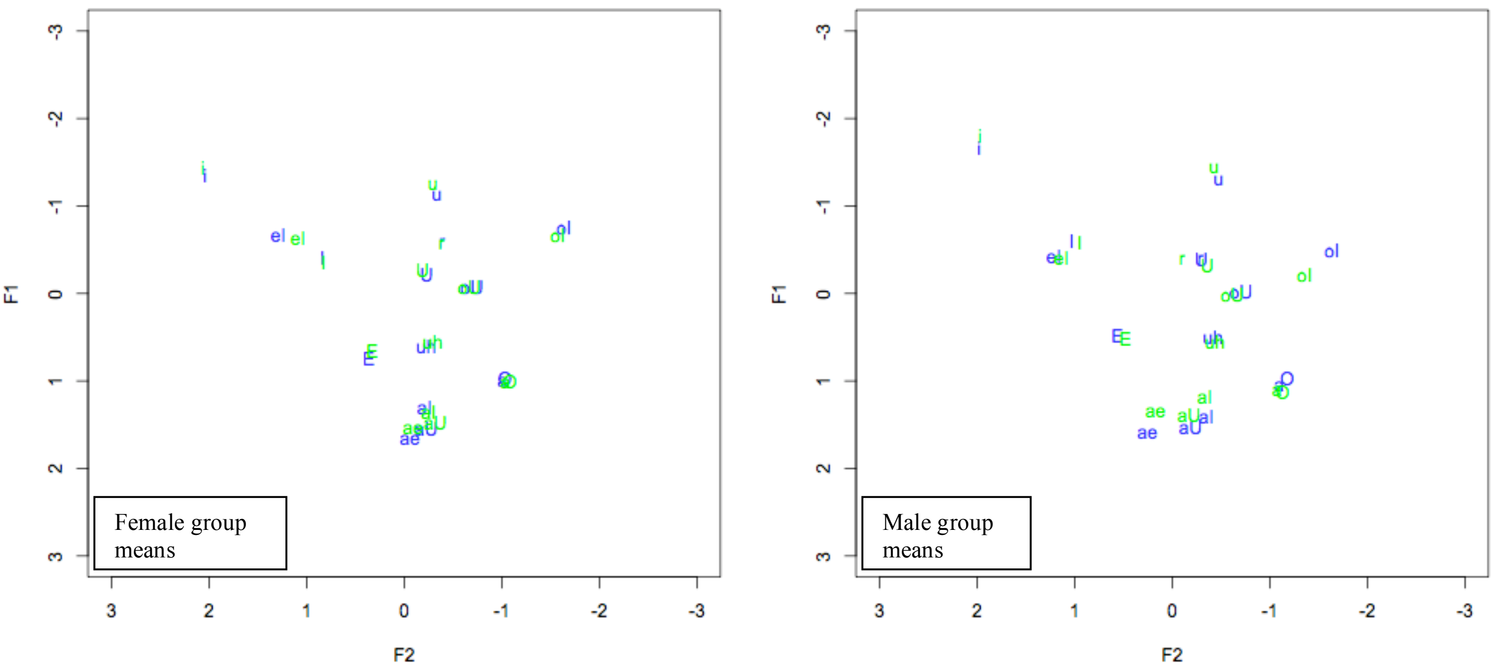

Fig 2: Normalized mean values of the formant frequencies separated by gender. Green indicates Southern California speaker group means; blue indicates Northern speaker group means.

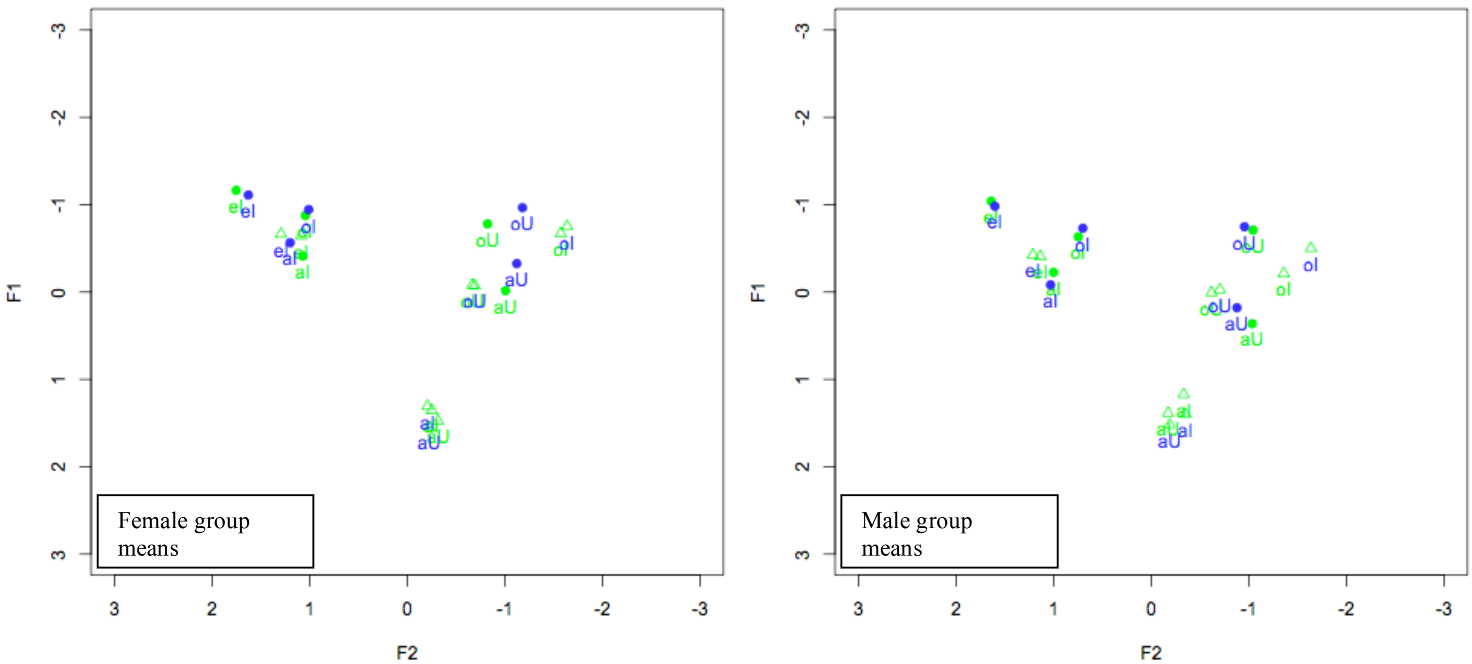

Figure 3: Normalized mean frequency values of diphthong progression separated by gender. The open triangle represents initial point of the diphthong, which corresponds to the 25th quartile measurement of the formants; the closed circle indicates the end point of the diphthong, which corresponds to the 75th quartile measurement. Green indicates Southern California speaker group means; blue indicates Northern speaker group means.

As one can see, the regional productions within both genders are remarkably similar; the Southern and Northern California vowels, both the average points of the monophthongs as well as the progressive points of the diphthongs, lay nearly on top of one another in each scatter plot. Any slight differences, such as the higher F_2 value and onset of the back diphthong [oɪ] for Southern California males as compared to the Northern California males, cannot be extended to the region as a whole given that the Southern Californian female data do not exhibit a similar difference when compared to their Northern counterparts. Instead, the state as a whole seems to show an overall centralization of the low and back vowels. This is most notable when considering the front vowel [æ] along with the back vowels [ʊ], and [u]. The F_2 values of these vowels are very near to that of the central vowel [ʌ] and in the case of the Female group are almost in a direct vertical line with the latter. Although these data do not show a discrepancy in vowel production between Northern and Southern Californians, they can be used in support of previous findings for the state. Particularly, they extend the discovery that the Low-Back Merger is diffused throughout the State. Additionally, they confirm Eckert's (2008) conclusion that the back mid-diphthong [oʊ] is showing some fronting, although the movement is not as pronounced as the higher back vowels.

Because both the Northern and Southern vowel spaces are nearly identical, the patterns of vowel shift that Eckert (2008) has attributed to Northern California would seem to be true of the entire State. Yet, without a reference point for juxtaposition, this statement, as well as the statements of “shift” observed above, is hard to corroborate. By using a comparison to the data presented in Hagiwara (1997), one can hope to offer such support.

3.2.2 Southern California 1995 and 2010

The data used in Hagiwara (1997) was collected fifteen years before the current study.[10] This time span suggests an opportunity to find a difference between his speakers’ vowel spaces and those in the current study, under the assumption that a vowel change is indeed present in California. The age group of the former is nearly parallel to that of the current group (18-26 vs. 17-30), the difference being that the speakers of the current group were most likely still developing their phonological system at the time the previous study was conducted. If a change were taking place in California, this later generation would most likely exhibit more pronounced attributes of it. Figure 4 shows a scatter plot comparison between the normalized average formant values of the productions of 11 vowels as reported by Hagiwara (1997) and the same vowels as collected in the current study.[11] The vowel labels in black denote the normalized averages based on the data given in Hagiwara (1997) while the green vowels denote the current study’s values.[12] Although I will not be discussing Hagiwara’s results in terms of Hertz, they are included in Table 3. The reader may compare them to the present study’s values found in Table 1.

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[10] Hagiwara’s data in his 1997 paper was a re-examination of data used in 1995.

[11] Hagiwara (1997) gives the formant values in Hz. The normalized values used here were converted for the current study. I chose to compare normalized values instead of Hertz because upon inspection the latter would not have allowed for a fair comparison. Additionally, Hagiwara (1997) did not examine the diphthongs [aʊ],[aɪ], and [oɪ]. For this reason they are not included in the remaining discussion.

[12] The scatter plots and thus discussion only include the Southern California data from the current study. Since no differences were found between the latter and Northern California, conclusions drawn from Figs. 4 and 5 can be extended to the state as a whole.

Hagiwara's Southern California	F_1		F_2	
Vowel	*Women*	*Men*	*Women*	*Men*
i	362 (36)	291 (31)	2897 (176)	2338 (205)
ɪ	467 (62)	418 (36)	2400 (151)	1807 (85)
eɪ	440 (48)	403 (43)	2655 (187)	2059 (138)
ɛ	808 (167)	529 (68)	2163 (195)	1670 (67)
æ	1017 (134)	685 (105)	1810 (131)	1601 (59)
ɑ	997 (102)	710 (97)	1390 (99)	1221 (69)
oʊ	516 (130)	437 (37)	1391 (212)	1188 (118)
ʊ	486 (115)	441 (40)	1665 (166)	1366 (122)
u	395 (48)	323 (31)	1700 (364)	1417 (215)
ʌ	847 (154)	574 (80)	1753 (140)	1415 (88)
ɹ	477 (82)	429 (40)	1558 (170)	1362 (79)

Table 3: Mean values of the first two formants of Southern California speakers in Hertz as reported by Hagiwara (1997). Standard deviations are in parentheses.

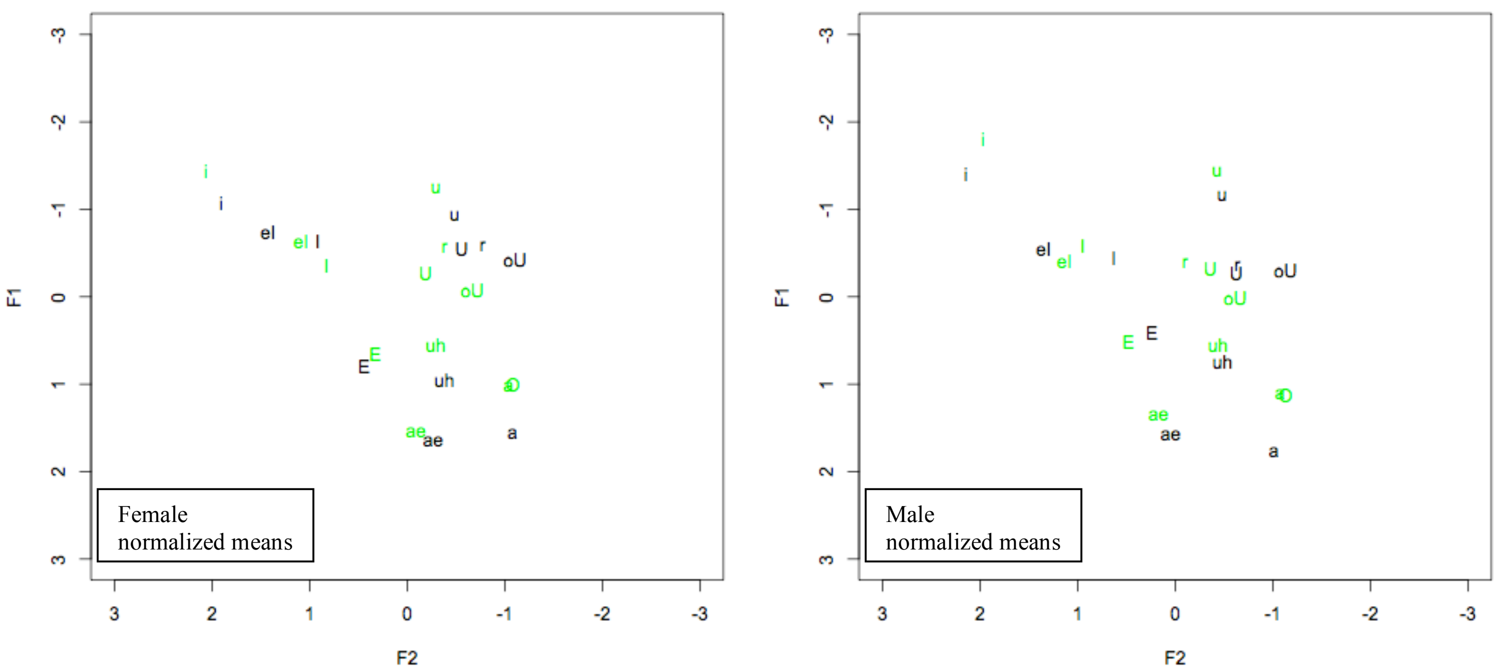

Figure 4: Normalized mean frequency values of vowel productions comparing Hagiwara (1997), in black, to the current study, in green.

Examining these plots offers a look at the current state of affairs of California vowels and the extant changes. In particular, there are some moves that seem to substantiate Eckert's (2008) statements as well as others that do not. A change that is seemingly emerging for the high vowels [i] and [u] and undocumented to my knowledge, is that of raising. Both gender groups of the current study produce these vowels with a markedly lower F_1 than Hagiwara's gender groups. Shifting attention to the low back vowel [ɑ] in both the female and male plots, one can see that the current vowel is also especially raised when compared to the Hagiwara vowel. Recall that in California not only is the back vowel merged with the mid [ɔ], but Eckert (2008) suggests the merger is moving into the space of [ɔ]. The position of the low vowel of the current data (in green) seems to support this idea. It has a lower F_1 than the Hagiwara point with a difference of about .5 normalized units. In further support of the Northern California Vowel Shift at present, we see that the back vowels [u], [ʊ], and [oʊ] have made movement towards the front of the vowel space in both genders as compared to the 1997 data. The high back vowel [u], however, has only slightly fronted, with the females showing this move more than the males. The female group also shows the lowering movement of [ʊ] as suggested by Eckert (2008).

As for the lax front vowels, [ɪ], [ɛ], and [æ], less of an argument for the Northern California shift can be made. Remember that [ɪ] is allegedly moving into the space of the mid lax [ɛ]. In the female plot, this appears just so: the current data point does have a higher F_1 than that of the previous data point. The males, however, do not show this same lowering trend. In fact, the current data point [ɪ] is *above* that of the previous data point. The opposite looks to be true of [ɛ]. For the males, this does exhibit a slight lowering suggesting a move towards the low [æ], but for the females the former seems to have moved higher, keeping the relative distance from [æ] the same when compared to the 1997 data points. These last observations of [ɛ], however, are hard to solidify and, as one will soon see, become insignificant when looking at the standard error of the current study.

Figure 5 shows the error bars of the mean formant frequencies produced by Southern California speakers in the current study. These are represented in black and grey and are plotted against the average formant values of the data from Hagiwara (1997) in purple. Such a representation should help to determine if the movement we see in Figure 4 can be attributed to a progressing sound change. If Hagiwara's points lie within a significant portion of the distribution of the current study's points, it would be hard to characterize a change. On the other hand, if Hagiwara's points rest at the edges of or outside the distribution of the current study's vowels, we may begin to conclude that there is a good chance that there has been a shift in the vowel spaces of Southern California speakers. I do recognize that the observations based on this cannot allow a statistical conclusion that the vowel spaces of the two groups are different. Nonetheless, it can visually suggest that the vowels may be trending in a certain way.[13]

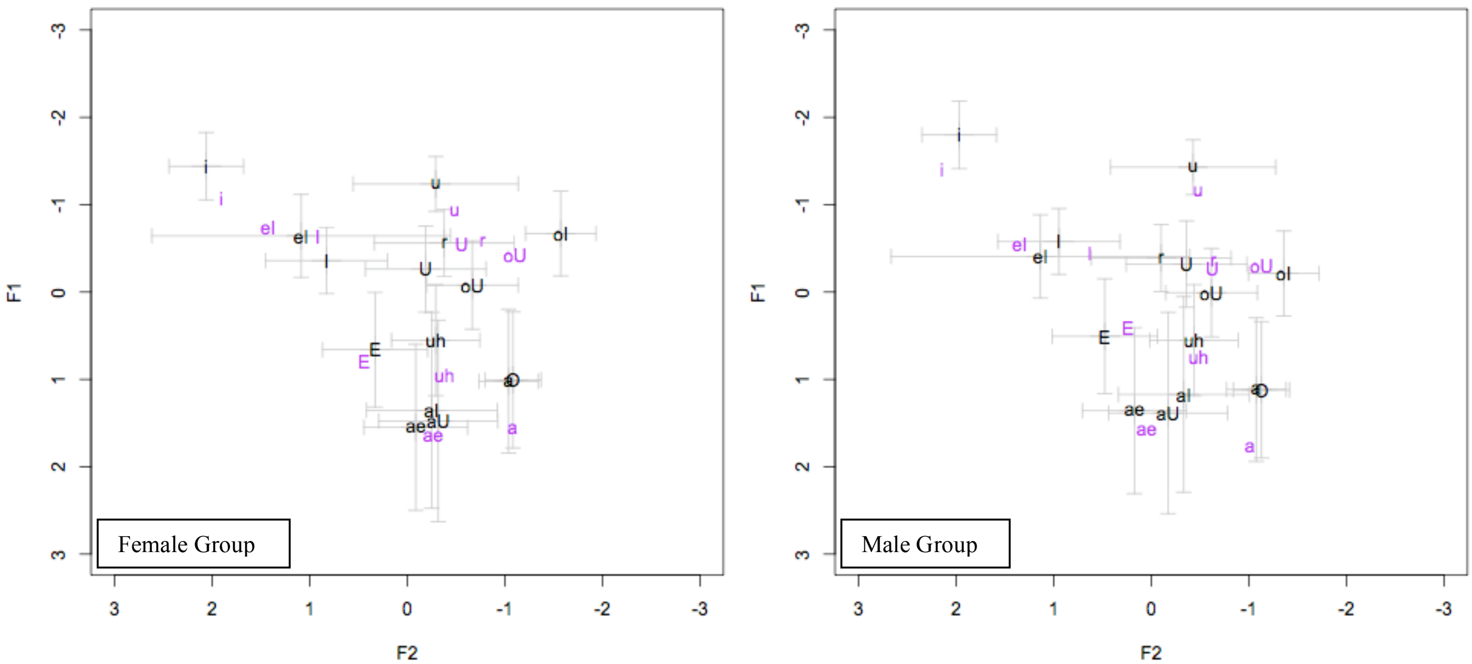

Figure 5: Normalized values of Southern California speakers from the current study indicated with black vowels as compared to Hagiwara's (1997) normalized vowel means (in purple). Error bars represent standard error.

In observing the scatter plots in Fig. 5, some of the previous findings from Fig. 4 can be supported while others cannot. Beginning first with the high vowels [i] and [u], the noted change in the F_1 dimension is supported. That is, these vowels as produced by Southern California speakers in the current study have a lower F_1, resulting in an upward shift. Both the [i] and [u] from the previous study sit very close to the bottom edge of the vertical bar. On the other hand, there is not much change in the fronting dimension. Looking next at the previously observed movements of [ɪ] and [ɛ], the former vowel's shift can be somewhat supported while the latter vowel's shift cannot. In the female group, on the left in Fig. 4, the Hagiwara point [ɪ] lies near the top edge

[13] An increase of participants would allow the deviations to reduce and become more reflective of a population as a whole. Recall that only 6 Southern Californian females were averaged here. Additionally, without access to normalized standard deviation values of the Hagiwara data, a statistical claim would be without substantiation.

of the F_1 standard error bar, confirming that there is some lowering of this vowel. There is also movement of it in the male group; however, the direction is swapped. While Hagiwara's vowel point sits at the right edge of the current male speakers' F_2 standard error line, there is quite a bit of overlap in the horizontal dimension suggesting a fronting but no lowering movement for this vowel. The previous study's plots for [ɛ] are very close to the current plots. Furthermore, the minor shifts it does show do not put it far enough outside of the current study's distribution of [ɛ]. Thus, [ɛ] has not moved towards the space of [æ], in disagreement with Eckert's claim.

Parts of the Northern California vowel shift can also both be supported and discounted when considering the low vowels [æ] and [ɑ]. In particular, one of the claims made by Eckert in outlining this shift is that [æ] is moving into the space of [ɑ], and [ɑ], merged with [ɔ], is moving up into the original space of [ɔ]. While the movement of [ɑ] is indeed supported above, there has been virtually no movement of [æ] in the fifteen years between the studies.

Finally, in considering the back round vowels [oʊ] and [ʊ], the most movement (and in the directions indicated by Eckert (2008)) is viewed. For both genders in Hagiwara's study, [oʊ] sits at the top edge of the F_1 bar and the right edge of the F_2 bar of the current speakers' productions. This offers confirmation of a general fronting and lowering across genders. However, for [ʊ], there is a discrepancy between genders. The female data affirms the Northern California Shift in showing not only a fronting but also a lowering of this vowel. This is exhibited by the position of the Hagiwara [ʊ] in relation to the current study's [ʊ]: the 1997 vowel point is nearly outside of the latter's distribution. On the other hand, the production of this vowel within the male group is fairly consistent across studies. The Hagiwara plot point is nestled close to the present point. The last observation Figure 5 shows that the syllabic [ɹ] is fronting for both genders, although the females show significant overlap in this dimension with the previous study's point.

In conclusion of the comparison across studies, both genders of the Southern California speakers (and thus Northern California speakers by extension) show a shift in the spectral qualities of at least 6 vowels ([i], [ɪ], [ɛ] [ɑ], [oʊ], [ʊ], [u], [ɹ]). Of these [ɪ], [ɑ], [oʊ], [ʊ] are moving in directions put forth by Eckert (2008). However, the current findings cannot definitively reinforce the socio-linguist's assertions, nor can the discrepancies decisively offer a counter-argument to them. For example, it could well be that Eckert is documenting and tracking change in the next generation of California speakers who, consequently, show a more advanced stage in the shift. Under this view, it is possible that the current study has documented an intermediate stage in the vowel shift.

Although some existing change of California vowels can be defended by the findings discussed in this section, this development offers no evidence of a dichotomy between Southern and Northern California English. Since the present vowel spaces of speakers from both zones are alike (illustrated in Figs. 2 and 3), both can be deemed to be at a similar stage of shift and following the same pattern. Subsequently, no phonological difference can be found based on the vowels of the regional speakers. Instead, an examination of sub-phonemic attributes, and in particular duration, revealed a difference in the way Northern and Southern Californians speak.

3.2.3 Gender differences between the Californian regions

Recognizing that language differences might lie outside of the vowel space, three additional parts of the speech signal were examined for the current California data: duration, pitch, and jitter. The results of the latter two showed no difference between the Northern and Southern speakers. Instead, for pitch, they were as expected: females from both Northern and Southern California had a higher F_0 than their male counterparts. Furthermore, the average pitch for each subgroup was nearly identical. The amount of jitter in the speakers of each region showed no marked difference as well. For these reasons, a detailed presentation of pitch and jitter has not been included in the present discussion. Conversely, a thorough presentation of the findings with regards to duration will follow. The inspection of duration exposes a difference between the regions that is not an obvious one. Rather, within region differences present a broader generalization couched in gender identification.

Previous studies on social expression through linguistic variables have found that speakers may tap into certain features in order to identify with certain social groups, including gender (Labov 1963; Eckert 2008b). Thus both for physiological and behavioral reasons, gender differences may manifest themselves in certain parts of the speech signal. Particularly, it has been found that women tend to have a higher F_0 and produce longer vowels than men (Simpson, 2009). Likewise, Van Bezooijen (1995) showed that differences in the F_0 of Dutch and Japanese women reflected a difference in the realization of gender based on the notions of femininity in their respective cultures.

Although the focus of this study is not to highlight gender speech characteristics, regional differences may present themselves in such components. In fact, as will be shown below, the two areas in California do show a divergence from one another in duration, ostensibly based on the realization of gender. Below is a graph showing the average duration of vowels as produced by females and males, separated by region.

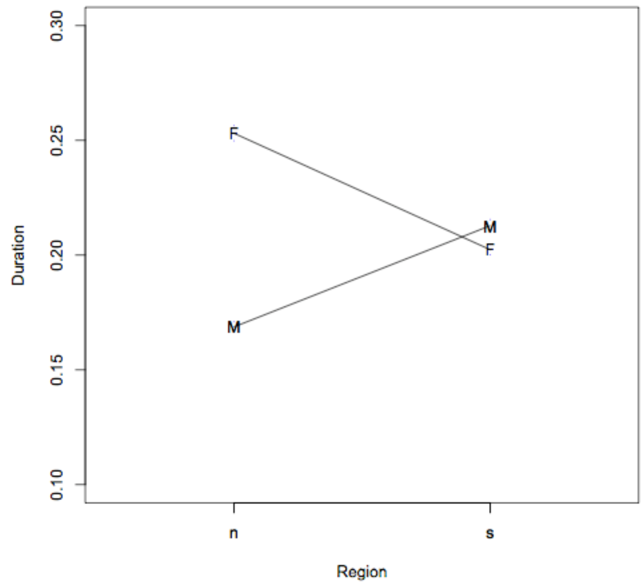

Figure 6: Average Vowel duration in seconds divided by region and gender.
F= female, M=male, s= Southern California, n= Northern California

Figure 6 shows an interesting dichotomy in gender between the North and South. Firstly, it is important to note that there is no consistency between regions in the length of their vowels. Southern California speakers, male and female, produce vowels with a duration falling between those of Northern females and males. Furthermore, there is no uniformity in how the genders realize their vowels durationally across regions. In the North, females have quite long vowels as compared to males. In the South however, this difference is very minimal and swapped: Southern California males tend to produce longer vowels than the female Southern California speakers.

In order to further support the duration differences in Figure 6, the average durations of each vowel according to gender and region are given in Figure 7. As one can see, it is not the case that one single vowel production of a certain gender is skewing the distribution of length. Instead, they follow a consistent pattern of duration. That is, all vowels across variables are produced with a similar variance in length when compared to the other vowels.

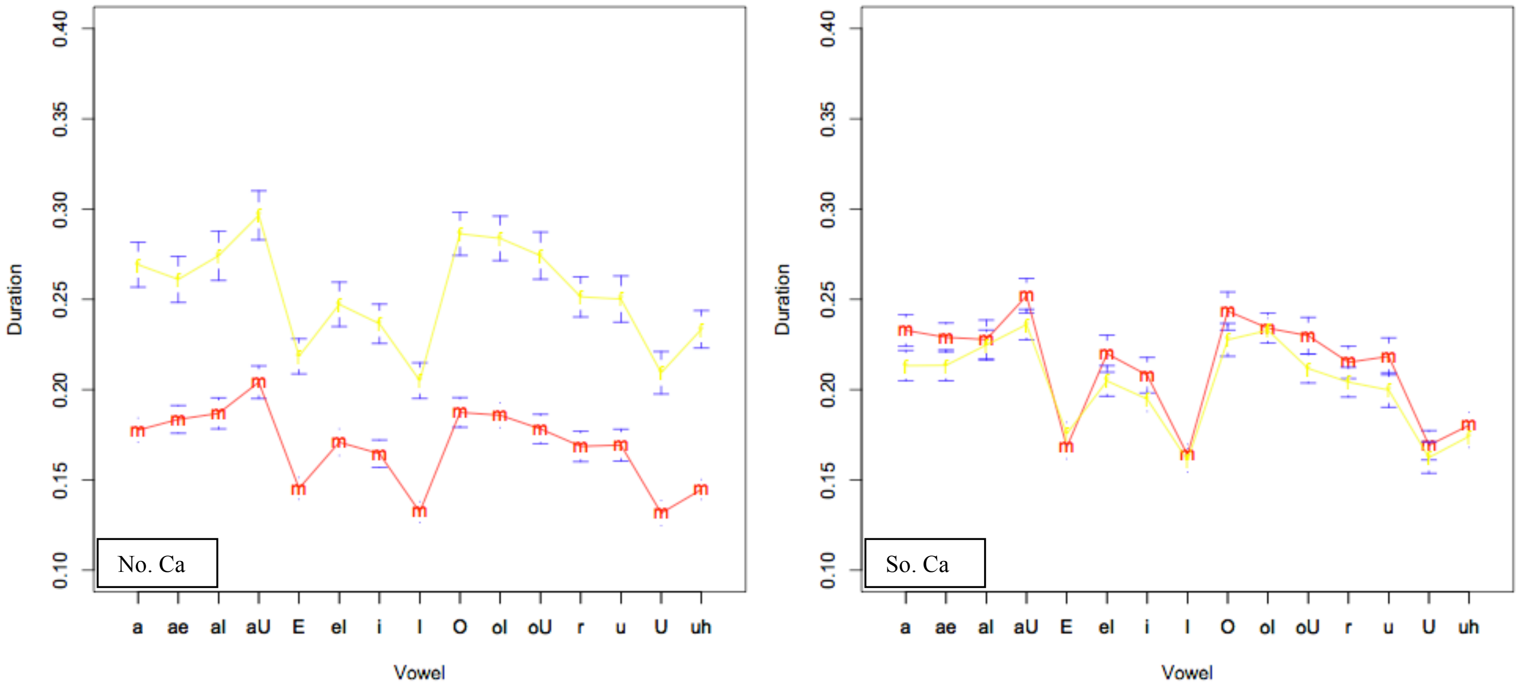

Figure 7: Average vowel durations according to gender, region and vowel. Northern California is on the left; Southern California is on the right. Male averages are in red; female averages are in yellow.

Turning to table 4, which shows the average vowel along with word durations per group, the reader can see that not only were the vowels of the Northern California women longer, but the words were longer overall as well. Consequently, the generalization seen in Figures 6 and 7 can be attributed to the fact that these speakers tended to simply speak slower; that is, the Northern females produced longer vowels because they produced longer words. This, however, does not weaken the underlying finding based on the duration difference: the regions still show a split in relation to length between genders' speech productions. The Northern females produce longer words than their male contemporaries, while the Southern females produce words at nearly the same length as their male counterparts.

Gender	Region	Vowel Duration	Word Duration
Female	Northern Ca	.25	.41
Male	Northern Ca	.17	.32
Female	Southern Ca	.20	.36
Male	Southern Ca	.21	.38

Table 4: Average word and vowel durations in seconds for according to gender and region.

Figure 6-7 and Table 4 suggest that in the North, gender differences via speech rate, and thus token duration, are active and in line with previous findings (Simpson, 2009). There, women speak slower than the men. In Southern California, however, this realization is not as great, if existing at all. Moreover, if present, it is trending in an opposite fashion. In Southern California, the men speak slower than the women. Under this view, the two regions are expressing gender differently.

3.3 Discussion and Conclusions

If indeed these regions use vowel duration in order to express gender, one must wonder why we see a difference between Northern and Southern California. As already noted, in the North the genders are exhibiting “typical” behavior and thus “typical” differences. In the South, however, we do not see the same distinction. Not only is the distance between the duration measures significantly reduced, the women’s productions are trending to be shorter than the men’s productions, the opposite of what we would expect. Within the context of gender roles, this may suggest that there is more of an apparent division in the North. Such role identification via speech production in the South would then be unavailable or reduced and perhaps not as pronounced throughout the social stratum. In order for such a correlation to be accepted, additional studies of gender roles in areas such as sociology and psychology are necessary to verify that these theories are in line with other manifestations of gender.

In a similar vein, it could be that this study has caught a static moment in the midst of a socio-linguistic change. If previous data on duration were available (or future data becomes available) one could hypothesize about a convergence or divergence of gender realizations via speech rate in Southern California. That is, could it be that the gender gap is collapsing or that gender realization is at a moment of flipping but ultimately moving away from each other? If another study were conducted in a 15 more years, imaginably Southern Californian men might speak at a rate that is more similar to the Northern California women.

Despite this split between the regions corresponding to gender, the fact that the present study found no difference in the vowel spaces of Northern and Southern California speakers suggests that the two areas make up a single cohesive dialect in regards to resonance frequencies. Any social divisions of the North and South are thus not reflected in a purely phonological way. This was determined not only by comparing current measurements of the first and second vowel formants but also through the consideration of vowel movement. While on the one hand the aspects of the Northern California Vowel Shift that are present are found in both the Northern and Southern productions, those that are not present are consistently absent across the regions.

These details stimulate some scrutiny regarding the Northern California Shift (Eckert, 2008). Particularly, because the movements that we do see are true of both regions, the Northern California Vowel Shift is perhaps improperly named. That is, if the entire State seems to be at the same point of change, on what basis has the origin of shift been given to the North? Additionally, one has to wonder why only a subset of the changes outlined in the aforementioned shift is seen. Perhaps Eckert has noticed changes that are specific to the Palo Alto Area (and possibly a sub-group within that city) or maybe she has observed a later stage of a shift that is indeed happening in all of California. However, as mentioned before, her claims about the shift are troublesome to substantiate and thus these speculations are difficult to verify without a reference point. These shortcomings aside, Eckert (2008) herself has provided an orientation for the present examination of California. In turn, the conclusions established here provide a context for future studies investigating the Western dialect.

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