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Sound Change in General American: an Acoustic Analysis of Vowel Production in Female Californian Speakers.

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Index

Abstract

The term "General American English" used by Peterson & Barney (1952) has been regarded to be inaccessible as multiple differences in language production across America have been recorded and studied since then (Hagiwara 1997, 658). The present study focuses on Southern Californian English vowel production by exploring the current status of some of its inhabitants' vowels. Details of the acoustic features and the *distributions* of vowels produced by different native speakers of Southern Californian English (SCE) in citation disyllables in which the vowels are followed by bilabial stops will be presented, and a comparison between them will be drawn. The results of these comparisons reveal differences in the formant frequencies of specific vowels between today's Southern Californian English and the Californian English spoken 23 years ago. These dissimilarities served me to see whether the results of this study are in agreement with the California Vowel Shift. The main focus will be on the segments /ʊ/ and /ə/ which, after analyzing the spectral features of the vowels, seem to be going through a change in their production in Southern California as compared to Hagiwara's study carried out 23 years prior to this present paper.

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1 Introduction

When it comes to the English language, nothing divides its diverse dialects more efficiently than how English speakers pronounce vowels. Although dialectal differences can be based on syntax or the lexicon of a specific language, it is currently more likely for the different dialects of a language to be classified based on its phonological features. There has been ongoing interest over the last 20 years on investigating American English production and perception of sounds across the country. This increase in the interest on the field was due to the publication of Hagiwara's study in 1997 which challenged the thought of an existing standard or General American English language which was previously put forward by Peterson & Barney in 1952. In fact, vowel change has been a topic widely discussed since then in the field of sociophonetics around the world and "has provided a rich basis for the examination of both internal (i.e., system-driven) factors and a variety of external (i.e., contact-driven) factors in different varieties of English in the world" (Jacewicz, Fox and Salmons 2011, 45). Peterson and Barney (PB) were pioneers in the studying of acoustics and perception of vowels. Their experiment served to prove a "strong relationship between the intended vowel and the formant frequency pattern" (Hillenbrand et. al. 1995, 3099) and, as they were the first to carry out a study as such, their measurements, known as the PB measurements, have played an important role in the evolution of theories of vowel recognition (Hillenbrand et. al. 1995, 3099). However, many authors such as Hagiwara or Hillenbrand have recognized multiple limitations to the PB measurements experiment and that is one of the reasons why, through time, multiple studies have obtained results that differ from those obtained by Peterson and Barney. Hagiwara notes that, in his study, "the Southern Californian data are seen to differ greatly from that described by Peterson and Barney (1952)" (Hagiwara 1997, 655) and, therefore, confirms regional differences within the English language in the US. This supposed a shift in the mindset of experts who, since then, have been investigating speech differences and changes through time and across America. Thus, there is now evidence that indicate the importance of dialectal differences in vowel production and perception (Strange et. al. 2007, Hagiwara 1997, Robles-Puente 2019).

1.1 Vowels' acoustic features

Vowels are classified in terms of articulation and in terms of their acoustic properties. The major articulators are the tongue, the lips and the velum. These articulators are the ones which play the most central role in the production of vowels. However, "the majority of studies analyzing phonetic variation across dialects have based their conclusions on differences in the acoustic properties of the dialects in question" (Blackwood, Shaw and Carignan 2017, 363). The acoustic properties of a vowel comprise the so-called vowel frequency formants. The formants more commonly used with the purpose of studying within-language differences in vowels are the F1 and the F2, which are assumed to be related to the tongue height and tongue backness, respectively. The present paper will mainly focus on the acoustic properties of different vowels from English produced by 5 different American speakers in order to illustrate the change through which some vowels are going in Southern California.

1.2 Studies on North American vowels

I would like to highlight that the reason why studies like the one following the next pages can be carried out is *The Atlas of North American English* (*ANAE*) by William Labov in 2006. It is a study about vocalic variation in North American English. I mention this work because it is the first study about dialect geography that took advantage of modern technologies and this is what makes it more relevant and reliable than previous studies done on the same topic. It served to revive the relevance of dialect geography and to provide evidence of the fact that new phenomena continue to differentiate dialects even when previous contrastive features disappear or slowly fade away. The results of *ANAE* confirm ongoing vowel shifts in the South (the Southern Shift) and in the Northern cities in which, for instance, the lowering of the vowel /ɔ/ results in speakers affected by the shift pronouncing *cot* and *caught* in the same way because the vowels have merged. This is just to illustrate how Labov has proved that, although this paper is focused on specific changes in South California, English in the entire country goes through adjustments in pronunciation and it is not something exclusive of Southern Californians. So big has the impact of Labov's survey been that "future scholarship on the vowels of any English-speaking community in North America cannot be taken seriously without implicit or explicit reference to the changes in perspective that *ANAE* has brought about" (Thomas 2016, 496). However, what happens with this work is that, while the Eastern part of the country was divided into many different dialects, the western part of the United States was grouped together under a single dialect since "the defining features of the West as a dialect area are more complex and less consistent than for other areas" (Labov, Ash and Boberg 2006, 26). For this reason, Californian English has attracted the attention of linguists over the past decades.

1.3 Previous studies on Southern Californian English vowels

While a reasonable number of experts have focused their studies on North American English (Blackwood, Shaw and Carignan 2017; Strange et. al. 2007, Hillenbrand et.al. 1995, Eckert 2008), many researchers have been studying in depth the different ways in which English is produced throughout America but, specifically, in California (Hagiwara 1997, D'Onofrio et. al. 2018, Robles-Puente 2019) since the Californian Vowel Shift was first detected in the 1980s. This vowel shift is central in the development of phonetic studies of American English and is described as "a series of counterclockwise vowel changes" (Eckert 2008, 29) which involve "in addition to the well-known fronting of back vowels, a counterclockwise rotation of the front and low vowels" (Eckert 2008, 34). This variation in language has been regarded as a product of macro-social categories such as class, ethnicity or gender. Eckert notes that "Spanish has a deeper history in California than English, as California was originally a Spanish colony and from Mexican independence until 1848, it was part of Mexico. Anglo American adventurers began to arrive in the early part of the 19th century, and groups of Anglo-American settlers started arriving halfway through the century. Now, 32% of the California population is Latino, and of them, 84% are of Mexican origin" (Eckert 2008, 26). Taking this sociolinguistic situation into account, not only does the following study try to illustrate some vowel changes that distinguish Californian English from 25 years ago to today's Californian English, but it also reflects the consequences of the possible influence of Spanish in Southern Californian language production and possible changes that this might be triggering in Californian English since it is the area in the US that has been most in constant contact with the Hispanic population throughout history. This variation "is the expected situation for regions that have been formed more recently as the result of population shift from several dialect areas, as in the West" (Labov, Ash and Boberg 2006, 43).

In fact, the study to which the present paper will be compared highlights this variation of the Californian dialect. It is an important study on vowel production in Southern California and it was carried out by Hagiwara et. al. in 1997. In his study, he puts emphasis on the fact that the Southern Californian English is expected to show a defined amount of variation due to ethno-social factors. For his results to be as precise as possible, he chose a group of college students who were of similar age and also had similarity in geographic, educational, and socioeconomic background and, therefore, could be considered to represent an unmarked, middle-class population. Finally, although the participants included Anglo-Americans, Asian Americans and African Americans, Hagiwara considered that they could "appear to represent as unified a speech community as can reasonably be studied without imposing predetermined sociometric boundaries on a target group of speakers" (Hagiwara 1997, 655). That is, that in spite of the possible background differences, the group of participants chosen did not differ greatly and represented one same speech community. In the present study, a similar approach was taken so the profiles of the informants were quite similar.

1.4 The Present Study

The present study was designed with 2 questions to be answered in mind. On the one hand, I intended to analyze the within-dialectal differences between the speakers to see whether there were gross dissimilarities in the pronunciation of specific vowels even amongst the speakers of the same dialect. On the other hand, I aimed at illustrating the shift in vowel production in Southern California and demonstrate these within-language dissimilarities between dialects of America. I will do so by comparing the average of the F1 and F2 of the participants of this study with those of Hagiwara's study carried out in 1997 and see whether the changes agree with what experts named the California Vowel Shift (Eckert 2008). I will use recordings made by Mark Amengual, professor in the department of Languages and Applied Linguistics at the University of California in Santa Cruz, to a group of young Californian people in which they produced /hVbba/ utterances. Measurements were made of the vowels' acoustic properties and an analysis of their spectral features was carried out. This means that the F1 and F2 of each vowel token were extracted and normalized aiming at erasing the effects of the different vocal tract sizes and other anatomical dissimilarities. To continue, a comparison between the results of each separate participant will be performed in order to illustrate the similarities and differences amongst the speakers. Finally, the average results of this present paper and those obtained by Hagiwara in 1997 will be contrasted with the aim of illustrating the possible changes that the Southern Californian English's vowels might have gone through over the past 23 years.

2. Method

2.1 Participants

This study draws upon recordings conducted by Professor Mark Amengual at the University of California, Santa Cruz. Five speakers were selected for analysis. In order to minimize the possible dissimilarities between the participants (due to age, family, etc.), they were asked to complete a background information questionnaire. The participants were all women born between 1997 and 2000 and who have similar linguistic backgrounds. They are all native English speakers who have lived in California since they were born and they are daughters to Californian parents, except for *Speaker 2* whose parents are both from Chicago.

2.2 Stimulus Material

Protocols consisted of randomized lists of 22 non-sense words. Speakers were shown a presentation with 22 slides and a different non-word on each on the screen of a computer. The presentation changed slides automatically and the target words were presented orthographically with no carrier phrase. In the task, each participant had to read isolated hVba tokens which appeared on their screens. These non-words were the same as those used by Strange et. al. (2008) and the bilabial context was chosen because it has no articulation effects on the vowel. The non-words were citation disyllables, for which words were spelled as follows: /i/ *heeba*, /ɪ/ *hibba*, /eɪ/ *hayba*, /ɛ/ *hebba*, /æ/ *habba*, /u/ *whoba*, /ʊ/ *hooba* (book), /oʊ/ *hoaba* (boat), /ɔ/ *hawba*, /ɑ/ *hobba*, /ʌ/ *hubba*, /ə/ *h@bba* (the), /ɔɪ/ *hoiba*, /ɚ/ *hrba* (pap*er*), /aʊ/ *howba*, /aɪ/ *highba*, /ɔr/ *horba*, /ar/ *harba*, /ʊr/ *hourba* (tour), /ɛr/ *hairba*, /ɪr/ *here-ba*, /ɝ/ *herba*. As noted, for some of the non-sense words, real words were provided, such as *paper* or *book,* in order to help the participants know which vowel they were supposed to pronounce since the vowels for which these real words were provided have variable spellings in English and, therefore, are considered ambiguous. These ambiguous segments were [ə, ʊ, oʊ, ʊr, ɚ]. Each of the speakers read five repetitions of each word presented randomly and the tokens were recorded and digitized. For the purpose of this paper, only the acoustic features of the vowels from *heeba, hebba, hibba, hebba, habba, hooba, h@bba, whoba*, and *hubba* were examined.

2.3 Acoustic analysis procedure

The speech samples were analyzed acoustically with the Praat program (Boersma and Wennink 2020). First, the target words were first segmented and then labelled and annotated through the TextGrid utility. For the segmentation part, the general procedure was to select the periodic portion on the waveform and spectrogram. This is presented in fig.1. For instance, to find and place the onset and offset boundaries of the segment /ʌ/ in the made-up word *hubba,* the frication noise release of the preceding affricate /h/ was considered to set the onset boundary for the vowel segment while the other offset limit was placed on the dip of spectral energy of the following bilabial plosive (fig.2). Therefore, the limits of the beginning and ending of each vowel were located by hand. The context for each different vowel is the same as they are all preceded by a voiceless, fricative, glottal consonant, and followed by a voiced, bilabial, plosive consonant. For this reason, the process was exactly the same for the segmentation of each different token.

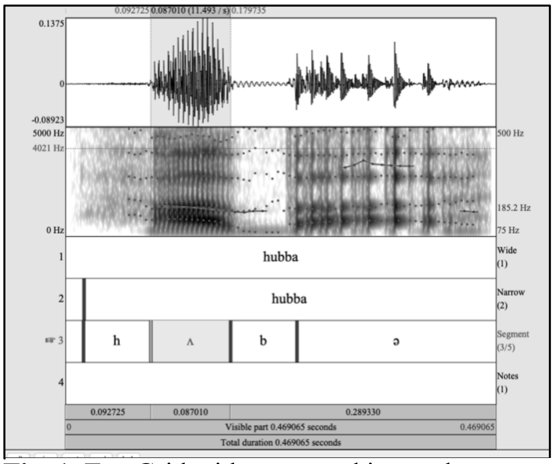

Fig. 1. TextGrid with annotated intervals

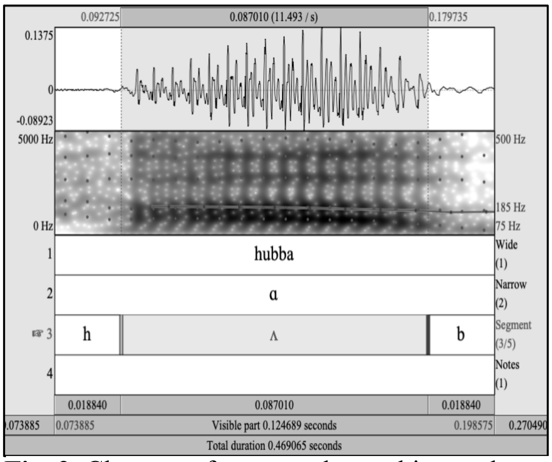

Fig. 2. Close up of annotated vowel interval

This process served to isolate the vowels from the rest of the word and, therefore, be able to analyze the acoustic features of the vowels in a more precise way. To continue, previously labelled TextGrids were opened in Praat and an acoustic analysis of vowel dynamics, such as formant movement, was carried out with the aim of exploring possible variation in the spectral change for all the vowels. F1 and F2 values were extracted automatically using Pratt, which displayed these values together with the F3 and F4. All of these values were checked by hand and changed if considered necessary using the formant tracking option. Later on, an excel document was created in order to get the average of the F1, F2 and F3 of each vowel segment. A calculation of the general average of the formants of each vowel from the 5 speakers altogether was carried out, but also the average of the formats of the vowels produced by each speaker separately. So, for instance, I calculated the average of the F1 of the vowel /u/ for all the speakers together and also the average of the F1 of /u/ produced by just *Speaker1*.

A limitation of analyzing vowel production across different speakers is that there will be differences from one speaker to another due to anatomical dissimilarities which will influence the formant values. For instance, "in the case of formants, differences in vocal tract length influence the average formant values" (Blackwood, Shaw and Carignan 1997, 366) and it is very plausible that we come across larger distinctions between the formants of the same vowel produced by different speakers than between the formants of different vowels produced by the same speaker. Thus, these limitations are to be taken into account in order to achieve more precise results. For this reason, the formant values obtained through Praat were normalized. The different techniques for vowel normalization have been developed, amongst other things, "to eliminate variation caused by physiological differences among speakers (i.e., differences in mouth sizes)" (Thomas and Kendall 2007) which makes the process of contrasting vowel production across the different speakers more accurate, meeting the objective of speaker production comparison.

There are different softwares to carry out this task. For instance, NORM is a software that serves phoneticians to handle and normalize vowel formant data and gives the option to choose a number of different methods. However, in the case of this research, I used a script written by Mietta Lennes obtained from the *SpeCT* - The Speech Corpus Toolkit for Praat (formerly known as *Mietta's Praat scripts*) which automatically normalized the vowel formant data following the Bark Difference Metric method and created a Bark-scale F1/F2 chart. This method "does a reasonable job of filtering out physiological differences while retaining sociolinguistic differences" (Thomas and Kendall 2007) which is the goal that I needed to achieve for the purpose of this paper.

3 Results

The results of this study are structured as follows: first of all, I will analyze and compare the formant frequencies obtained from each of the speakers individually. These will reflect similarities and dissimilarities noticed amongst the participants that influence the final outcome of the study. These comparisons of the individual speakers of the current study will be performed based on the Bark-scale F1/F2 charts I created with the frequency data obtained from the recordings. These formant charts for each individual participant were created using, not the average, but the F1 and F2 obtained from each one of the recordings. I used 4 recordings for each vowel from each participant which means that each speaker's individual chart displays 4 different F1/F2 values for each vowel. In these charts the vowels will be exposed as follows: /i/ appear in purple, /I/ in lime, /ɛ/ in green, /ə/ in black, /ʌ/ in cyan, /æ/ in blue, /ʊ/ in red, /u/ in grey, and /ɑ/ in silver. This needs to be taken into account considering that in some of the charts the IPA symbols of some vowels are not in sight because they overlap with other vowels and only the color can be distinguished.

3.1 Vowel production differences in participants

The distribution of normalized F1 and F2 values across the acoustic vowel space recollected for this study for Southern Californian English is presented in fig. 3. This figure indicates the average position of the resulting formant frequencies obtained. The most notable aspect that can be noticed just by looking at the formant chart is that the back vowel /ʌ/ appears to have been fronted by the participants to the point that it sounds more like an /ə/ than an average /ʌ/. That is because the F1 and F2 frequencies for both vowels in this group of people are very similar. This fronting is in agreement with the changes that the Northern Californian cities are experiencing in vowel production according to Eckert (2008). As maintained by the expert, the California Vowel Shift provokes, amongst other changes, the fronting of back vowels. Although with the other back vowels this does not happen, these results show that the Southern Californian participants do front the /ʌ/ vowel. Later on in the paper, I will particularly focus on this matter.

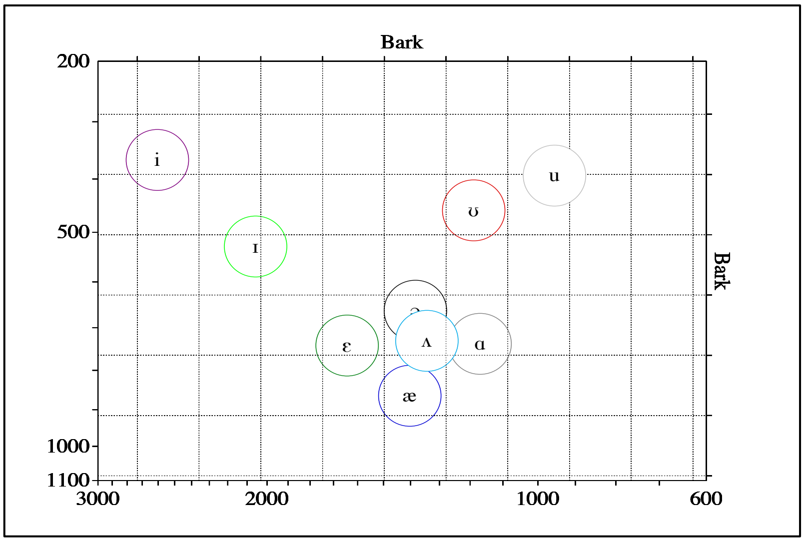

Fig. 3. Bark-scale F1/F2 chart with formant averages for 5 Southern Californian participants.

However, as mentioned earlier, this figure only shows the average of the values obtained and, therefore, does not serve to compare the individual results of each of the participants. This is worth mentioning because I have found some significant dissimilarities between them that need to be taken into account when interpreting these final average results. The participants of this study show substantial differences in the distribution of their F1 and F2 values across the formant chart. Therefore, before moving on to comparing my results to previous studies to illustrate any possible change in the dialect over the past two decades, I will comment on the individual similarities and dissimilarities between the participants of the current study. With this aim I will be referring to the different informants as *Speaker 1, Speaker 2, Speaker 3, Speaker 4* and *Speaker 5*

To begin with, the high back vowel /u/ and its laxed version /ʊ/ are differentiated by all of the speakers since the formant frequencies obtained from them are divergent. Nevertheless, as seen in fig. 4 below, *Speaker 4*'s /ʊ/ merges with /u/ which means that she pronounces both vowels almost identically for the human ear. The chart for *Speaker 5* (fig. 5) also shows this merging process of the /ʊ/ with the high back vowel. However, *Speaker 4* also pronounces the high front vowel /i/ and the lax /ɪ/ identically while *Speaker 5* frequencies for both of these two vowels are contrastive. This reveals that *Speaker 4* does not differentiate /i/ and /u/ from their lax versions /ɪ/ and /ʊ/ which, as I will illustrate in the following pages, contrasts greatly with the results from the other participants who seem to be on the way of merging /ʊ/ and /ə/.

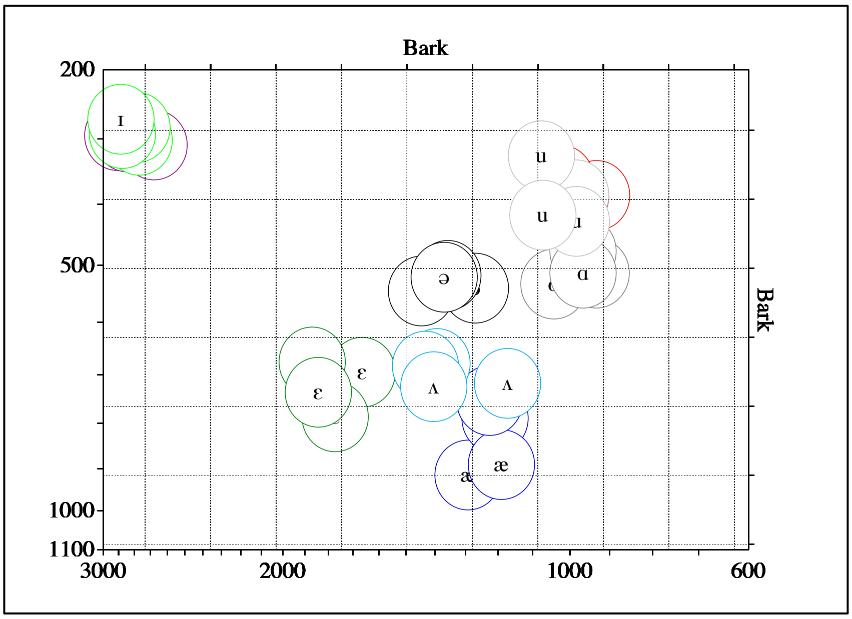

Fig. 4. Bark-scale F1/F2 chart with F1 and F2 frequencies for *Speaker 4*.

Another peculiarity revealed in fig. 4 is that *Speaker 4* seems to pronounce the low back vowel /ɑ/ in a different manner than all the other participants. The F1 of every speaker for /ɑ/ is between 600 and 900 Hz, but the formant chart for *Speaker 4* illustrates that the F1 for this participant is lower than for the rest of the informants as it is around 500Hz. As a consequence, the /ɑ/ is brought closer to the /ə/ while the /æ/ is dragged to the back and it is on its way to occupy the space left by the /ɑ/ in the acoustic vowel space of this particular speaker.

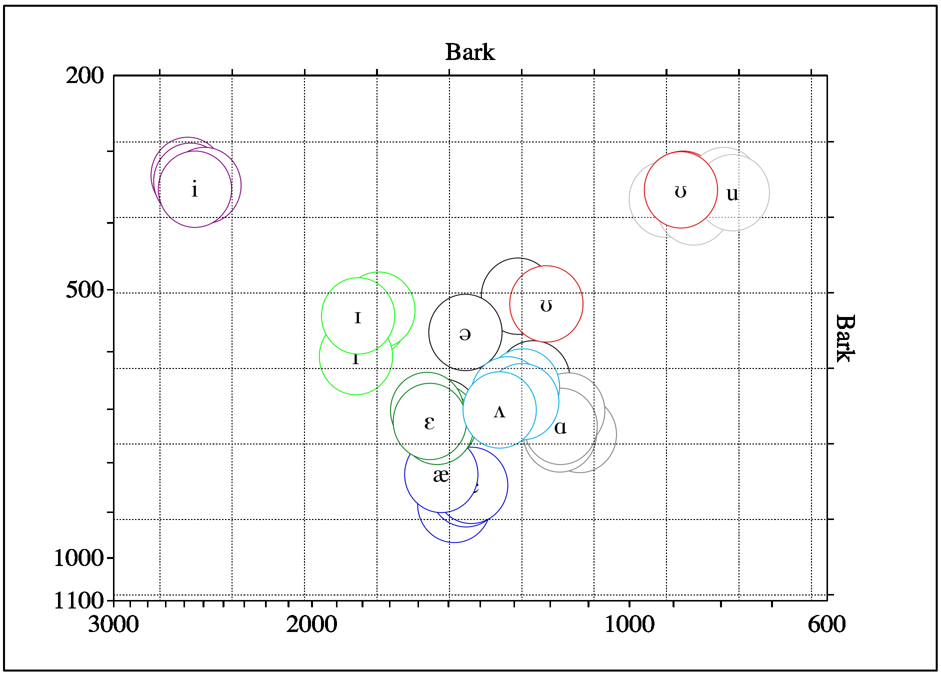

Fig. 5. Bark-scale F1/F2 chart with F1 and F2 frequencies for *Speaker 5*.

Moreover, notice that fig. 5 above shows that in one of the recordings the participant pronounced /ʊ/ and /ə/ in a very similar way. This leads us to the possible fronting and centralization of this back vowel considering that this did not happen only with *Speaker 5*. This centralization process is especially illustrated in the results obtained from the recordings of *Speaker 1* and *Speaker 2*. As seen in fig.6 below, *Speaker 2* shows lower F1 and higher F2 values for /ʊ/ which bring the vowel closer to the center of the system and, therefore, closer to the neuter vowel /ə/, which appears in black in the charts. However, this speaker tends to centralize most of the vowels. Taking a look at fig. 6, we notice that the lower vowels gather all together almost merging with the /ə/. Firstly, as already mentioned, the /ʊ/ is centralized and lowered. Moreover, /æ/ has very similar F1 and F2 values to /ə/ which means that it has been backed and heightened. At the same time, /ʌ/ has also been fronted to the point that it has merged with /ə/. This last shift from /ʌ/ to /ə/ is also present in the formant chart for *Speaker 5* (fig.5 above) and *Speaker 1* (fig.7) which could mean that it is becoming a tendency in Southern California. All these changes seem to reveal that this particular speaker has a tendency to neutralize the mid and low vowels making them all sound similar to an /ə/.

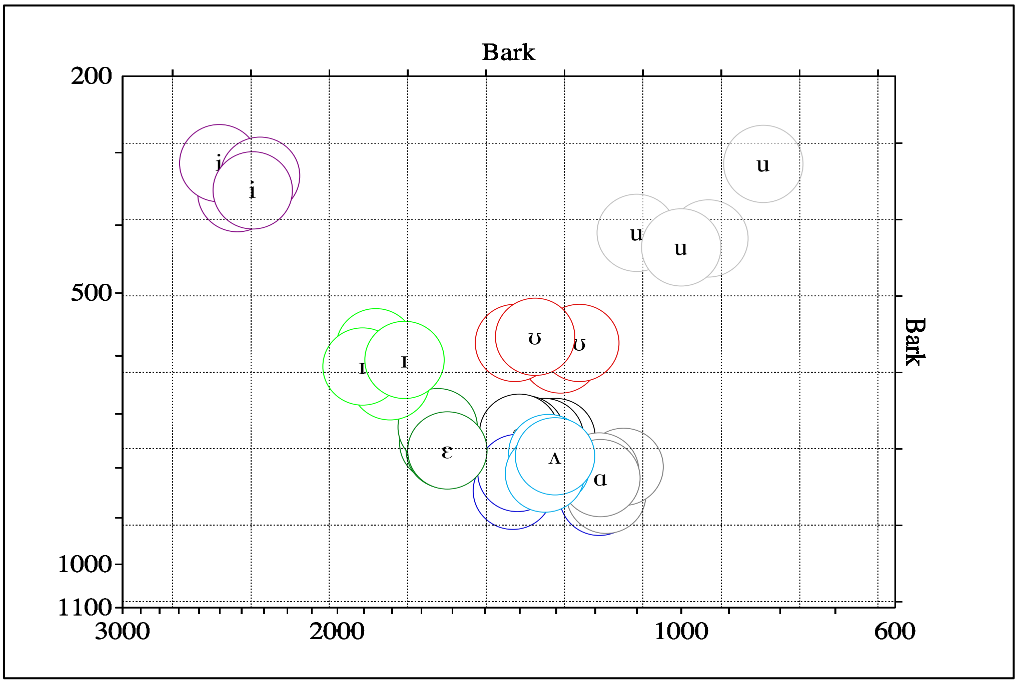

Fig. 6. Bark-scale F1/F2 chart with F1 and F2 frequencies for *Speaker 2.*

Finally, another relevant aspect that might illustrate a possible shift in the vowels of California is present in the formant chart for *Speaker 1* (see fig. 7 below). This chart also reflects a centralization process of the lower vowels and, as *Speaker 2*, *Speaker 1* also specially merges the /ʌ/ and the /ə/. In this individual case, I did not have the any *whoba* tokens needed to analyze the formant values of the /u/ so I cannot draw any comparisons with it. However, this participant does differentiate /i/ and /ɪ/, unlike *Speaker 4* and *Speaker 5,* so I assumed that she also differentiates the lax /ʊ/ and the /u/, but does not comply with the tendency of lowering of the /ʊ/ that is shown in other speakers, like *Speaker 2* or *Speaker 3*. Nevertheless, there is a fronting process of /ʊ/, which shows a higher F2 frequency than most of the informants. This means that the merging of /ʊ/ and /ə/ does not completely take place in *Speaker 1* because the lowering activity of the vowel present in speakers who do merge the two vowels does not take place here, although one of her four recordings does display a lower /ʊ/ than the rest do, which almost merges with the schwa.

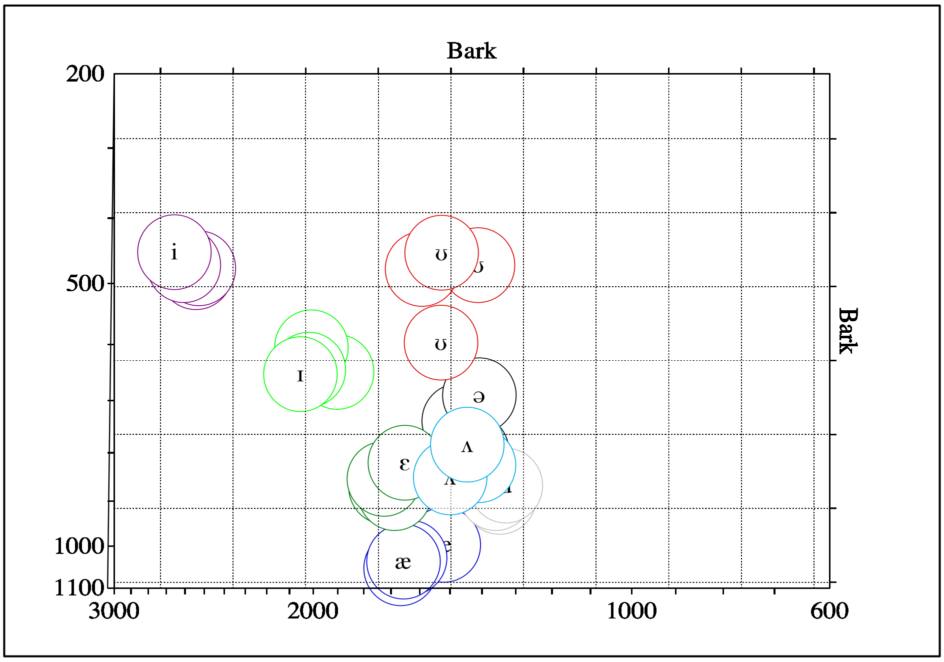

Fig. 7. Bark-scale F1/F2 chart with F1 and F2 frequencies for *Speaker 1*.

4. Discussion

4.1 California Vowel Shift

In order to interpret the following formant charts, it is relevant to take into account the California Vowel Shift (CVS). Over the last decades, experts have been studying a vocalic shift happening in Californian speakers. This change is deemed the California Vowel Shift. The main points of the California Vowel Shift and that are relevant to this study are to be considered in order to facilitate an interpretation of the possible changes that the Southern Californian English might have gone through over the past years. Firstly, according to the CVS, there is a fronting of the high and mid-high back vowels. In addition, a process of backing and lowering of the lax vowels is taking place. While this is happening, /ʌ/ is moving slightly forward to yield /ɛ/ and /ɛ/ is backing and lowering towards /æ/. Moreover, "the merged /o/ (cot) and /oh/ (caught) are moving into the vowel space of /oh/" (Eckert 2008, 34) and, finally, /ae/ lowering and backing in non-nasal contexts. Therefore, the main points of the California Vowel Shift would be as follows:

1. Fronting of high and mid-high back vowels.
2. Backing and Lowering of lax vowels.
3. /ʌ/ is moving slightly forward to yield /ɛ/.
4. /ɛ/ backing and lowering towards /æ/.
5. /ae/ lowering and backing in non-nasal contexts.

4.2 Southern Californian Vowels in 1997 and 2020

With the aim of analyzing whether this change is present in Southern California, and in order to be able to define changes in vowel production through time in Southern California, a comparison between the average of the results of F1 and F2 for every vowel and the results of a similar study performed 23 years ago by Hagiwara will be drawn in the following pages. This comparison will be based on Bark-scale F1/F2 charts created with the average results of this study and the F1 and F2 average values for women taken from Hagiwara's research from 1997. The results show that the majority of the vowel classes have changed over time although do not necessarily reflect the chain-shift progression that the California Vowel Shift represents. The vowel segment that could not be contrasted in this section was the /ə/ due to the lack of data for this specific vowel in Hagiwara's study. As seen in fig.8, the results from this study seem to differ greatly from those obtained by Hagiwara 23 years ago.

Firstly, the results show an overall backing of the vowels. The most notable change in backness is the one is experienced by the /u/ which, comparing it to Hillenbrand et. al.'s results of the production of vowels in Michigan in 1995, seems to be more similar to the pronunciation of the /u/ in the northern part of the country (fig.9). Although the results from the back vowels are not in agreement with what the California Vowel Shift (CVS) states, the results obtained from the changes in the front vowels do seem to be supporting the CVS. First of all, the CVS causes a fronting of /ɪ/ before nasals, but a backing and lowering in other contexts (Eckert 2008, 34). Therefore, since this study consisted on disyllabic words that did not involve any nasal consonant, the mid-high front vowel /ɪ/ has shown a process of backing and lowering over the last 23 years (fig.8). Another change that supports the CVS is that of the /ɛ/. 1997 Californian English /ɛ/ studied by Hagiwara displayed a higher F2 frequency than the /ɛ/ in today's Southern Californian English which agrees with the CVS in that it has experienced a backing process over time. However, according to the CVS, the /ɛ/ segments is supposed to also lower and become more similar to an /æ/ (Eckert 2008, 34), but, in this case, the vowel does not experience a notable change in height.

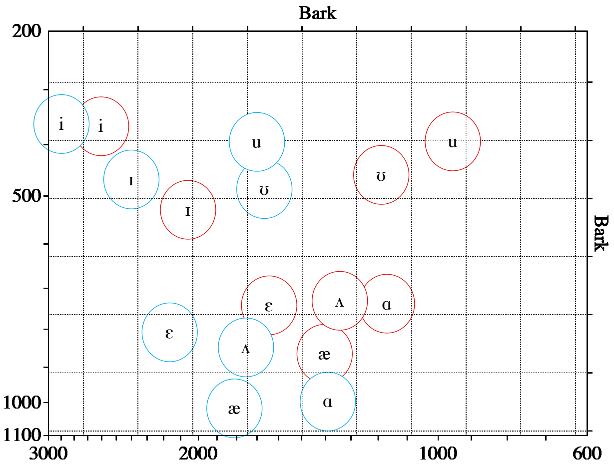

Fig. 8. Robert Hagiwara's results from 1997 in cyan. Results for the present study in red.

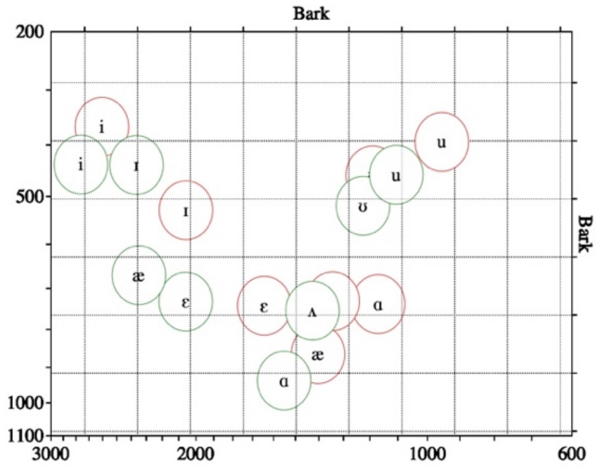

Fig. 9. Hillenbrand's results for Michigan vowels (Hillenbrand et. al. 1995) in green. Present study in red.

Moreover, the changes that are illustrated in fig.8 for the front low vowel /æ/ are also only partly in accordance with the CVS. According to Eckert (2008) the /æ/ in California has been experiencing a raising process before nasals and a lowering and backing process everywhere else. Nevertheless, this present study can only confirm the backing process that the vowel is supposed to be going through over time. The F2 values for this vowel segment were much higher in Hagiwara's study (fig.8) than in this one which means that it has experienced a change in depth, but the F1 values that mark the height of the vowel show that, instead of there being a lowering process, there has been a heightening one. However, the backing process of /æ/ results in the merging of today's /æ/ with the vowel /ɑ/ of 1997. This means that today's /æ/ and the /ɑ/ studied by Hagiwara in 1997 have very similar F2 values. At the same time, the results expose that today's South Californian /ɑ/ has raised and backed so as to occupy what would be the place of the /ɔ/ vowel, change which complies with the CVS. These raising of the low vowels results in a much more compressed vowel space, in which vowel cluster to the center, closer to where the /ə/ would be.

5 Conclusion

The present study investigated the production of English vowels by a group of female participants of around the same age in Southern California. I first addressed the fact that the results showed wide dissimilarities between the speakers. The second research question was whether the California Vowel Shift which researchers have identified over the past decades is reflected in these Southern Californian speakers and I carried this out by comparing my results to those obtained by linguist Robert Hagiwara in 1997. The results reflect that there are some changes that do agree with what researchers note about the CVS. Some speakers show a backing and lowering process of the lax vowels, the average results show that /ɑ/ has raised and backed so as to occupy what would be the place of the /ɔ/ vowel which means that there has been a merging process of the *cot* and *caught*. However, the changes observed through my analysis do not reflect the chain-shift progression that characterizes the California Vowel Shift. The changes reflect that the speakers do show adjustments that are congruent with the CVS chain-shift but not all of them. For instance, the /ʊ/ and /u/ have not fronted since Hagiwara's research in 1997. Moreover, I believe that the most relevant change that is observed in the individual analyses of the participants' vowel production is that 3 out of the 5 speakers show that the /ʊ/ and the /ə/ are becoming more similar and in the rest of the speakers, some of the recordings reflect that, although they generally produce the /ʊ/ with a higher F1 frequency, they occasionally do merge the / ʊ/ and the /ə/ too. This could mean that, even though it is not established yet, these two vowels might merge in the future, although further research needs to be done in order to be able to confirm this shift. However, these results are not conclusive since the number of participants and the data are not enough to deem these changes as a general tendency in the whole Southern California area and the speakers themselves presented wide differences that might have had an effect on the final results when comparing them to the previous studies. What is relevant about this study is that I added data of the schwa which had not been widely studied before. For instance, Hagiwara's study, to which the average results are compared, does not provide any data for this vowel, but the data I gathered for the schwa in this research has helped me to illustrate matters such as the merging process of the the /ʊ/ and the /ə/, and a raising of the low vowels which results in vowels clustering to the center, where the schwa is.

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