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An acoustic analysis of the vowels of Hawai‘i English

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This paper provides an acoustic phonetic description of Hawai‘i English vowels. The data comprise wordlist tokens produced by twenty-three speakers (twelve males and eleven females) and spontaneous speech tokens produced by ten of those speakers. Analysis of these vowel tokens shows that while there are similarities between Hawai‘i English and other dialects, the particular combination of vowel realizations in Hawai‘i English is unique to this dialect. Additionally, there are characteristics of the Hawai‘i English vowel system that are not found in other English dialects. These findings suggest that Hawai‘i English is a unique regional variety that warrants further description.

1 Introduction

Though much has been written of dialects of English found in North America (e.g. Wells 1982, Olive, Greenwood & Coleman 1993, Clopper, Pisoni & de Jong 2005, Labov, Ash & Boberg 2006), the variety of English spoken in the Hawaiian Islands has received very little attention. As a necessary first step in documenting this unique dialect of English, this paper presents an acoustic analysis of the vowel systems of young adult Hawai‘i English speakers from the island of O‘ahu.

1.1 English in Hawai‘i

Though Hawai‘i is politically affiliated with the United States, the social demographics of Hawai‘i inhabitants are quite different than those of other areas in the country. In Hawai‘i, there is no clear numeric ethnic majority, and there is a wide diversity of first languages. In addition, many people from Hawai‘i align themselves with a ‘local’ identity, an identity that is tied with language, place, and ethnicity. This identity is salient to inhabitants of the state

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and distinct from mainland U.S. identity. At the same time, the state is highly influenced by mainland media and tourists from various English-speaking countries. As such, we believe that the circumstances exist for the variety of English spoken in Hawaiʻi to be quite different from varieties found in other parts of the world, but the specific linguistic features that make Hawaiʻi English different from other varieties has received little attention from scholars.

English was first spoken in Hawaiʻi in the 18th century, when sailors began to stop in the islands to trade. Before then, the population spoke Hawaiian; but as explorers, sailors, missionaries, and workers came to Hawaiʻi, they brought with them a variety of languages (including English), as well as trade pidgins. With the establishment of plantations, even more people arrived in Hawaiʻi, bringing with them the languages they spoke, including Cantonese, Japanese, Portuguese, and Filipino languages. These languages came into contact on the plantations, where many new pidgins formed. The most prevalent of these was Pidgin Hawaiian, which had Hawaiian as its lexifier and which was spoken into the 1890s (Siegel 2000). However, as American political influence in Hawaiʻi grew, so too did the influence of English, especially in education (Stueber 1964). As a result, the primary lexifier to the local pidgin became English. The children of the plantation workers nativized the pidgin into a creole (Robert 2004), which became known as Pidgin and is often referred to by linguists as Hawaiʻi Creole. Hawaiʻi Creole became the mother tongue of many inhabitants, while English was used in official capacities. Throughout the 20th century, efforts were made to further promote the use of English, particularly in academic settings. Both Hawaiʻi Creole and English continue to be used in the islands today (Drager 2012) and, given that many people speak both, it is likely that Hawaiʻi Creole and Hawaiʻi English have exerted some amount of influence on one another's structures (Sato 1985). Therefore, it is important to provide information about descriptions of both Hawaiʻi English and Hawaiʻi Creole that have been given in the literature, particularly because many of our speakers are speakers of both languages, and also because it is possible that some of the different phonetic realizations produced in the dialect of English in Hawaiʻi overlap with those found in the creole.

The small amount of documentation of Hawaiʻi English can be found in Sato (1993) and Hay, Drager & Thomas (2013). Sato describes a continuum of how Hawaiʻi Creole is spoken, and introduces Hawaiʻi English as one end of that spectrum. Sato (1993: 135) lists four features as indicative of Hawaiʻi English: fully realized vowels where schwa might be used in other dialects (e.g. 't[u]day'), stopping of the voiced interdental fricative, monophthongized mid vowels /e/ and /o/ where other varieties may have diphthongs, and the vocalization of syllable-final /ɹ/ (e.g. [k^hɑ] 'car'). The analysis of Hawaiʻi English low back vowels in Hay et al. (2013) shows overlapping realizations by young Hawaiʻi English speakers, suggesting that these sounds are merged in Hawaiʻi English. However, Hay et al. (2013) did not investigate any other Hawaiʻi English vowels, so little else is known about the vowel system. With the limited descriptions of Hawaiʻi English and with virtually no available acoustic data, it is important that a preliminary acoustic analysis of the vowels be undertaken.

It is possible, however, that phonetic realizations of Hawaiʻi English vowels are similar to those found in Hawaiʻi Creole. While there has been no acoustic analysis of the vowels of Hawaiʻi Creole as of yet, data obtained through auditory analysis by Sakoda & Siegel (2008) suggest that there are seven vowels in the basilectal Hawaiʻi Creole system. The FLEECE and KIT vowels have a single realization most similar to English FLEECE; DRESS and TRAP are not distinct and are realized most similarly to English TRAP; GOOSE and FOOT are not distinct and are realized similarly to English GOOSE; and LOT and STRUT are not distinct, and some speakers realize this single phoneme more similarly to English LOT and others more similarly to STRUT (Sakoda & Siegel 2008: 221–225). In addition, GOAT and FACE are sometimes monophthongal, but the realizations of Hawaiʻi Creole FACE and GOAT depend on context; FACE is monophthongal word-finally and before voiceless sounds, and GOAT is monophthongal word-finally and before /m/ (Sakoda & Siegel 2008: 223). Our data are compared with Sakoda & Siegel's description of Hawaiʻi Creole vowels in order to determine how similar the phonological systems of Hawaiʻi Creole and Hawaiʻi English are.

1.2 Vowel realizations in dialects of English

The present work illuminates how the English spoken in Hawai‘i fits into the greater picture of the phonetic variation found in other varieties of English, particularly those of North America.[1] North American varieties are likely candidates for sharing phonetic features due to the historical settlement of English-speaking Americans in the islands. Non-American varieties also have a history in Hawai‘i (Reinecke & Tokimasa 1934, Kent 1993). We have provided an overview of vowel systems found in these varieties in order to compare them with what we observe in our Hawai‘i English data, and we will return to these descriptions throughout the paper.

1.2.1 Front vowels in English

The short front vowels (KIT, DRESS, and TRAP) are involved in different shifts across the English-speaking world, and the direction of the shift depends largely on the region in which the variety is spoken. In the American North (New York, New England, the Inland North, and the Mid-Atlantic), TRAP is raised and diphthongal before both oral and nasal consonants (Labov 2001). Furthermore, KIT and DRESS, in the Inland North, are often realized in a centralized or, in the case of DRESS, a low-central position (Labov 2001, Labov et al. 2006). In the South, the short front vowels KIT and DRESS are realized as raised and tense, so that the pronunciation of *sit* and *set* approximate *see it* and *say it*, respectively; TRAP follows a similar trajectory to that found in the North (Labov et al. 2006: 243). In contrast, the short front vowels are lowering and retracting in the West (Eckert 2008, Kennedy & Grama 2012) and Canada (Clarke, Elms & Youssef 1995), except that, among Anglo speakers in California, TRAP appears to be raising in pre-nasal position (Eckert 2008). Outside the United States in New Zealand and Australia, the short front vowels are moving in the opposite direction. In New Zealand, KIT centralizes so that *fish* sounds like *fush*, and TRAP and DRESS are realized in raised, lax positions, so that *had* sounds like *head* and *head* sounds like *hid* (Watson, Maclagan & Harrington 2000). In Australia, KIT and DRESS are raising and tensing, so that *hit* sounds like *heat*, and *head* sounds like *hayed* (Harrington, Cox & Evans 1997, Cox 1999); the nucleus of TRAP, however, appears to be lowering and retracting (Cox 1999).

Realizations of FLEECE and FACE also vary according to region. In American dialects, FLEECE is generally realized as tense with a slight offglide, while FACE is realized with either a lax or a tense nucleus with an offglide (Wells 1982: 487). In the American South the nucleus of FLEECE and FACE are lower and laxer, as they participate in the Southern Shift (see discussion of KIT and DRESS in the previous paragraph). In addition, speakers of the North-Central dialect generally realize FACE as tenser and more monophthongal than the rest of North America (Wells 1982: 487). The pronunciations of FLEECE and FACE vary much more considerably in non-American English dialects; FLEECE is realized with a lax nucleus in Australian (Wells 1982: 597) and New Zealand English (Wells 1982: 607), and FACE is realized in both varieties with a front, low nucleus close to TRAP (Wells 1982: 597, 609). In some varieties of the British Isles (e.g. London), FLEECE tends to be diphthongal with a mid or high-mid nucleus (e.g. [əi]) in open syllables (Wells 1982: 366). FACE is realized with great range across the British Isles, as [eː] in the north (e.g. Leeds and Yorkshire) and [ʌɪ] in the south (e.g. Birmingham and London) (Wells 1982: 363–364).

[1] Note that we do not refer to Hawai‘i English as a dialect of American English. This is for geographic reasons (i.e. Hawai‘i is not located on either American continent) and political reasons (i.e. the illegal overthrow of the sovereign Kingdom of Hawai‘i and the subsequent annexation to the United States makes the classification a pointed one). Additionally, we would not want to categorize the dialect without first comprehensively examining it.

1.2.2 Back vowels in English

One of the most prominent ongoing changes in the Englishes around the world is the fronting (or centralizing) of the high, back vowel GOOSE. [2] GOOSE is fronted in post-coronal positions in North American English, with the exception of only a few dialect regions (Labov 2001, Labov et al. 2006: 152). GOOSE is also fronting in London, especially among non-Anglos (Kerswill et al. 2007), as well as elsewhere in England (Torgersen, Kerswill & Fox 2006), New Zealand (Maclagan et al. 2009) and in Australia (Harrington et al. 1997, Cox 1999: 9–10). The fronting of GOOSE in post-coronal contexts has to do with a glide between coronals and GOOSE that is no longer realized in most North American dialects. However, a difference in the vowel quality remains for some speakers, resulting in a fronter onglide in those cases where there would have historically been a glide (Labov et al. 2006: 150). Given the widespread occurrence of this fronting and the phonetic motivation for it, it would be unsurprising to observe front or at least central realizations of GOOSE in Hawai‘i. For many of the mainland American varieties in which GOOSE-fronting has been observed (such as in the Pacific North-West and California), GOAT is also fronted in post-coronal environments (Ward 2003, Hall-Lew 2009, Kennedy & Grama 2012). In fact, ‘in the history of many languages, the fronting of /o/ or /ow/ [GOAT] is found parallel to and somewhat behind the fronting of /u/ or /uw/ [GOOSE]’ (Labov et al. 2006: 155). Thus we might expect that if we observe GOOSE fronting in Hawai‘i, we would also find GOAT fronting, especially if the fronting of GOOSE appears to be well-established.

The behavior of the low back vowels LOT and THOUGHT is highly dependent on region. LOT and THOUGHT are largely distinct in the Commonwealth, with the notable exception of Scotland (Wells 1982, Stuart-Smith 2008), where they are merged. By contrast, the LOT–THOUGHT merger is quite common in the United States, for example, in the West of North America (Clopper et al. 2005, Labov et al. 2006), and these vowels are completely merged or undergoing merger in many other parts of North America as well (Gordon 2006, Baranowski 2007, Irons 2007, Bigham 2010), including Canada (Avis 1972, Roeder & Gardner 2013). In the North and the West, few speakers make a distinction in either production or perception (Labov et al. 2006: 264). In these cases, THOUGHT is said to have merged into the space of LOT.

In Midlands and California English, STRUT is realized in a fronted (Labov et al. 2006: 265) or centralized (Hinton et al. 1987, Eckert 2008: 34) position, respectively. However, in the North, STRUT is realized in a low back position (Labov et al. 2006: 188). In various dialects in the North of England, FOOT and STRUT are merged, so that both vowels are realized as high and lax (Wells 1982: 197), while some more conservative dialects realize FOOT before /k/ as high and tense (Wells 1982: 198). In some dialects across the English-speaking world (e.g. Scottish English), FOOT is realized as high and tense (Wells 1982: 133). That these changes in back vowels are so widespread across different English-speaking countries may suggest that these changes are more likely to also be evident in Hawai‘i English.

1.2.3 Diphthongs

Realizations of MOUTH and PRICE are also dependent on region. In the Northern U.S. and in Canada, these vowels participate in the Canadian shift, where the nuclei of these vowels are raised before voiceless obstruents (Chambers 1973). Elsewhere in the U.S. (e.g. the West, the Midlands, and the South), the nucleus of MOUTH is realized in a fronted position, a pattern which mirrors the fronting of GOOSE and GOAT throughout the country (Labov et al. 2006: 157). Furthermore, PRICE is realized as monophthongal in much of the Southern Midwest and the South (Labov et al. 2006: 129).

[2] Throughout the paper, we use Wells’ (1982) lexical set terms to refer to the vowel classes. Therefore, GOOSE refers to all instances of /u/ and does not specify the surrounding phonological environment.

2 Methodology

This study presents the vowels of speakers of Hawaiʻi English, reporting wordlist data as well as naturalistic data collected in casual conversational settings. While wordlist data provide a high level of control in regard to phonological environment and phrasal context, it is important to analyze spontaneous speech concurrently because spontaneous realizations of the vowels more authentically represent the phonetic realizations that are used outside of a laboratory setting. As such, a larger group of speakers' wordlist vowels were analyzed (to minimize the effect of outliers), and a subset of these speakers' spontaneous speech was also analyzed (to maximize naturalness). Results from both types of data are presented in this paper.

The interviews with each speaker were around one hour long and took place either where the speaker worked or on the university campus where they study. Interviewers were speakers of American English between the ages of 23 and 33 years who presently live in Hawaiʻi but are not from the islands. Using interviewers from other parts of America better ensures that participants will speak English throughout the interview and not switch into Hawaiʻi Creole. The interview questions were meant to elicit casual spontaneous speech from the speakers, and the interviewers worked to create a reciprocal conversational environment instead of strictly following a script so that the data would more closely represent an authentic conversation style. Following the interview, speakers read a short wordlist. The wordlist included vowels in a variety of phonological environments, but for this paper, only the vowels which were preceded by /h/ and followed by either a voiced or a voiceless coronal stop were analyzed, except for the CHOICE vowel, which was collected in the v_d frame to avoid including a non-word.[3] Recordings were made in a quiet room using either a Zoom H2 portable recorder or a Tascam DR-05, depending on availability. All recordings were made at a sampling rate of 44.1 kHz.

The wordlist data of 23 speakers were analyzed. All 23 were between the ages of 18 and 26 years at the time of the interviews; 12 speakers were male and 11 female. All of the speakers were born and raised on the island of Oʻahu and had not lived for an extended period of time anywhere else. From these 23 speakers, 10 (five females and five males) were selected for the analysis of spontaneous speech tokens as well. These speakers were between the ages of 19 and 24 years at the time of the interviews.

At least 20 minutes of each of the interviews were transcribed and time-aligned in Transcriber for analysis of spontaneous speech. The transcriptions and their corresponding audio files were then force-aligned at the segment level using the HTK (the Hidden Markov Model Toolkit) forced-aligner. For each vowel in the vowel system, a variety of phonological contexts and word types were chosen for analysis, with a maximum of 10 instances of a single lexical item used for each vowel for each speaker. Both function and content words were analyzed, but, for simplicity, only values from content words are reported in this paper. Vowels followed by /ɹ/ were not used because the forced aligner was not accurate in segmenting these environments, and they are notoriously difficult environments to consistently segment by hand. Vowel realizations in this context will be analyzed in future work. The textgrid and audio alignments were checked individually by hand for 100% of the tokens to ensure correct alignment, and any alignments that were not satisfactory were not analyzed for this study. If there was background noise or overlapping speech, the token was set aside and not analyzed.

A Praat script was created to extract information from the audio file and textgrid: the identity of the vowel, the word in which it appeared, the preceding and following environments, and the vowel's duration and mean f0. Additionally, readings of F1, F2, and F3 were extracted at seven points throughout the vowel: at 20, 30, 40, 50, 60, 70, and 80 percent through the

[3] Due to an error, the wordlist does not contain tokens of FOOT. Realizations of this vowel are reported for spontaneous speech and wordlist tokens containing this vowel will be collected and analyzed in future research.

duration of the entire vowel. The formant values were plotted, and outliers were checked for accuracy in Praat and discarded if deemed to be an incorrect reading. Three hundred and fifty-eight vowels from the wordlists were analyzed, and 2931 vowel tokens were examined from spontaneous speech.

Since seven readings were taken for each vowel, the data can be presented in different ways, including both midpoint values and vowel trajectories. Though average formant values at the midpoint of a vowel are valuable, vowels are not static segments; they are constituted by movement of the tongue, even during the production of a single segment. Vowels differ in their formant contours, and listeners use these differences to identify the vowel (Watson & Harrington 1999). In addition, spectral change is an important aspect of regional dialect variation (Fox & Jacewicz 2009). Readings from multiple points throughout the vowels can show us the direction and degree of the movement, telling us much more about the individual realizations of the vowels.

Formants' Hertz values are provided for reference in the appendix, but because all speakers have unique physiological traits related to the size and length of their vocal tracts, the plots contain normalized values. We use the Lobanov method of normalization due to its comparative advantage in preserving phonemic and social variation while reducing physiological difference (Adank, Smits & van Hout 2004). Using the same methods outlined for spontaneous speech, formant values were extracted from /h/-initial words in the wordlist for the four vowels at the corners of the English vowel space: *had*, *hot*, *heed*, and *who'd*. The mean and standard deviation of the vowels' midpoints were calculated, and these were used to normalize the formant values from both the wordlist tokens and the interview data. Wordlist recordings were used for calculating the speakers' vowel spaces because wordlist data tend to be less centralized and thus better represent the outer boundaries of a speaker's vowel space. Moreover, this ensured that the measurements used for normalization were comparable across speakers, since not all speakers produced all vowels in all phonological contexts during the interviews.

3 Hawai‘i English vowel spaces

3.1 Midpoint values

In order to examine the vowel system of Hawai‘i English, we begin by discussing vowel plots based on the midpoints of F1 and F2, for the wordlist data and for spontaneous speech. We then turn to plots of the first and second formant trajectories in order to investigate the possibility of differences in the movement of the vowels across time.

Figure 1 shows the median values of each vowel's temporal midpoint for both the wordlist and spontaneous speech data. Crosses extend to the interquartile values of each midpoint, showing the amount of variation in midpoint values across tokens and speakers (see Ferragne & Pellegrino 2010). Thus, each cross accounts for the inner 50 percent of the data analyzed, as an indicator of each vowel's central tendency and also its relative variability. In comparing vowel plots from the wordlist with those from spontaneous speech, the spontaneous data are more centralized than that from the wordlist. The high peripheral vowels FLEECE and GOOSE are lower in the space in the spontaneous data, and the low peripheral vowels are higher. The vowels along the front dimension are proportionally backer, while the vowels along the back dimension are fronter. For the most part, the difference between the formants of the vowels in spontaneous versus read contexts reflects the centralization that is related to shorter durations and less careful speech, though the difference exhibited in GOOSE is more than just centralization, as there is a great deal of variability in F2. The primary reason for this difference is the consonantal context effects that will be discussed later in this section, though another possible cause for this difference is the that GOOSE in particular has been shown to

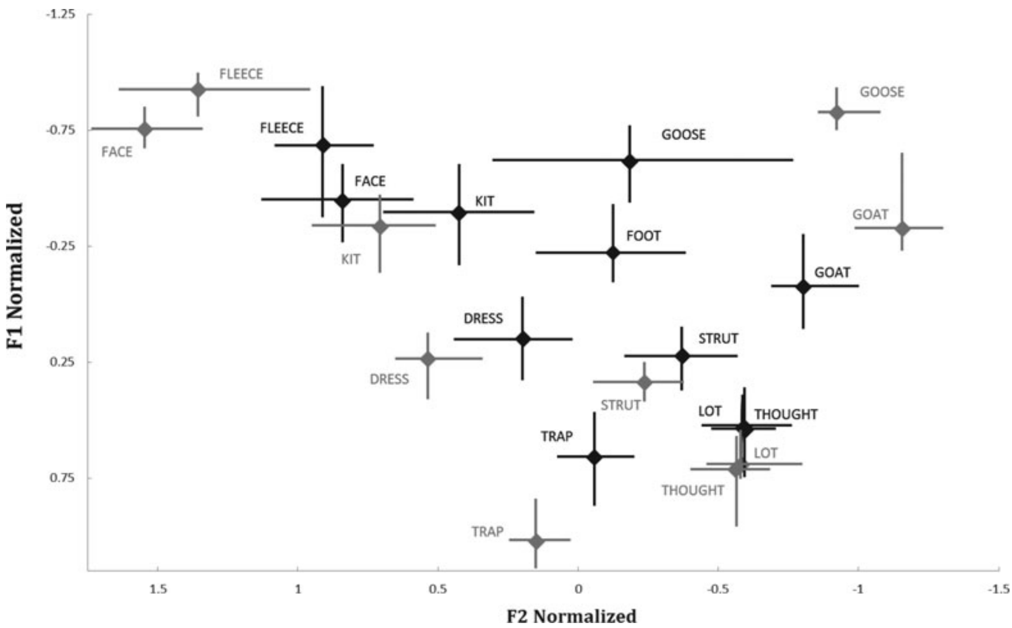

Figure 1 The medians and interquartile ranges of the midpoints of readings of the vowels taken from both the wordlists and interviews. Readings from the wordlist are shown in gray while readings from the interviews are shown in black.

exhibit atypical behavior in F2 due to environment and prosodic effects (Hillenbrand, Clark & Nearey 2000). Apart from centralization, there were few inconsistencies between the two types of data. We first discuss the consistencies, since we feel we can more safely say that these are characteristic of Hawai'i English, and we then turn to those where there is less (and in some cases very little) consistency across the two data elicitation types.

Evident in both sets of data is the merging of LOT and THOUGHT. Their medians are extremely close, with their interquartile ranges showing a great deal of overlap. The overlap of individual tokens is also shown in Figure 2, where LOT tokens are shown in gray while THOUGHT tokens are in black. The two vowels occupy the same space, though LOT seems to have a wider dispersion than THOUGHT. In addition, contrary to the result found in Hay et al. (2013), there was no distinction between pre-alveolar and non-pre-alveolar realizations. Both phonetic environments showed equal amounts of merging, as can be seen in Figure 3. Of the dialect regions included in the Atlas of North American English (ANAE), roughly half of them show a complete merger in all phonological contexts for LOT and THOUGHT. The merger appears to be advancing in most other areas as well, such as in New York (Dinkin 2011), New Jersey (Coye 2009), Missouri (Gordon 2006), and the South (Fridland 2001, Irons 2007). Our data show that Hawai'i also seems to be participating in this merger.

Another finding from this set of data is the realization of the short front vowels DRESS and TRAP. Though the status of KIT is unclear, as its realization seems to vary widely by speaker in our data, DRESS and TRAP are realized much lower in the vowel space than in some other dialects (see Labov et al. 2006: 78–82). As can be seen in Figure 1 above, in both the wordlist and the spontaneous data, the F1 median of the midpoint of DRESS is similar to that of STRUT and the median of the midpoint of TRAP is below that of LOT and THOUGHT. Thus, both DRESS and TRAP are quite low in the vowel space for these speakers. TRAP is also very close to STRUT in backness, showing that it has been backed to a central position. A similar change, the lowering and retraction of the short front vowels, KIT, DRESS, and TRAP, is found in the Canadian Shift (Clarke et al. 1995) and in the Californian Vowel Shift (Eckert 2008).

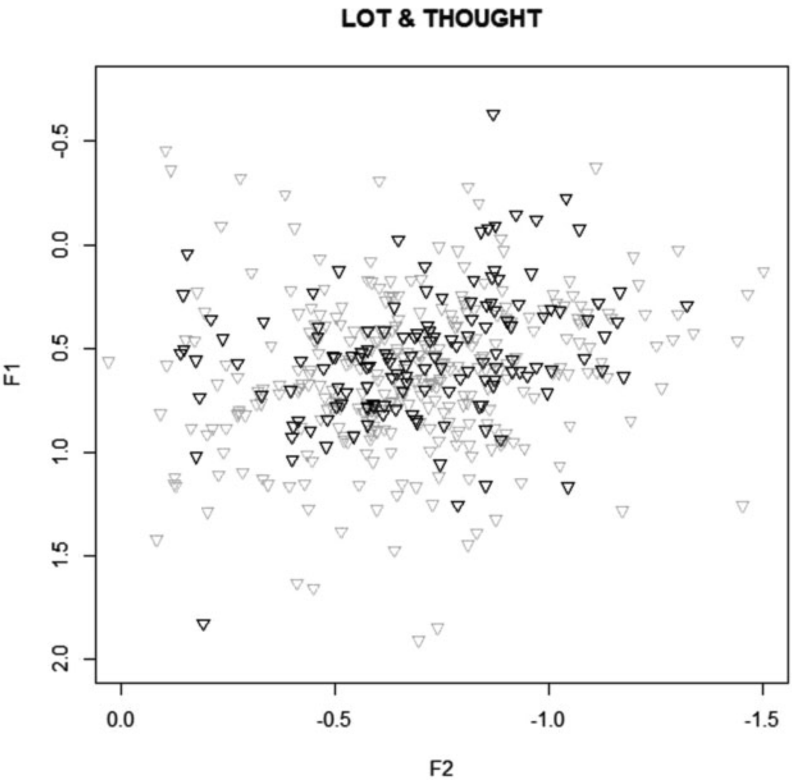

Figure 2 Dispersion of LOT and THOUGHT tokens for all speakers. The LOT tokens are shown in gray and the THOUGHT tokens are shown in black.

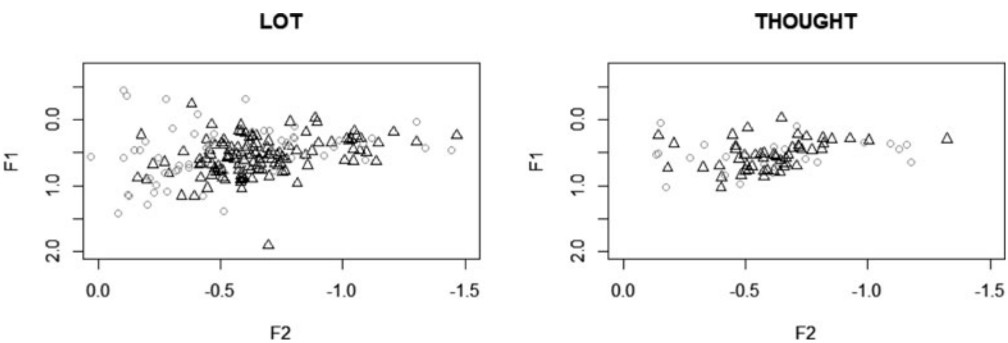

Figure 3 Dispersion of LOT and THOUGHT in pre-alveolar and non-pre-alveolar contexts. In each plot, pre-alveolar tokens are shown as gray circles while non-pre-alveolar tokens are shown as black triangles.

Labov et al. (2006) characterize the Canadian shift as a backing and lowering of DRESS and TRAP, made possible by the space made available because of the LOT–THOUGHT merger. The California Vowel Shift is characterized in Eckert (2008) as including a lowering and backing of the three vowels, though it is also marked by a fronting of STRUT, a feature which does not seem to be part of Hawai‘i English. Furthermore, according to Eckert, Anglo speakers raise TRAP before nasals, whereas Latinos produce back realizations of TRAP regardless of

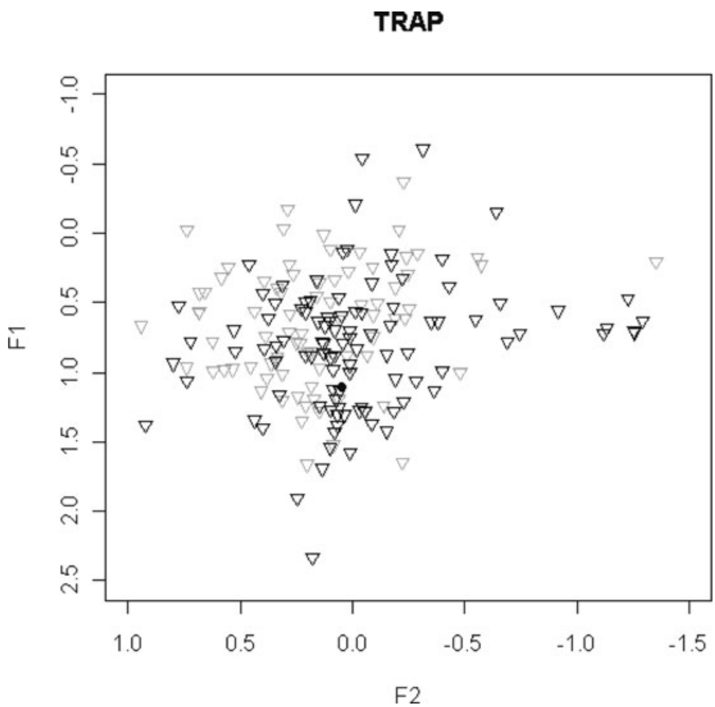

Figure 4 Pre-alveolar TRAP tokens for all speakers, showing the overlap between tokens that occur before nasal (gray) and non-nasal (black) segments.

context (Eckert 2008: 34).[4] We investigated this context in our data and found that TRAP is produced with a similar F1 in both pre-nasal and pre-oral contexts. Figure 4 shows instances of TRAP before a nasal in gray and before all other segments in black. The clouds of tokens occupy a similar place in the vowel space, and we do not observe the clear split evident in the Californian-Anglo data.

There are also some inconsistencies between the wordlist and spontaneous speech data shown in Figure 1, and these deserve special comment. As mentioned above, GOOSE appears to be realized differently across the data sets. We believe that this is due to a combination of the overall tendency to centralize vowels in spontaneous speech and an effect of phonological environment.[5] In Hawai‘i English, like many other varieties, GOOSE fronts in post-coronal position. This causes the distribution of readings of the second formant of GOOSE tokens to be spread out in the spontaneous data, as non-post-coronal tokens are not fronted. In the wordlist data, however, there are no post-coronal lexical items collected, so all GOOSE tokens are realized in the back of the vowel space. This difference provides an excellent example of the importance of collecting different types of data from participants, as wordlist data alone would not demonstrate the realization of GOOSE across contexts if those contexts were not included in the wordlist.

The tendency to produce fronted realizations of GOOSE is also seen in other dialects of English and is largely mediated by preceding context. Since there are only a small number of regions in the North and the East that do not show participation in this distinctive fronting (Labov et al. 2006: 152) and since there is phonetic motivation to front back vowels in this

[4] An investigation of the link between vowel realizations and ethnicity in Hawai‘i is currently underway.
[5] As mentioned previously, it could also be related to effects of prosody. As investigating this is beyond the scope of this paper, we leave this question to future research.

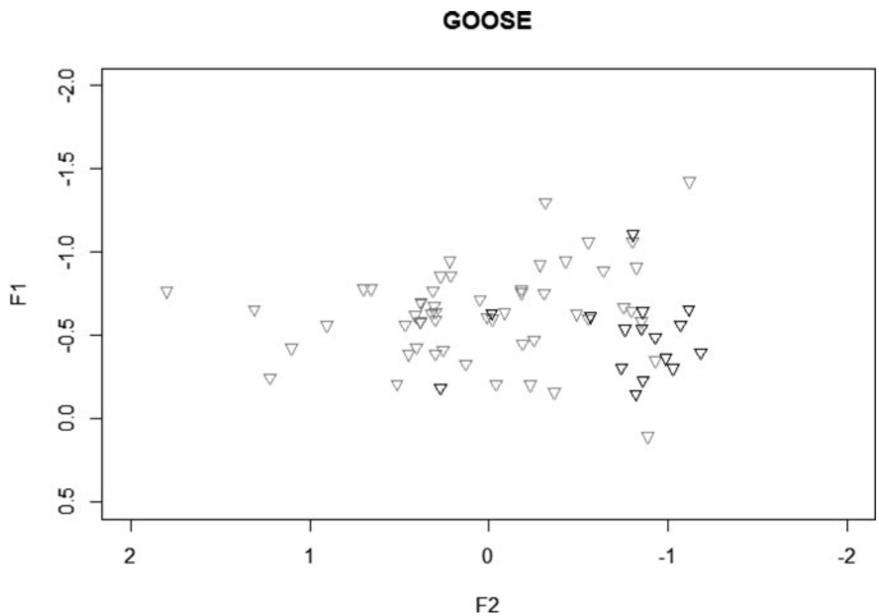

Figure 5 GOOSE midpoint tokens from the interview data for all speakers, showing how post-coronal vowels (in gray) are fronted.

context (Harrington, Kleber & Reubold 2011), it is not entirely unexpected that Hawai‘i would also participate in this change. Instances of GOOSE in Hawai‘i English seem to follow the same pattern as that found in other dialects, with higher F2 values at the beginning of the vowel, lowering as the vowel progresses. However, other regions participating in GOOSE fronting generally also participate in the fronting of GOAT in post-coronal environments (Labov et al. 2006). For our speakers, GOAT is back in all positions, regardless of preceding phonological environment. While post-coronal tokens may be realized in a slightly less back position, as shown in Figure 6, the difference between them is small and the post-coronal tokens are certainly not centralized. It is believed that the back and monophthongal quality of GOAT in Hawai‘i English (discussed further on) has a social significance, so this may be one reason for its resistance to fronting.

Finally, Figure 1 shows that the position of FACE in the vowel space is different across the two data types. For spontaneous data, FACE is found lower and slightly backer than FLEECE. For the wordlist data, however, FACE is realized in a fronter position than FLEECE; in fact, quite far front in the vowel space. Closer analysis of this difference shows that for the wordlist data, there is a great deal of overlap in the midpoint readings of the two vowels, with the outer readings pulling the averages of the two vowels away from one another; FACE to the front and FLEECE further back.

3.2 Trajectories

While midpoint values are informative, it is also possible for formant trajectories to play a role in, for example, maintaining distinctions between vowels, and the temporal midpoint may not be the best representation for some vowels. Thus, to explore the vowel realizations further and to examine the diphthongs, the trajectories of all of the vowels are presented in Figures 7 and 8 for wordlist and spontaneous speech data, respectively. The trajectories are calculated as means of the Lobanov normalized values from the seven equidistant points that were measured for each vowel. In Figures 7 and 8, a line is drawn between these seven points for each vowel. Drawing a line segment between measured points is used in lieu of a smoothed

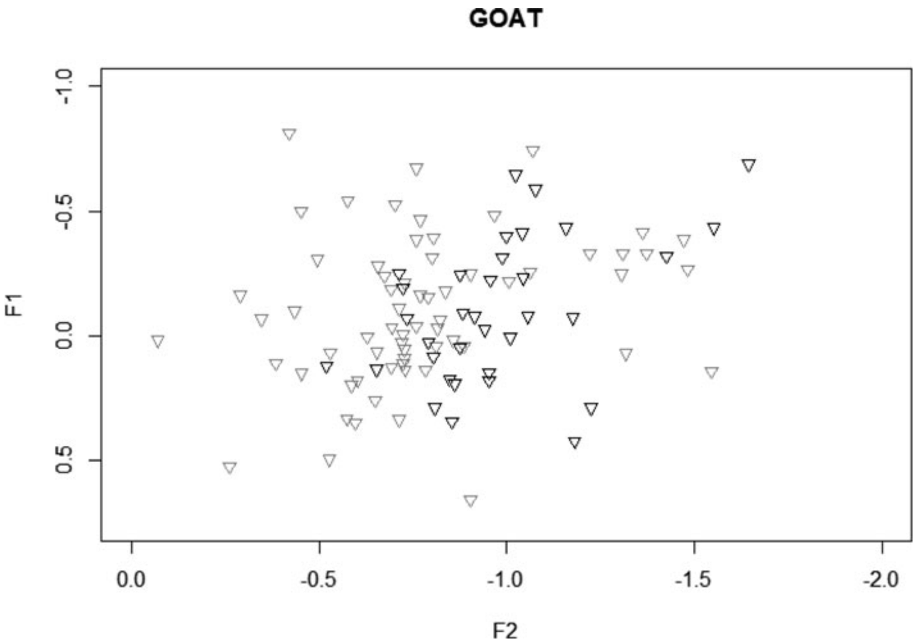

Figure 6 GOAT midpoint tokens for all speakers, showing how the distributions of vowels in post-coronal position (in gray) overlaps with tokens in non-post-coronal position (in black).

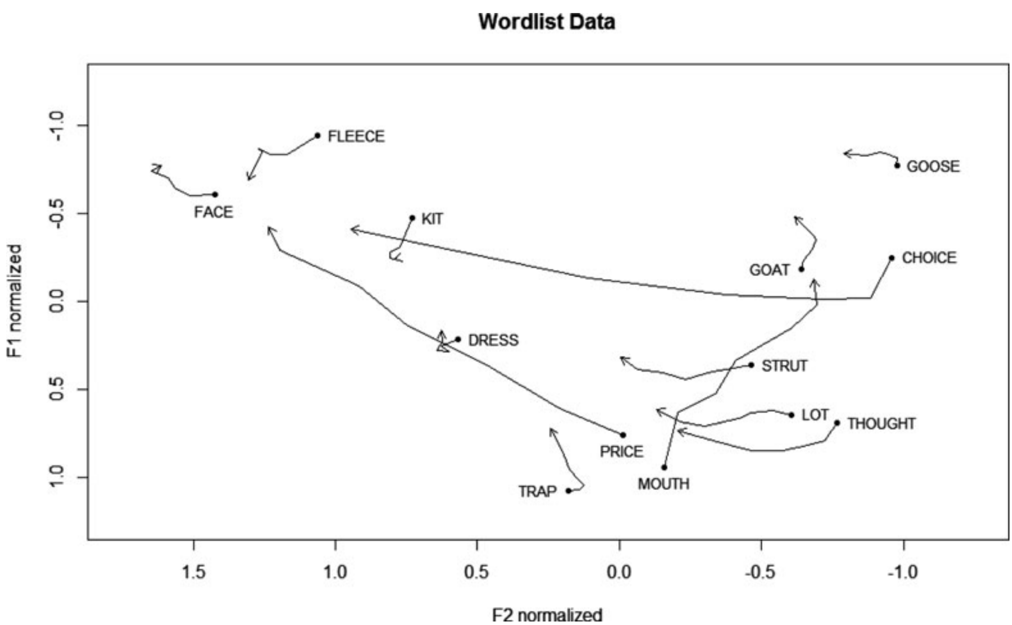

Figure 7 Trajectories of all vowels from the wordlist, based on the means of measurements taken at seven equidistant points within the vowels' durations

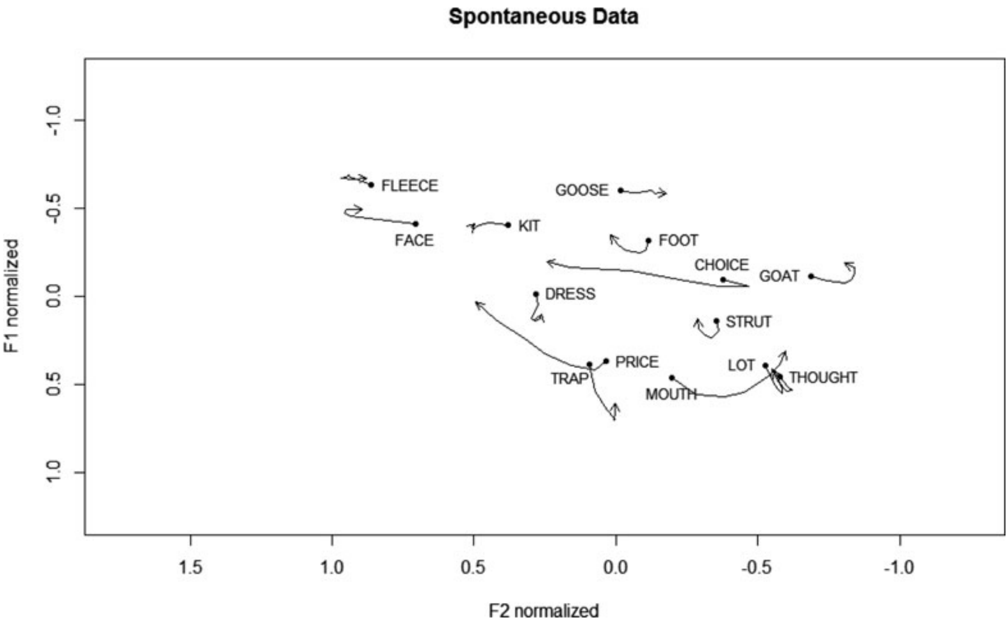

Figure 8 Trajectories of all vowels from the interviews, based on the means of measurements taken at even equidistant points within the vowels' durations

curve between the first and last measurements as it more faithfully represents our data. Furthermore, taking multiple measurements provides clearer information about the vowel's movement over its trajectory in comparison to, for example, taking two measurements (e.g. one at 20% and one at 80%). For example, Koops (2010) demonstrates that though Southern /u/ sounds monophthongal in perception, a close analysis of its trajectory behavior indicates that the vowel behaves more like a triphthong. In the current study, tables with the vowel durations and raw Hertz values at each of the seven points are provided in the appendix for each of the vowels.

Both CHOICE and PRICE are realized in a way that is typical of non-Southern American English varieties. Given our data, there is no marked difference between the CHOICE vowel in Hawai‘i and any other North American variety[6] (Labov et al. 2006: 96–97). PRICE has a raised nucleus and offglide when preceding voiceless obstruents, though this difference is not nearly as pronounced as that found in Canadian English (Labov 2001). The trajectories of MOUTH are quite different across the data sets. In the spontaneous speech data, MOUTH begins in the F1-F2 space of the low and back realizations of TRAP and moves into the space of LOT, and the movement of the vowel is toward the back of the vowel space rather than an upward movement. Compared to the normalized values for /aw/ in the ANAE, the nucleus of Hawai‘i English MOUTH in the spontaneous data appears to be backer and higher than what is found in many other dialects (compare Labov et al. 2006: 105). The realization of MOUTH in the wordlist data begins lower in the vowel space and moves all the way into the space of GOAT. It moves back simultaneously, but to a much lesser degree than in the spontaneous data, where much of the movement is along the front/back dimension. Therefore, the realization of MOUTH from interview data is different than that found in other varieties whereas the wordlist data are similar.

[6] As CHOICE is a less common vowel, we have only 23 tokens of this vowel in the data from the interviews.

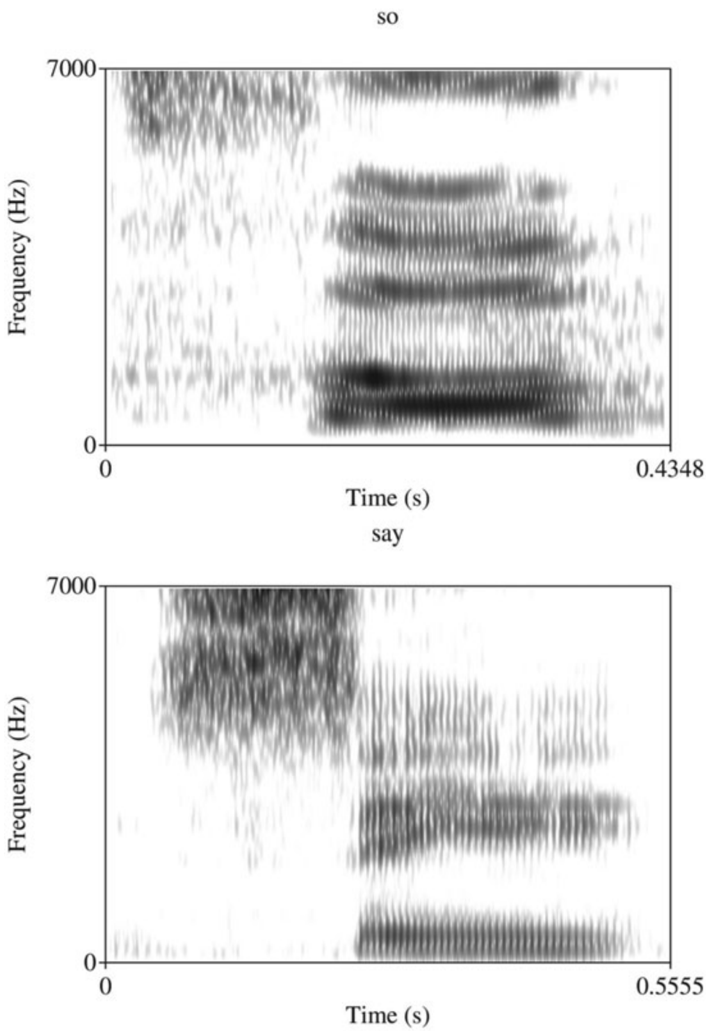

Figure 9 Female speaker saying ‘so’ with a monophthongal realization of GOAT (top), and male speaker saying ‘say’ with a monophthongal realization of FACE (bottom).

Note that the trajectories of both GOAT and FACE are very short in the data from both the wordlists and the interviews, particularly when compared to PRICE, CHOICE, and MOUTH. A typical GOAT vowel shows very little spectral change. This lack of spectral change is apparent in the top spectrogram in Figure 9, which is from a female speaker’s pronunciation of *so*. The FACE vowel reveals a similar lack of spectral change, as demonstrated by the spectrogram of a male speaker saying *say* shown in the bottom spectrogram in Figure 9.

As mentioned above, Hawai‘i Creole shows a differentiation in phonetic environments wherein GOAT and FACE are realized as monophthongal, GOAT word-finally and before /m/ and FACE word-finally and before voiceless sounds. While in Hawai‘i English, there seems to be little difference in the amount of movement of FACE in each of these conditions, word-final and pre-bilabial GOAT segments are more monophthongal in Hawai‘i English than other segments, suggesting that attention to phonological context may be carried over from Hawai‘i Creole in the case of GOAT only. If the monophthongal realizations have been borrowed from Hawai‘i

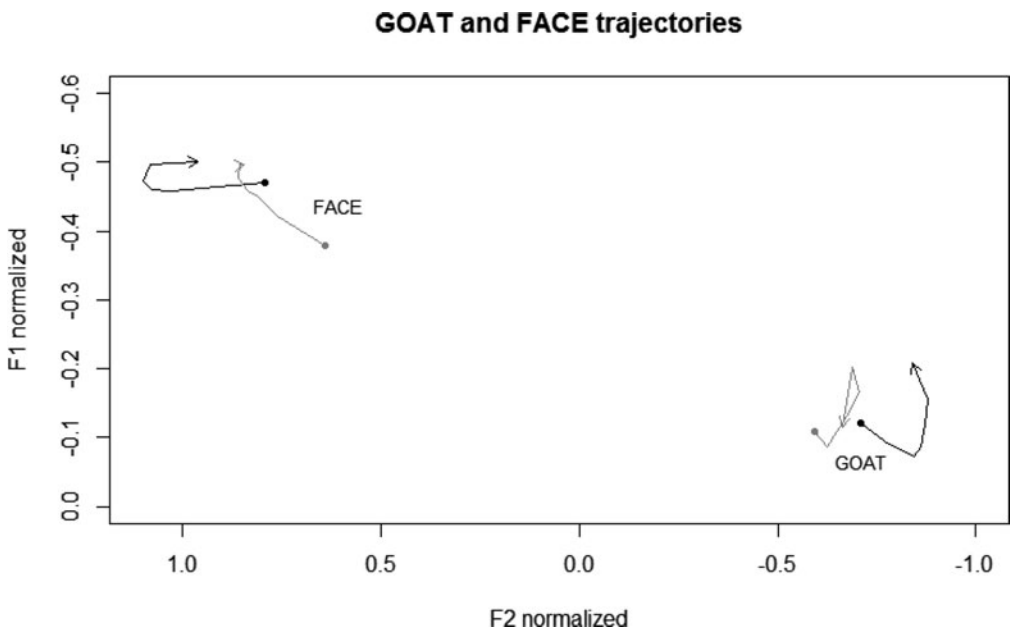

Figure 10 FACE and GOAT trajectories for all speakers. Word-final and pre-voiceless tokens of FACE are shown in gray, and word-final and pre-bilabial nasal tokens of GOAT are shown in gray.

Creole, most speakers appear to have generalized monophthongization to all instances of FACE after transfer. These relationships are shown in Figure 10.

The monophthongal quality of the Hawai‘i English GOAT vowel is not entirely unique to Hawai‘i, nor is the monophthongal quality of FACE. These two vowels are realized without their upglides in parts of the Northern Midwest, and are lengthened and most common before voiceless consonants (Gordon 2004). Several researchers view the monophthongal realizations found in these varieties to be consequences of language contact, and Thomas (2001) notes that places where GOAT and FACE are realized in this way are regions that have had high numbers of second language speakers. While the languages of influence may be different in Hawai‘i and the Northern Midwest, Hawai‘i English has been in constant contact with other languages over an extended period of time, and many of these languages also have monophthongal /o/ and /e/ (e.g. Japanese, and Hawai‘i Creole).

5 Conclusion

This study has provided an acoustic analysis of the vowels of the dialect of English spoken in Hawai‘i, highlighting the ways that Hawai‘i English is different than other varieties of English, while also noting similarities. The realizations of vowels in Hawai‘i English are found in varieties of English spoken in the continental United States. The amalgamation of the various realizations, however, is not found elsewhere. The similarities between Hawai‘i English and other dialects referred to above involve regions throughout the Northern and Western dialects of North America, and the vowel system described herein does not behave exactly as any of these regional varieties. There are many influences on language use in Hawai‘i, including political ties, tourism, immigration, and geographical isolation. Thus, we might expect that English in Hawai‘i would be affected by any or all of these factors, and that people born and raised in Hawai‘i might speak a unique variety of English. We hope that this paper sets the groundwork for the continuation of acoustic phonetic work in Hawai'i English (on the consonants, vowels, intonation patterns, and the socially meaningful ways in which these realizations may vary), and that these data serve as a foundation in understanding the dialect.

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Appendix. Frequency values

Frequency values from spontaneous speech for 1st and 2nd formants for both male and female speakers at 20%, 30%, 40%, 50%, 60%, 70%, and 80% through the duration of the vowel

Table A1 Females' mean F1 values, collected from wordlists, at seven points throughout the vowel, shown in Hertz.

Segment	Dur. in ms	20%	std dev	30%	std dev	40%	std dev	50%	std dev	60%	std dev	70%	std dev	80%	std dev
FLEECE	281	386	60	395	69	393	73	397	74	388	67	382	68	484	69
FACE	226	456	38	446	24	435	24	435	31	427	31	425	37	424	43
KIT	210	502	89	531	80	538	80	552	87	556	80	558	79	561	78
DRESS	215	700	86	707	76	706	74	713	70	707	72	693	76	673	86
TRAP	242	964	116	948	120	947	123	941	115	914	108	882	106	845	118
STRUT	131	712	102	723	80	738	71	750	73	743	66	735	58	714	68
GOOSE	196	415	44	416	38	413	53	407	53	405	62	406	52	405	62
GOAT	321	601	73	571	105	534	100	505	93	480	73	471	69	476	68
LOT	178	809	107	820	126	823	110	842	116	832	119	812	95	789	95
THOUGHT	126	810	111	830	97	829	110	839	97	832	89	812	91	797	99
CHOICE	305	549	58	592	103	592	102	585	85	558	70	517	73	505	92
PRICE	269	846	125	806	141	728	141	663	146	597	114	537	101	499	99
MOUTH	269	858	206	813	161	778	142	730	143	659	125	622	107	594	82

Table A2 Females' mean F2 values, collected from wordlists, at seven points throughout the vowel, shown in Hertz.

Segment	20%	std dev	30%	std dev	40%	std dev	50%	std dev	60%	std dev	70%	std dev	80%	std dev
FLEECE	2474	546	2577	423	2620	417	2630	402	2655	389	2632	360	2608	367
FACE	2620	336	2695	253	2746	238	2793	232	2816	236	2811	244	2776	321
KIT	2158	357	2186	324	2191	307	2176	281	2165	281	2150	277	2135	260
DRESS	2041	273	2049	249	2056	238	2041	209	2052	203	2029	192	2046	182
TRAP	1831	178	1797	168	1776	155	1805	143	1822	148	1843	133	1889	111
STRUT	1425	169	1472	184	1528	177	1589	192	1644	195	1693	208	1739	218
GOOSE	1097	223	1064	199	1082	161	1098	155	1107	177	1126	204	1182	296
GOAT	989	87	994	82	983	60	981	103	1006	143	1009	138	1024	167
LOT	1325	166	1310	196	1350	189	1393	169	1494	210	1592	215	1650	235
THOUGHT	1217	123	1235	104	1274	125	1343	148	1440	184	1543	228	1614	235
CHOICE	1164	396	1218	384	1310	395	1529	445	1839	505	2066	521	2222	435
PRICE	1692	299	1824	343	1958	375	2122	376	2191	471	2464	347	2411	480
MOUTH	1560	298	1547	309	1484	318	1450	377	1298	345	1246	367	1226	398

Table A3 Males' mean F1 values, collected from wordlists, at seven points throughout the vowel, shown in Hertz.

Segment	Dur. in ms	20%	std dev	30%	std dev	40%	std dev	50%	std dev	60%	std dev	70%	std dev	80%	std dev
FLEECE	240	330	48	350	79	352	85	347	84	340	79	350	86	349	80
FACE	207	416	50	416	65	405	68	384	67	374	60	372	71	362	61
KIT	195	430	61	463	84	469	81	472	85	471	84	470	79	467	73
DRESS	177	562	65	577	82	585	80	585	82	590	70	578	81	569	82
TRAP	190	754	103	768	103	761	113	751	120	745	127	727	126	696	127
STRUT	131	608	87	608	68	606	59	607	54	605	55	600	59	586	58
GOOSE	171	369	52	367	57	356	59	355	64	351	66	358	71	352	66
GOAT	248	498	58	495	95	489	95	485	95	492	107	484	126	452	101
LOT	163	663	130	675	149	676	155	678	163	701	140	701	142	694	146
THOUGHT	109	676	97	697	82	709	88	716	91	720	87	712	91	701	85
CHOICE	376	483	87	518	50	523	49	526	51	513	58	467	65	433	64
PRICE	218	681	104	654	96	610	101	567	112	519	117	474	106	447	97
MOUTH	246	742	131	709	156	687	141	640	110	607	113	574	111	520	80

Table A4 Males' mean F2 values, collected from wordlists, at seven points throughout the vowel, shown in Hertz.

Segment	20%	std dev	30%	std dev	40%	std dev	50%	std dev	60%	std dev	70%	std dev	80%	std dev
FLEECE	2057	511	2085	508	2099	496	2111	503	2133	503	2134	481	2166	417
FACE	2185	320	2237	308	2250	306	2242	302	2281	286	2282	286	2280	276
KIT	1857	344	1878	318	1896	323	1906	283	1898	284	1898	288	1917	294
DRESS	1765	323	1816	277	1803	273	1797	291	1814	301	1811	287	1800	296
TRAP	1583	220	1569	207	1565	214	1558	201	1579	201	1583	185	1592	185
STRUT	1225	214	1252	197	1282	192	1325	192	1360	202	1413	211	1434	205
GOOSE	937	201	963	191	947	195	963	184	989	188	1026	201	1060	229
GOAT	1099	655	1084	667	1063	682	1046	720	1034	730	1048	737	1087	725
LOT	1140	221	1184	211	1210	225	1218	246	1273	259	1279	244	1325	231
THOUGHT	1076	127	1108	150	1128	147	1158	145	1199	165	1256	196	1313	194
CHOICE	849	277	877	276	981	279	1172	206	1452	247	1859	325	2005	240
PRICE	1445	233	1569	263	1715	346	1862	373	1967	392	2075	385	2135	372
MOUTH	1348	242	1316	264	1234	224	1181	243	1107	251	1057	252	1074	305

Table A5 Females' mean F1 values, collected from interviews, at seven points throughout the vowel, shown in Hertz.

Segment	Dur. in ms	20%	std dev	30%	std dev	40%	std dev	50%	std dev	60%	std dev	70%	std dev	80%	std dev
FLEECE	104	464	123	456	103	455	102	453	98	455	124	450	108	448	103
FACE	115	507	112	496	83	490	71	488	70	485	70	483	69	479	72
KIT	78	520	106	513	81	515	76	518	78	523	81	519	80	514	81
DRESS	77	630	126	652	106	668	102	679	99	679	111	677	104	663	109
TRAP	112	750	154	800	154	838	157	855	159	860	155	850	156	834	151
STRUT	81	692	120	712	116	723	112	726	108	721	104	712	99	698	99
GOOSE	91	461	67	467	93	467	76	461	84	466	79	465	82	465	88
FOOT	91	581	91	598	92	605	91	603	97	600	104	596	106	585	106
GOAT	88	588	93	593	91	589	97	584	95	578	93	570	102	563	109
LOT	120	773	141	805	154	829	154	841	160	832	149	821	152	795	151
THOUGHT	105	760	121	774	119	787	118	795	126	800	126	787	128	768	124
CHOICE	140	586	51	607	53	617	63	607	69	605	59	604	67	598	77
PRICE	129	757	167	769	163	764	157	741	148	710	141	672	136	636	132
MOUTH	154	743	178	783	156	791	140	792	144	761	140	742	130	716	130

Table A6 Females' mean F2 values, collected from interviews, at seven points throughout the vowel, shown in Hertz.

Segment	**20%**	std dev	**30%**	std dev	**40%**	std dev	**50%**	std dev	**60%**	std dev	**70%**	std dev	**80%**	std dev
FLEECE	2295	291	2364	273	2356	283	2363	272	2403	303	2349	296	2322	330
FACE	2151	351	2255	360	2294	347	2318	365	2337	354	2345	356	2314	392
KIT	2013	267	2059	243	2081	245	2093	241	2090	252	2095	239	2087	250
DRESS	1877	262	1865	253	1877	231	1874	211	1860	227	1847	251	1841	243
TRAP	1752	238	1726	242	1691	224	1671	205	1669	200	1658	214	1655	208
STRUT	1512	252	1512	238	1531	221	1540	211	1555	209	1576	210	1581	216
GOOSE	1693	385	1671	382	1642	413	1589	441	1582	436	1567	444	1551	448
FOOT	1637	324	1645	306	1662	299	1664	297	1677	298	1699	291	1716	293
GOAT	1192	234	1183	223	1166	210	1147	201	1142	193	1146	193	1133	198
LOT	1411	272	1386	237	1366	236	1353	219	1353	226	1361	236	1378	245
THOUGHT	1247	185	1236	165	1238	160	1250	156	1255	158	1272	151	1298	145
CHOICE	1327	433	1286	422	1342	412	1423	383	1550	392	1718	421	1758	473
PRICE	1700	272	1735	280	1798	302	1866	304	1912	311	1973	325	2025	340
MOUTH	1549	277	1478	278	1405	272	1368	254	1312	227	1295	211	1263	225

Table A7 Males' mean F1 values, collected from interviews, at seven points throughout the vowel, shown in Hertz.

Segment	**Dur. in ms**	**20%**	std dev	**30%**	std dev	**40%**	std dev	**50%**	std dev	**60%**	std dev	**70%**	std dev	**80%**	std dev
FLEECE	85	401	105	382	59	382	61	387	63	390	61	395	63	395	65
FACE	110	457	77	457	55	455	56	454	59	449	66	440	64	443	70
KIT	72	453	69	450	51	455	49	458	51	457	51	455	52	452	52
DRESS	73	546	81	558	67	566	65	572	66	574	67	573	69	569	73
TRAP	115	644	85	671	75	684	73	691	71	691	73	682	75	667	77
STRUT	74	572	68	581	59	588	55	587	53	583	54	575	59	563	68
GOOSE	76	400	61	399	51	402	49	402	53	405	57	404	62	404	68
FOOT	65	477	54	486	50	489	50	489	53	487	65	479	67	461	70
GOAT	104	505	90	513	71	521	60	517	57	507	56	496	67	489	71
LOT	106	623	67	635	61	641	65	642	67	638	75	625	79	616	77
THOUGHT	104	624	72	636	54	637	59	637	57	634	66	623	65	606	74
CHOICE	158	537	55	540	45	529	46	515	49	486	70	473	86	456	90
PRICE	131	624	79	635	74	629	75	618	81	603	85	586	84	567	85
MOUTH	161	663	90	666	72	663	63	651	69	641	71	624	70	612	98

Table A8 Males' mean F2 values, collected from interviews, at seven points throughout the vowel, shown in Hertz.

Segment	**20%**	std dev	**30%**	std dev	**40%**	std dev	**50%**	std dev	**60%**	std dev	**70%**	std dev	**80%**	std dev
FLEECE	2114	239	2155	216	2161	192	2165	189	2155	190	2141	194	2102	246
FACE	1947	347	2011	301	2049	285	2070	282	2085	288	2071	312	2039	308
KIT	1656	310	1698	285	1720	262	1727	249	1747	246	1749	241	1743	244
DRESS	1652	297	1649	256	1663	229	1682	215	1688	200	1681	227	1684	224
TRAP	1550	216	1555	170	1542	161	1531	161	1544	166	1555	173	1557	187
STRUT	1222	205	1212	178	1224	179	1231	182	1240	183	1245	185	1243	201
GOOSE	1364	374	1323	400	1330	387	1322	386	1322	386	1326	386	1315	364
FOOT	1393	308	1395	291	1411	272	1443	266	1470	276	1482	285	1503	297
GOAT	1057	353	998	305	944	169	938	154	925	156	921	170	971	270
LOT	1121	177	1116	162	1110	157	1106	153	1107	156	1115	164	1116	179
THOUGHT	1148	210	1127	173	1115	152	1127	146	1129	138	1149	139	1163	141
CHOICE	1265	428	1204	272	1276	234	1386	284	1418	312	1409	359	1560	550
PRICE	1505	300	1516	268	1552	250	1607	253	1660	266	1734	300	1768	318
MOUTH	1289	214	1246	172	1199	163	1135	146	1091	141	1056	136	1076	180

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