VARIATION AND CHANGE IN HAWAIʻI CREOLE VOWELS

A DISSERTATION SUBMITTED TO THE GRADUATE DIVISION OF THE UNIVERSITY OF HAWAIʻI AT MĀNOA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF

DOCTOR OF PHILOSOPHY

IN

LINGUISTICS

MAY 2015

By

James M. Grama

Dissertation Committee:

Katie Drager, Chairperson
Victoria Anderson
Robert Blust
Patricia Donegan
Marta Gonzalez-Lloret

Keywords: Hawaiʻi Creole, Pidgin, variation, change, vowels

To the people of Hawai‘i, whose
stories have guided this research.

ACKNOWLEDGEMENTS

This has been quite the experience. For as long as I have been in the business of reading dissertations, I have loved reading the acknowledgements that foregrounded the research. For all the wonderful insights and new ideas cultivated in the hundreds of pages of thought-provoking research, it was in the acknowledgements where the human face of the dissertation shined brightest. The more I thought about writing my own acknowledgements, the more I realized that I love reading them so much not just because they are outpourings of love and affection for the people in the author's life, but also the acknowledgements are the place where I can unapologetically recognize every person that has helped make this work what it is. A dissertation (and really, all research) is as much a product of the person that writes it as it is a product of the data discussed, and no person does anything as daunting and involved as a dissertation alone. In a significant way, these people, my friends and family, are every bit as responsible for this dissertation as I am. I thank you, I love you, and I can never express my full gratitude for each and every one of the people who have contributed to my life (and this dissertation, specifically) in such positive ways.

There are so many people I want to thank, and I am afraid any attempt to relegate my gratitude to these few pages will fall woefully short of what I actually feel. So, while I've sometimes been accused of being a bit wordy, I can think of no better section to place my words than here. In these short pages, I wish to thank these people directly, as much as I reasonably can. This dissertation is as much theirs as it is mine:

> Melody Ann Ross – Thank you for being my partner, my happiness, my most vocal supporter, my most understanding critic, my willing editor, my sounding board, my caretaker, my friend, and my love. You have been all the things I wanted and all the things I never thought I needed, both in writing this work and in life. You have endured my struggles, celebrated my victories, and you have never wavered in your support of me. Without you, this dissertation would have never been written. I am a better person for knowing you, a happier person for being with you, and I know that "via a discussion", with you, anything is possible.
>
> My parents – Your love and support have been offered generously and unconditionally. You have always allowed me to find my own path, and I cannot thank you enough for the guidance and perspective you have so willingly and selflessly offered my entire life. That you've shown an interest in what I have chosen to do with my life is something I can never repay you for, and it speaks volumes about the people you are. I love you and thank you for this and so much else.
>
> Karrie, Bryan, Levi, and Lily – Your love and understanding have meant the world to me. The trips to San Diego to see the whole family have grounded me in a way I can scarcely articulate. You are beautiful, caring people, and I can't thank you enough for the constant vows of love and support you have given me.
>
> Katie Drager –Without you, I would not be a linguist. You have molded and guided my understanding of linguistics, research, and to a large extent, life and how to live it. Every

conversation we have ever had has expanded my world view, and you have always challenged me to push boundaries and test myself in ways I never considered. I cannot begin to detail my indebtedness to you for being not only the type of researcher I want to be, but the kind of adviser and mentor I want to be. Beyond that, you have been a consistent voice of reason and support, a caring confidante and friend. It means so much to me that you have invited me so many times into your home and treated me so well. Keola and Paʻi are lucky to have you. This space does not afford me adequate room to thank you completely, but suffice it to say that I will always treasure not only what you have taught me, but the way in which you have taught it to me.

Patricia Donegan and David Stampe – You have always been watchful supporters and eager conversationalists. I look fondly on the long discussions we have had about vowels, (non-?) chain shifts, music, and some of the more whimsical aspects of life. You have both offered your advice without hesitation, and your perspectives have greatly impacted my own. The times spent with you both over the past six years have been irreplaceable, and you are both role models and wonderful friends.

Robert Blust – Without you, I would have a duller eye for detail and be a much less-developed writer. You have contributed substantially to my development as a scholar and a person, and you are the very model of the thoroughness I wish to cultivate in my own research. I will always be thankful for the insights you've lent me and for being in my corner.

Victoria Anderson – Your devotion and help over the years is matched only by your tireless and unwavering passion for life and your work. You are one of the most dedicated teachers I have ever met, and the passion you have for what you do is infectious. Every interaction with you has taught me something new, brightened my day, and helped put things into perspective. Thank you.

Marta Gonzalez-Lloret – Thank you for your support, flexibility and availability during this process. This work and its author has benefited greatly from your insights and assistance.

Mary Walworth – You were a friend as soon as I met you. From the hours we spent in Unit Mastery, battling through problem sets, to somehow fitting life around countless days under abrasive fluorescent lighting (which motivated such insightful comments as "woof" and "meow"), you have been there for and with me. I have always benefitted from and looked forward to the levity and perspective you've brought into my life, as well as the dedication you have to everything you do. I could not have done any of this without you, and I am so grateful for our friendship.

Kent Sakoda – You are one of the most genuine and generous souls I have ever known. Our conversations over the years have only made me wish that I met you earlier in life. Your insights, and friendship have been invaluable to me, and I can't thank you enough for your vocal support of this project.

My participants – I do not personally know any of you, but I have listened to your personal stories, your laughter and struggles, accounts of your loves and losses, hopes

and regrets, triumphs and failures. Without knowing it, you have invited me into your lives. Some of you have since passed on, and your stories and memories are merely a part of what is left of you. Many of you have only just begun to make an imprint on the world. But none of you, who I have come to know from afar, are mere data points to me. Despite never personally knowing you, I feel each of you has made an impact on my own life and I have learned much from you. I thank you for allowing your stories to be shared, and I will ever remain in awe of how beautiful, complex, and sometimes heartbreaking those stories can be.

Joelle Kirtley – The hours we've spent together have enriched me as a person and a linguist. The conversations we have had over the now six years (and counting!) we've known each other will ever be among my fondest memories in grad school. Your friendship, feedback, and your support, as well as your eagerness to be a sounding board during this process (and throughout grad school) has been irreplaceable and immense.

Bob Kennedy – Without your interest and faith in me as an undergraduate student at the UC Santa Barbara, I would never have been motivated to pursue linguistics further. Your class on dialectology will forever be one of the most transformative experiences of my life, and I in no small part owe my entrance into linguistics to you. Deebs, Bob.

My "linguists in crime" (in no particular order), John Van Way (my accountabilibuddy and close friend), Chae-eun Kim (my *nuna*), Mike Clauss, Stephanie Locke, Tobias Bloyd, Bodo Winter, Bing Feng, Jonathan Kuo, Hyunah Ahn, Hannah Rosenberg-Jones, Nala Lee, Katie Gao, Mónica Vidal, Tom Dougherty, Raina Heaton, Mayumi Oiwa, Kate Hardeman-Guthrie, Nozomi Tanaka, Rachel Schutz, Sean Simpson, Kavon Hooshiar, Jonny Kim, James Crippen, On-soon Lee, Eve Okura, Hiroko Sato, Akiemi Glenn, Kanjana Thepboriruk, Kaori Ueki, and Heeyeon Dennison – Each of your voices has contributed in a large way to my own, and I am greatly indebted to you for your friendship. I can't believe how lucky I am to call you colleagues and friends for the rest of my life.

Bethany Chun Comstock – Thank you for your insights on the lack of gender differences in Pidgin. Your observations have significantly improved the quality of this study.

Jen and Nora – Without you, the department would crumble. Thank you for always knowing the answer to everything, for always being willing to help, and for being the most patient souls ☺.

Chris Atashian – You have been a genuine, unwavering friend for as long as I care to remember. Thank you for knowing me well enough to ask me the perfect questions about my dissertation, like, "are you done with your homework yet?"

Bryan Gonzalez – You have been a remarkable friend, and I can't thank you for that enough. You have brought welcome diversions, much-needed levity, and you've always somehow known when I've reached my limit and needed a break.

Dan Smith – I don't know what I'd do without the co-founder of the "Dissertation, Drawing, Drinks…and maybe some other alliterative words" group that got me through so many long days.

And to the following people, who have helped and supported me in more ways than you know over the past years:

Chris Packer
Andres Sistos
Varty Hindoyan
Andrea Berez
Christina Higgins
Alicia Beckford Wassink
Evelyn Reder
Lyle Campbell
Kamil Deen
Hassan Naveed
Aaron Tarbell
Penny Eckert
Matthew Stone
Todd Davis
Gavin Furukawa
Mary Bucholtz
Nancy Schmicker
Emily Krause
Amelia Weldon
Eifeh Strom
Hunter Hatfield
Britney Carey
Jorge Emilio Rosés Labrada
John Witkowski
Lauren Cohen
Jennifer Rhodes
Aleš Đevenica
…and the baristas and patrons in every coffee shop and café on Oʻahu

---

This project was funded by the Bilinski Fellowship in Linguistics, the University of Hawaiʻi Department of Linguistics Graduate Assistantship, Merit Scholarship, and Achievement Scholarship.

ABSTRACT

This dissertation presents an acoustic phonetic examination of the vowel systems of 32 Hawaiʻi Creole speakers with special attention paid to how these vowel realizations have changed across time, gender, phonological context, and the number of Hawaiʻi Creole morpho-syntactic features exhibited by speakers. This research was motivated by an interest in two questions in creole and variationist linguistics: how does Hawaiʻi Creole differ from its main lexifier language, English; and how has the language changed over time?

To address these questions, vowel data was taken from existing sociolinguistic interviews archived in Kaipuleohone at the University of Hawaiʻi. The analyzed speakers come from two corpora conducted at different points in time: one conducted in the 1970s, and one conducted in the 2000s; 16 speakers from each corpus were analyzed, and these speakers were evenly distributed across age and gender. The first two formants and the duration of 11,191 vowels in fourteen vowel classes were analyzed from spontaneous speech produced during these interviews.

Analysis revealed that the vowel spaces of speakers recorded in the 1970s vary significantly with respect to the vowel spaces of speakers recorded in the 2000s. 1970s speakers show substantial spectral overlap between high front vowels /i/ and /ɪ/, and overlap between the high back vowels /u/ and /ʊ/. 1970s speakers are also more likely to realize low vowels /a/ and /ʌ/ as spectrally overlapped and distinct from /ɔ/, which is realized as higher and backer in the vowel space. While each of these vowel classes exhibits significant spectral overlap, each is differentiated by vowel length for all age groups, suggesting that Hawaiʻi Creole (at least for speakers sampled in the 1970s) exhibits contrastive vowel length. By contrast, 2000s speakers realize /ɪ/ and /ʊ/ as distinct in spectral space from /i/ and /u/, respectively, and the low back

vowels /a/ and /ʌ/ are less overlapping in spectral space for the youngest age group. 2000s speakers also realize /ɔ/ as fronter in comparison to older speakers. 2000s speakers also exhibit a number of other differences with respect to 1970s speakers, including lower and backer realizations of /æ/, fronter realizations of /e/ and /i/, fronter realizations of the high back vowels /u/ and /ʊ/, and higher realizations of the nucleus of /ai/.

Despite the number of changes that manifest between 1970s speakers and 2000s speakers, few differences in vowel realizations arise across gender. Over time, only /a/ and the nucleus of /au/ raise for females but not males. Females also exhibit slightly lower variants of /ɪ/ and more similar realizations of /a/ and /ɔ/ than males. That relatively few differences arise across gender in Hawai‘i Creole is noteworthy, especially since English (the main lexifier language for Hawai‘i Creole and a language with which Hawai‘i Creole is in heavy contact) exhibits many differences across gender in terms of vowel realizations.

Many phonological effects were also identified, including, for example, that Hawai‘i Creole speakers exhibit a complete merger of /ɛ/ on /æ/ before /l/. Hawai‘i Creole speakers also exhibit fronter realizations of /u/ following coronal consonants, and a resistance to the fronting of /ɔ/ before /l/. Speakers also show slight differences in /æ/ before nasals, but do not show the same degree of difference as is evident in some English varieties (e.g., California or New York; see, e.g., Eckert 2008 and Labov et al. 2006). Hawai‘i Creole speakers also show evidence of a split between long and short /a/ (reminiscent of the TRAP-BATH split; see Wells 1982), suggesting that this split existed in the English spoken during Hawai‘i Creole’s formation.

Variation in vowel formant frequencies for speakers recorded in the 2000s was also conditioned by whether that speaker exhibited a higher number of Pidgin morpho-syntactic markers. Speakers who used more Pidgin morpho-syntax in their interviews exhibited more conservative vowel realizations than speakers who exhibited fewer Pidgin morpho-syntactic features. For example, speakers who exhibited high rates of Pidgin morpho-syntax were more likely to exhibit more overlapping realizations of /ɪ, i/, /ʊ, u/, and /ʌ, a/, and less overlapping realizations of /a/ and /ɔ/.

Taken together, these findings provide evidence that the vowel space of Hawai‘i Creole speakers has changed substantially over time; many of these changes have caused Hawai‘i Creole vowel spaces to approximate English vowel spaces. However, younger speakers of Hawai‘i Creole who exhibit higher rates of Hawai‘i Creole morpho-syntactic markers are more resistant to these changes. Together, findings from this study help characterize and describe the vowel system of Hawai‘i Creole and how it has changed over time, as well as contributing to an understanding of how creoles interact at a structural level with their main lexifier language over time.

TABLE OF CONTENTS

LIST OF TABLES

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

LIST OF FIGURES

Chapter 2

Chapter 3

Chapter 4

Chapter 5

Chapter 6

Chapter 7

Chapter 8

LIST OF LEXICAL SETS USED TO REPRESENT VOWELS

Vowels (IPA)	Wells (1982)	Grama (2015)	English Transliteration
/i/	FLEECE	SHCHRIT	*street*
/e/	FACE	FES	*face*
/ɪ/	KIT	STIK	*stick*
/ɛ/	DRESS	JRES	*dress*
/æ/	TRAP, BATH	CHRAEP	*trap*
/u/	GOOSE	SHUTS	*shoots*
/ju/	FEW	FYU	*few*
/o/	GOAT	JOK	*joke*
/ʊ/	FOOT	FUT	*foot*
/ʌ/	STRUT	STAF	*stuff*
/a/	LOT, PALM	LAT	*lot*
/ɔ/	THOUGHT, CLOTH	TAWK	*talk*
/ai̯/	PRICE	PRAIS	*price*
/au̯/	MOUTH	HAUS	*house*
/ɔi̯/	CHOICE	BOIZ	*boys*

CHAPTER 1

INTRODUCTION

Sociolinguists have long noted that variability is inherent in human speech; people do not talk the same way all the time in all contexts, but instead adjust their speech to, for example, accommodate to that of their interlocutor or take a particular stance. Despite the inherent variability of human speech, certain groups of people are more likely to exhibit shared linguistic features than outsiders to that group. Whether conditioned by phonological environment, gender, or time, these differences in speech can manifest as differences in phonetic realizations that are quantifiable and distributed in principled ways across and within social groups. Though these patterns are well-described for varieties across the English-speaking world (see, e.g., Labov 2001), there has been surprisingly little research conducted on the phonetic variation that is exhibited by creoles (for counterexamples, see Veatch 1991; Sabino 1996, 2012; Wassink 1999, 2001, 2006). Creoles represent sociolinguistic settings where at least two languages, the creole and the "standard"[1] may exist in a relationship which motivates a considerable amount of variation (DeCamp 1971). Hawai‘i is perhaps one of the best places to undertake such research, as there is a relatively well-documented history of consistent language contact, and a sizeable amount of research on the creole spoken there—Pidgin (also known as Hawai‘i Creole).[2] However, while research has described the phonological system of Pidgin (e.g., Bickerton & Odo 1976; Sakoda & Siegel 2008), this work has been based on auditory analysis. Furthermore, the phonological work on Pidgin has often cited a large amount of inter- and intra-speaker

[1] I use quotes here as I find it dubious that the forms (e.g., phonetic realizations) found in any variety of a language can be defined as standard. All languages of the world demonstrate some degree of stylistic, register, or dialectal variation, therefore rendering it difficult to claim that any particular set of pronunciations is "standard" (see, e.g., Trudgill 1999[2011]).

[2] This dissertation makes frequent use of the endonym Pidgin to refer to what linguists often call Hawai‘i Creole (see §2.1 for a more substantive discussion of why the term "Pidgin" was chosen to refer to this linguistic variety).

variation attributed in large part to influence from English, which is both the main lexifier language for Pidgin and the language in which most Pidgin speakers are bilingual. However because no acoustic phonetic work has been done on Pidgin, a significant portion of this variation remains undescribed.

This dissertation seeks to fill this gap in the literature by providing an acoustic phonetic description of the vowel system of Pidgin, and by describing variation in the vowel system that arises as a function of time, gender, and how basilectal the variety of Pidgin is that a speaker uses. To address each of these questions, this dissertation analyzes acoustic phonetic data taken from interviews of 32 Pidgin speakers recorded in the 1970s and 2000s (archived in Kaipuleohone, the University of Hawaiʻi's digital ethnographic archive). The changes that have taken place in the vowel space of Pidgin speakers are described and characterized using a longitudinal trend study, which compares the vowel realizations of speakers in the 1970s corpus with those of speakers in the 2000s corpus. Additionally, this dissertation analyzes changes in apparent time (that is, it compares the speech of relatively older and younger speakers within each corpus; see, e.g., Labov 1963) in order to identify the direction of changes which are newer, and to verify whether speakers exhibit continuation of changes in real time that appear in apparent time. Vowels from both males and females are investigated and tested in a variety of phonological contexts to establish not only a snapshot of a population's vocalic system at a single point in time, but also characterize how patterns and trends have emerged in the speech community over time. Furthermore, this dissertation formulates a Pidgin Density Measure (PDM), inspired by Dialect Density Measures, (see, e.g., Craig & Washington 2006; Van Hofwegen & Wolfram 2010), which quantifies how basilectal the variety of Pidgin is that a speaker uses. PDM is calculated as the ratio of Pidgin morpho-syntactic elements to total word count of the interview, and it yields a single number for a speaker which characterizes how basilectal speaker's Pidgin is. By operationalizing Pidgin use in this way, the current study treats a speaker's use of Pidgin as an objectively assessed continuous variable (instead of describing a speaker as categorically basilectal, mesolectal, or acrolectal; see, e.g., DeCamp 1971). The PDM can then be used as a predictor of vowel variation that is completely independent from the test variables (i.e., Pidgin vowels).

This dissertation contributes to the field of linguistics in several ways. The clearest contribution is the impact of this work on the understanding of the way language is used in Hawaiʻi. Despite claims of heavy inter- and intra-speaker variation, no acoustic phonetic research has been done on Pidgin, which might serve to describe and characterize this variation. Variation that has been described as context-free or expected due to Pidgin's status as a creole (see, e.g., Bickerton & Odo 1976; Sakoda & Siegel 2008) is quantified in the current study and shown to vary across age, gender, phonological environment, and be linked with a speaker's use of Pidgin morpho-syntactic items. The current study also contributes to the understanding of how a creole changes phonetically alongside its main lexifier language over time, when those two languages co-exist in the same geographical space. As acoustic phonetic work in Hawaiʻi English has begun to show, the way English is spoken in Hawaiʻi is both unique from other varieties and changing over time (Drager et al. 2013; Kirtley et al. forthcoming). An accompanying investigation of the sound system of Pidgin (the focus of this dissertation) sheds light on how both systems interact, leading to a clearer understanding of variation and change in Hawaiʻi. This dissertation also contributes to the study of creoles by forwarding a quantitative metric (via the Pidgin Density Measure, or PDM) to gauge how basilectal a speaker's Pidgin is. This metric quantifies the rate of a speaker's use of Pidgin morpho-syntactic items so that it may be used as a predictor of vowel variation. Since the PDM score is calculated based on linguistic variables that are not the test variables (e.g., vowels), it is possible to assess whether speakers that are more basilectal behave differently with regard to sound change than more acrolectal speakers. Furthermore, the PDM score allows for increased objectivity on the part of the researcher, in contrast with previous work which has used researcher-imposed categories: basilectal, mesolectal and acrolectal (see, e.g., Wassink 1999). Through using the PDM score, it is possible for the researcher to be sure that the PDM score is independent of the test variable (which is not the case with researcher-imposed categories) and treat the basilect-acrolect continuum as continuous rather than categorical. This is desirable from a research standpoint because it more accurately reflects the behavior of creole languages (see, e.g., DeCamp 1971; Sato 1993; Wassink 1999, 2001; Sakoda & Siegel 2008).

1.1. Organization of this dissertation

This dissertation is organized into eight chapters. The first chapter introduces and outlines the main goals for the dissertation. Chapter 2 addresses the relevant literature from which this dissertation draws. The history of the development of Pidgin is discussed along with the language situation in Hawai‘i today (§2.2). This chapter also addresses the need for an acoustic phonetic study of Pidgin vowels, as well as the benefits of using a trend study and an apparent time study when characterizing acoustic phonetic change over time (§2.3). To establish a baseline expectation for how Pidgin vowels vary acoustically, §2.4 addresses existing descriptions of the phonological vowel system of Pidgin, which (as discussed in §1) are based on auditory impressions. Special attention is also paid to variation that arises in Hawai‘i English, as Pidgin and Hawai‘i English are closely linked and focusing on variation identified in Hawai‘i

English provides an important reference point for the kind of acoustic phonetic variation that might be observed in Pidgin.

Chapter 3 describes the methodologies employed to address variation in Pidgin vowels. This includes a detailed description of the way in which Pidgin interviews were selected from the existing corpora (§3.1), and how these interviews were coded and prepared for analysis (§3.2). This chapter also addresses how the Pidgin Density Measure (PDM) was calculated (§3.3), the way vowel distributions are represented in this dissertation (§3.4) and the way inferential statistics are used to corroborate the findings (§3.5).

Chapters 4-7 describe the acoustic phonetic results for each of the fourteen vowels analyzed in this study, focusing on how these vowels exhibit variation over age group, gender, phonological context, and a speaker's use of Pidgin morpho-syntactic items. Each chapter addresses a section of the vowel space: chapter 4 focuses on the front vowels in Pidgin, SHCHRIT, STIK, FES, JRES, and CHRAEP;[3] chapter 5 focuses on the high back vowels, SHUTS, FUT, and JOK; chapter 6 focuses on the low back vowels, LAT, TAWK, and STAF; finally, chapter 7 focuses on the diphthongs, PRAIS, HAUS, and BOIZ.

Chapter 8 concludes the dissertation with a discussion of the findings of the research, the motivations for the variation exhibited by Pidgin vowels, and the implications for future research. This section also addresses the contributions of this dissertation to the field of linguistics in more depth. Additionally, there is a discussion of the challenges associated with completing the current study, and some opportunities for future research.

[3] These vowel representations are discussed in §2.4.2.1; they are based on the Wells (1982) lexical sets which I have adapted to Pidgin.

CHAPTER 2

LANGUAGE USE AND VARIATION IN HAWAIʻI

> When the infernal machine of plantation slavery began to grind its wheels, iron laws of economics came into play, laws that would lead to immeasurable suffering but would also, and equally inevitably, produce new languages all over the world—languages that ironically, in the very midst of man's inhumanity to man, demonstrated the essential unity of humanity. (Bickerton 2008: 152)

This chapter discusses the literature concerning the history and linguistic landscape of Hawaiʻi as it relates to the development of Pidgin, and the relevant body of literature that has explored the linguistic structure of Pidgin. It is vital for any research on Pidgin to be mindful of the unique socio-historical context that gave rise to Pidgin. To address these questions, this chapter is organized as follows. First, the use of the word "Pidgin" in this dissertation to refer to Hawaiʻi Creole is discussed in §2.1. Then, §2.2 addresses the language situation in Hawaiʻi, paying special attention to the language contact and immigration that has characterized the history of Hawaiʻi (§2.2.1), the social setting which facilitated the development of Pidgin (§2.2.2), and the language setting in Hawaiʻi today (§2.2.3). Next, §2.3 identifies the need for a study of acoustic phonetic variation in Pidgin by discussing the findings of similarly focused research in sociolinguistics and creole studies. This section also addresses the benefits of using a trend study and an apparent time study to characterize acoustic phonetic change over time. Then, §2.4 addresses linguistic research on Pidgin which bears on the current focus of the dissertation, including the theoretical underpinnings and relevance of the creole continuum (2.4.1), and a sketch of the existing phonological work on Pidgin based on auditory analysis (§2.4.2). Also, §2.4.3 presents a summary of the acoustic work on Hawaiʻi English, the local variety of English, which is important to the current study both because English is the main lexifier language for Pidgin, and because most people who speak Pidgin on the Hawaiian Islands are also bilingual in

English. Finally, §2.5 underscores the importance of treating acoustic data as gradient and continuous when studying vocalic variation.

2.1. A brief aside regarding use of the word "Pidgin"

Throughout this dissertation, I make reference to Pidgin as the language of interest. Pidgin (spelled *pijin* using Odo Orthography; see Appendix A) is the Hawai‘i Creole word for itself, and it is the term most frequently used by Locals.[4] Though Pidgin is often referred to by linguists as Hawai‘i Creole English (e.g., Sato 1991; Ohama et al. 2000), this term implies a strong ideological connection with English that is not supported by the literature (e.g., Marlow & Giles 2008, 2010). Hence, I am more comfortable using the endonym Pidgin (albeit written using English orthographic conventions) than any of the commonly accepted exonyms (e.g., Hawai‘i Creole, Hawai‘i Creole English).[5]

Another important point must be made about Pidgin as a linguistic entity. Despite the perception that Pidgin is "broken English" among some Locals (see Marlow & Giles 2010; Drager & Grama 2014), it is a language, capable of the range of expression of any language (see, e.g., the discussion of the history of the development of Pidgin in §2.2). It is classified as an English-based creole, which arose out of an earlier pidgin (here, Hawai‘i Pidgin English). For the purposes of this dissertation, a pidgin is a linguistic system with limited morpho-syntax and variable phonology that is restricted in its usage to certain social domains (e.g., place of work, the plantation). Therefore, pidgins do not have the range of expression other languages are capable of, due in part to this restricted use across social domains. A creole is born from a pidgin

[4] Local with a capital <L> is used here broadly to refer to people who were raised in Hawai‘i; the term is capitalized following the convention used with other ethnic and racial groups (e.g., Asian-American). However, the term "Local" carries many shades of meaning, some of them highly variable and individual, including a connection to working-class immigrant workers during the plantation era (Ohnuma 2002).

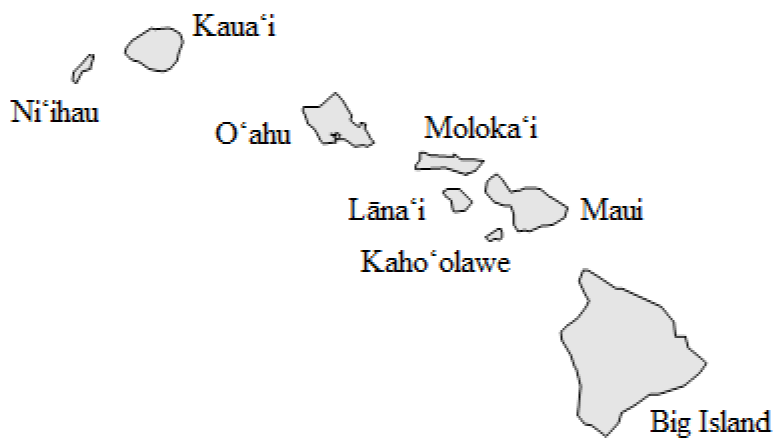
[5] Lewis et al. (2015) also lists Hawai‘i Pidgin as a possibility, though I feel this term evokes too strong a connection with Pidgin as an actual pidgin.

when children adopt the system as their first language. As this takes place, the linguistic system begins to broaden in its expressive ability and takes on characteristics common to extant languages (e.g., aspect markers). Therefore despite its name, Pidgin is in fact a creole, not a pidgin (compare similar uses of the word ‘pidgin’ to refer to other creoles, for example, in Tok Pisin and Solomon Islands Pijin). Finally, all speakers analyzed in this dissertation are speakers of Pidgin, not Hawai‘i Pidgin English (see §2.2.1).

2.2. History of Hawai‘i, the development of Pidgin, and Hawai‘i as a research area

Hawai‘i is an archipelago made up of eight main islands: from east to west, these islands are Hawai‘i from which the island chain gets its name (also known as the Big Island), Maui, Kaho‘olawe, Moloka‘i, Lānaʻi, O‘ahu, Kaua‘i, and Ni‘ihau.[6] These are the northernmost islands in Polynesia, located some 2,000 miles southwest of the North American mainland and some 3,800 miles southeast of Japan.

Figure 2.1. Image of the Hawaiian Islands (generated by `worldHires` in R; R Core Team 2013).



[6] The Hawai‘i archipelago is also made up of over 120 outlying islands and atolls; these islands have no permanent residents.

2.2.1. Contact and immigration

The linguistic makeup of Hawai‘i is, in many ways, a reflection of its long, complicated history of inter-cultural contact, immigration, occupation and colonization. This contact, despite Hawai‘i's seemingly remote location in the Pacific, began almost as soon as humans set foot on the Hawaiian Islands. Archaeological and paleo-ecological evidence suggest that ancient Polynesians first made physical contact with the Hawaiian Islands sometime between 1190 and 1293 CE (Wilmshurst et al. 2011). These ancient Polynesians were highly skilled seafarers, and there is good evidence to suggest that there was heavy contact between settlers on the Hawaiian Islands and other eastern Polynesians, traveling from Mangareva and the Pitcairn Islands, as well as the Austral Islands, the Marquesas Islands, the Tuamotu archipelago, and the Society Islands (Weisler 1998; Collerson & Weisler 2007; Walworth 2014).[7]

The first Europeans arrived in the Hawaiian Islands led by British explorer Captain James Cook in 1778. Upon arriving on the Hawaiian Islands, these explorers found a large population in excess of one million people (Bradley 2009). Cook's arrival triggered an influx of people from all around the world, including Europe, Asia and North America. Traders and merchants used Hawai‘i as a stopover between China and the west coast of North America during the fur trade, and contact persisted when Hawai‘i became a center for the sandalwood trade and the whaling industry (Reinecke 1969: 24). During this time, the indigenous population of Hawai‘i declined sharply due in large part to diseases introduced by the foreign population (Bradley 2009), and by 1848, the indigenous Hawaiian population had shrunk to just 88,000 (Sakoda & Siegel 2008: 210). Beginning in 1835, the first sugarcane plantations were established on the islands. This

[7] There is also evidence that Polynesian seafarers contacted the indigenous people of South America. *Comal*, the word for sweet potato in the language of Cañari spoken in coastal Peru and Ecuador, and the word for sweet potato in many Polynesian languages (e.g., *kumara* in Aotearoa and Rapa Nui, *umara* in Tahiti, and *‘uala* in Hawai‘i) is strikingly similar (Scaglion & Cordero 2011). The sweet potato is also a main food staple throughout Polynesia.

resulted in the mass importation of labor and an influx of Chinese, Portuguese, Japanese and Filipino workers, along with smaller groups from Korea, Puerto Rico, the rest of Europe and various Pacific islands (Sakoda & Siegel 2008: 210-211). At the time of the first sugarcane plantations in Hawai‘i, Hawaiians still held control over their recently unified island nation, and Hawaiian was the dominant language in Hawai‘i (Sakoda & Siegel 2008: 211).[8] As a result, Hawaiian was used among those who operated the plantations; however, the workers on the plantations (then, largely White, Chinese, Hawaiian, and Portuguese) used a Hawaiian-based pidgin as the primary means of communication (Reinecke 1938; Sakoda & Siegel 2008). This Hawaiian-lexified pidgin remained the main method of communication on the plantations until at least the 1890s (Sakoda & Siegel 2008: 211).[9]

2.2.2. The emergence of Pidgin

Hawaiian's status as the language of Hawai‘i would not last much longer. In 1875, the Kingdom of Hawai‘i, then still recognized as a sovereign nation, signed the Reciprocity Treaty with the United States, which allowed the duty-free importation of Hawaiian sugar into the United States. This marked a turning point in the social and linguistic landscape of Hawai‘i. The signing of the Reciprocity Treaty not only opened trade between Hawai‘i and the United States, but it also facilitated a greater influx of Americans alongside an ever-dwindling number of Hawaiians.[10] With more Americans came a greater number of English schools, and a greater number of Hawai‘i-born children were exposed to English in everyday life (Reinecke 1938). The growing influence of English at the expense of Hawaiian reached the multi-ethnic and multi-

[8] The eight major islands of Hawai‘i were unified under Kamehameha I in 1810 with the help of foreign advisors and weapons.
[9] In fact, this pidginized Hawaiian was still in use into the early 20th century in rural areas (Sakoda & Siegel 2008: 212).
[10] By 1888, the population of native Hawaiians had dropped to under 50,000, and according to the census of 1910, Hawaiians and Part-Hawaiians numbered just over 38,500 (see Appendix B).

lingual plantations, and this motivated the development of an English-based pidgin, Hawaiʻi Pidgin English (HPE). By 1900, generations of plantation workers and their families used both their native languages (e.g., Cantonese, Portuguese) and HPE in an increasing number of domains outside the plantation; in many cases parents spoke to their newborn children in HPE, rather than (or in addition to) their native language, causing the children to acquire HPE as their primary language (or one of their primary languages; Sakoda & Siegel 2008: 212). As HPE began to occupy more social spheres in Hawaiʻi, subsequent generations of plantation-born children began to acquire it as their first language (Roberts 2004). As HPE was spoken as a first language, it took the shape of what is now referred to as Pidgin—a creole language capable of the range of expression associated with all other languages.

In 1893, the Kingdom of Hawaiʻi was overthrown by wealthy American businessmen (The Big Five[11]), and just five years later in 1898, the islands were annexed as a territory by the United States.[12] Alongside the development and creolization of Pidgin, English gained an ever-stronger foothold as the language of overt prestige in Hawaiʻi; Hawaiian schools were almost completely replaced by their English-speaking counterparts, and English became the language associated with economic advancement at the expense of other languages, particularly Hawaiian (Siegel 2000). By 1920, Pidgin had become the dominant language of plantation children and had in many respects taken the place of Hawaiian as the language of the people of Hawaiʻi (Sakoda & Siegel 2008).[13] Over the next 25 years, sugarcane plantations and the Pidgin spoken

[11] This was the name given to the sugarcane plantation corporations that formed an oligopoly in Hawaiʻi: C. Brewer & Co., Theo H. Davies & Co., Amfac, Castle & Cooke, and Alexander & Baldwin.
[12] The legality of this annexation is still debated today. The sovereignty movement is a relatively strong and widespread movement in Hawaiʻi and sovereignty demonstrations are relatively common.
[13] According to the U.S. Census, the population of full or part Native Hawaiians was nearly 25% of the population in 1900; by 1970, the population had shrunk to just over 9% of the population. The population of ethnically Japanese (as well as Filipino and Chinese), however, has constituted the largest percent of the population of Hawaiʻi since 1900. For more historical demographic data, see Appendix B.

on them maintained a steady presence in Hawaiʻi, even as the population of Hawaiʻi grew by roughly 60,000 each decade from 1900 to 1950 (see Appendix B).

In 1954, Hawaiʻi laborers, driven by a desire for equal pay and benefits to their mainland counterparts, engaged in the Hawaiʻi Democratic Revolution, a nonviolent revolution characterized by protests and strikes (Beechert 1985: 106; Ohnuma 2002: 276). This revolution culminated in the democratic ousting of the Hawaiʻi Republican Party, and crippled the power of The Big Five (Beechert 1985). In 1959, Hawaiʻi became a state of the United States,[14] and the major industry shifted quickly from sugar production to tourism. Through this, Pidgin has endured, and it has solidified its role and importance in Local culture.

2.2.3. The linguistic landscape of Hawaiʻi today

Today, Hawaiʻi is the 40th most populous state, with just over 1.4 million inhabitants; however, it is the 13th most densely populated state with almost 219 people per square mile (~84 people per km^2). This population density is most pronounced on the island of Oʻahu, specifically in "town" (the southern side of the island where Honolulu is located), where over 65% of the population of the state of Hawaiʻi resides. Of all the people in Hawaiʻi, an estimated 600,000 (or

[14] Of the roughly 600,000 people on the islands at this time, approximately 155,000 were registered voters. Roughly 90% of these registered voters turned out for the election to vote on whether to make Hawaiʻi a state, and in a congressionally mandated plebiscite, citizens of the Territory of Hawaiʻi voted 132,773 to 7,971 in favor of statehood (Whitehead 1993: 43). Despite this apparent overwhelming support, there was significant local opposition to statehood. This sentiment was perhaps strongest among native Hawaiians who felt dispossessed of their homeland (Whitehead 1993: 60), but opposition to statehood was pervasive even in decades prior. As territorial delegate John Burns wrote in *State Government* in the summer of 1959:
"The reasons why Hawaii did not achieve statehood, say, ten years ago—and one could without much exaggeration say sixty years ago—lie not in the Congress but in Hawaii. The most effective opposition to statehood has always originated in Hawaii itself. For the most part it has remained under cover and has marched under other banners." (Whitehead 1993: 44)

roughly half) are speakers of Pidgin (Vellupillai 2003; Grimes 2010; Sakoda & Siegel 2008; Lewis et al. 2015).[15]

Hawaiʻi is also home to extreme linguistic, ethnic and cultural diversity, especially in the context of the U.S. The proportion of people who self-identify as White is the lowest of any state in the nation (U.S. Census Bureau 2010). Hawaiʻi has never had a White majority population (see Appendix B), and it has the highest percentage of people who report Asian-American descent of any state in the nation. Furthermore, many people report identifying with multiple racial and ethnic backgrounds.[16] In 2010, for example, Hawaiʻi had the highest percentage of people who self-reported more than one race at 23.1%;[17] the next highest percentage for a state was Alaska at 7.1% (U.S. Census Bureau 2010).[18] This ethnic diversity translates to a large amount of linguistic diversity as well, as over 28% of the population reports speaking a language other than English in the home (U.S. Census Bureau 2010).[19] In fact, many Locals and residents of Hawaiʻi alike believe that Pidgin varies depending on the ethnicity and linguistic background of the speaker (see Drager & Grama 2014: 45-46), though it is unclear exactly how ethnic groups in Hawaiʻi vary in their Pidgin use.[20] While the variation that Pidgin may exhibit across ethnicity

[15] Lewis et al. (2015) notes this number may underrepresent the total number of speakers. It notes an additional 100,000 speakers on the U.S. mainland located mostly on the west coast, and another 400,000 L2 speakers of Pidgin.
[16] This is corroborated by interviews conducted by Katie Drager, Joelle Kirtley, Sean Simpson, and the author, who find that interviewees will often self-report multiple ethnicities.
[17] For the purposes of the U.S. Census, categories such as White, Black, Asian, and Pacific Islander are viewed as "races"; other affiliations (e.g., Irish, Chinese) are viewed as ethnicities.
[18] The percent of people who report two or more races in the U.S. as a whole is 2.4%.
[19] This number is misleading as the US Census Bureau (2010) states that only 676 people self-reported speaking either "Pidgin" or "Hawaiian Pidgin" in response to the question "does this person speak a language other than English at home?" The reason for this deflated number is likely because speakers may not realize or be willing to admit that they speak Pidgin due to the history of language hegemony in Hawaiʻi.
[20] This information is also corroborated by unpublished interviews conducted by Katie Drager, Joelle Kirtley, Sean Simpson and the author.

is a worthwhile pursuit and may contribute significantly to phonetic variation in Hawaiʻi, it is not considered in this dissertation.[21]

The two most ideologically salient languages in Hawaiʻi are Pidgin and English. A large percentage of the Pidgin-speaking population of Hawaiʻi is bilingual in the local variety of English, referred to here as Hawaiʻi English (cf. Sato 1993; Drager et al. 2013), and many speakers can freely mix or code-switch between the two languages (Drager 2012: 61).[22] There is evidence to suggest that Pidgin and English are in many respects ideologically opposed to one another. For example, using Pidgin can be a linguistic means to simultaneously align with Local values, establishing familiarity between speakers (Sato 1991, 1993; Marlow & Giles 2008, 2010), and align away from non-Local values (Reinecke 1938). Furthermore, Pidgin is often wrongly cast as 'inferior', 'broken', or not 'proper' English (Marlow & Giles 2008, 2010; Higgins et al. 2012), and educational prejudice, viewing Pidgin as a barrier to acquiring English (the language of overt prestige in Hawaiʻi) has existed since before 1920 (Yokota 2008). Finally, while many Hawaiʻi residents believe Pidgin has local value, the language is delegitimized by the belief that it should be restricted to informal domains (Marlow & Giles 2008; Higgins et al. 2012). However, this belief does not appear to reflect actual linguistic practice, as individuals use Pidgin in a wide range of formal settings to achieve communicative goals (Marlow & Giles 2008). These findings underscore the complex relationship that Pidgin experiences with English, and they highlight the importance of considering the potential effects of Hawaiʻi English on Pidgin in this dissertation.

[21] It is not possible to investigate ethnicity with these data using a variationist approach because the data are unbalanced.

[22] Elsewhere, this English variety is referred to as Hawaiian English (Tsuzaki 1971), Hawaiian American English (Vanderslice & Pierson 1967), and Hawaiian Standard English (Reynolds 1999: 304).

2.3. The need for research on Pidgin

At present, the literature lacks a detailed, acoustic description of Pidgin vowels. This means that, despite the unique socio-historical origins of the language, there is no quantitative account of how the acoustic phonetic characteristics of Pidgin have changed or are changing throughout the community. One aim of variationist research is to identify and characterize the way phonological systems of languages change over time and how those changes spread throughout a community. Studies of language change in English (which often focus on vowels, which differentiate regional varieties of English) have dominated the landscape of variationist research, and they have been successful in identifying, among other things, sound changes in progress (see, e.g., Labov 2001).

While the majority of studies on the vowel systems of creoles have been auditory in nature (e.g., LePage 1960; Lawton 1963; Akers 1981; Wells 1982; Bickerton & Odo 1976), some studies have analyzed the acoustic phonetic structure of creole vowel systems from a variationist perspective (Veatch 1991; Sabino 1996, 2012; Wassink 1999, 2001, 2006). These studies have been able to quantify some of the variation that is described as context-free and expected due to the variable nature of creoles (see, e.g., Odo 1975). Sabino (1996), for example, uses acoustic methods to conclude that a length distinction in the mid and low vowels of Negerhollands (a now extinct Dutch-based creole that was spoken in the present-day U.S. Virgin Islands) is realized as a difference in vowel quality for the last remaining speaker. Additionally, Wassink (1999, 2001, 2006) identifies that speakers of Jamaican Creole exhibit quantifiable differences between vowel realizations (both in quality and duration) depending on whether a speaker came from an area associated with more basilectal speech or more acrolectal speech styles.[23] Furthermore, Wassink's findings indicate that while acrolectal Jamaican Creole is often conceived of as a regional dialect of English, there are clear differences in vowel length between Jamaican Creole speakers (regardless of lect) and English speakers. These studies identify structured variation in creoles that is not context-free, which not only helps tease apart the structural and social relationship creoles have with their main lexifier languages, but also helps lay the foundation for how sound change and new-dialect formation have taken place in these creoles (see §2.4.1). Furthermore, as Patrick (2009) suggests, sociophonetic studies of creole vowels may demonstrate that creoles may exhibit "an extra degree of variability" (Patrick 2009: 470) in comparison with other languages, as a result of the creole's social and linguistic relationship with the main lexifier language. That is, creole speakers may be able to take advantage of the full range of variation available to both the creole and the main lexifier language when constructing identity. Therefore, there is much to be gained in terms of understanding language use in Hawaiʻi and the way in which creoles exhibit variation from an acoustic phonetic study of Pidgin vocalic variation.

There are two ways variationist work has successfully described linguistic change over time: real time (or, longitudinal studies) and apparent time studies. Longitudinal studies best establish and characterize phonetic change (or stability) in a community over time (Sankoff 2006; Sankoff & Blondeau 2007). This is often done using a trend study (e.g., Trudgill 1988; Blake & Josey 2003), which involves resampling a population at two or more distinct points in time, generally separated by at least a decade.[24] By conducting a trend study, it is possible to assess whether, in what manner, and to what degree a sound change has taken hold in a community. On the other hand, apparent time studies constitute much of the research focused on

[23] For an in-depth discussion of the lects described by the creole continuum, see §2.4.1.
[24] Change over time may also be defined as change in the speech of the same speakers that is assessed at multiple points in time (cf. Sankoff 2006).

language change (e.g., Labov 1963, 1966, 1994). In apparent time studies, different generations at a single point in time are compared. The apparent time hypothesis assumes that an individual's speech is relatively stable over the speaker's lifetime. This means that older speakers can be compared with relatively younger speakers, where the older speakers represent a relatively older way of speaking, and younger speakers represent a relatively newer way of speaking (Labov 1963). While apparent time studies are good indicators of the direction of phonetic/phonological change, they often underestimate the rate of change (Sankoff & Blondeau 2007).

In this dissertation, a trend study is conducted along with two apparent time studies. Using existing corpora taken from interviews conducted at two points in time (one group of interviews conducted in the 1970s and the other group conducted in the 2000s) this study identifies and characterizes the changes that have taken place in the vowel system of Pidgin. In each of these corpora, relatively younger and older generations of speakers are identified as well, so that each corpus represents a study in apparent time. By taking an apparent time approach, this study can identify the direction of changes which might be newer (e.g., changes that are most evident in the younger group in the 2000s corpus), and whether older speakers exhibit continuation of changes in real time that appear in apparent time (e.g., whether changes in the younger speakers in the 1970s corpus continue for speakers in the 2000s corpus). In this way, this dissertation can identify and track changes in the sample of Pidgin speakers not only as a single snapshot of the population's linguistic makeup in apparent time, but also see how these patterns and trends are expressed over real time.

2.4. Variation along the creole continuum, and the vowel systems of Pidgin and Hawai‘i English

One of the goals of the preceding discussion is to show that the social and linguistic conditions of creole formation suggest that Pidgin is very likely to exhibit substantial structural variation, especially as a result of contact with English. This dissertation seeks to characterize and describe this structural variation (specifically across time, gender, phonological context, and as a function of the number of Pidgin morpho-syntactic features exhibited by the speaker); however, it is first important to consider the ways variation in Pidgin has been addressed in the existing literature. With this in mind, the following discussion addresses three bodies of research which help characterize variation in Pidgin. First, the concept of a creole continuum is unpacked. The creole continuum is a conceptualization of the spectrum of variation exhibited both by Pidgin and creoles more generally. In creole research, the continuum is perhaps the most widely-used way linguistic variation in creoles has been addressed. The creole continuum is a particularly important concept to consider because this dissertation uses the number of Pidgin morpho-syntactic features (some of the same features which have been used to characterize variation along the creole continuum) as a predictor of vowel variation. Second, the existing work detailing the phonology of Pidgin is discussed. The existing descriptions of the phonological system of Pidgin (Bickerton & Odo 1976; Odo 1977; Wells 1982; Sakoda & Siegel 2008) are based on auditory impressions,[25] but the findings from this research are important to consider for this dissertation, as they lay the framework for how Pidgin speakers may exhibit acoustic phonetic variation.[26] Third, the existing work detailing acoustic phonetic variation in Hawaiʻi English is discussed. As described in §2.2.3 (and see also §2.4.1), English and Pidgin are closely linked. Therefore, it is reasonable to expect that acoustic variation exhibited by Pidgin speakers is partly due to (and measureable in relation to) influence from English.

[25] Wells cites Vanderslice & Pierson (1967), Carr (1972) and Reinecke (1969), all publications which do not address the vowel system of Pidgin, but rather the intonation and timing (and, in the case of Reinecke, history, social domains, and vocabulary) of Pidgin.

[26] Sakoda and Siegel (2003) also address phonological variation, but this publication focuses more generally on Pidgin morpho-syntax.

2.4.1. Pidgin and the creole continuum

As one of the goals of this study is to identify how vowels differ acoustically in their realizations as a speaker exhibits more Pidgin morpho-syntactic variables in their speech, it bears describing the ways in which other creolists conceive of creole-based variation, both generally and specifically with regard to Hawai‘i. The relationship between Pidgin and Hawai‘i English has been described by some linguists as a continuum between the most basilectal forms of the creole and Hawai‘i English (Odo 1970; Sato 1993; Reynolds 1999).[27] The idea of a creole continuum was first introduced by DeCamp (1971) to describe the linguistic situation in Jamaica.[28] DeCamp identifies reference points along the continuum to describe the types of variation common in places with a co-existing creole and "standard" linguistic systems. It is worth noting that this "standard" is not the generally perceived standard form of the variety (e.g., "Standard American English"), but a locally constructed variety (e.g., Hawai‘i English) (DeCamp 1971: 350). On one end of the spectrum, DeCamp identifies the acrolect, defined as the variety most similar to the "standard" form of the overtly prestigious superstrate language (usually also the variety associated with socioeconomic prestige). The basilect exists on the other end of the spectrum, and is defined as the variety most distant from and often mutually unintelligible with the "standard" (or acrolectal) form. The mesolect is defined as any intermediate variety, which often demonstrates a large amount of linguistic variation and code mixing between the acrolect and basilect (DeCamp 1961, 1971).

[27] Some researchers (e.g., St. Clair & Murai 1974) claim that Pidgin and Hawai‘i English exist in a diglossic relationship, where one language is restricted in use to certain social situations (e.g., education) but not used for everyday conversation (Ferguson 1959). However, research discussed here (e.g., Marlow & Giles 2008) suggests that the relationship between Pidgin and Hawai‘i English involves much more mixing across social contexts (see discussion in §2.2.3).

[28] DeCamp (1971) refers to this as the *post*-creole continuum to highlight his belief that Jamaican Patois was in the process of merging with the local variety of Jamaican English. He believed this to be due to the long history of exposure to the socioeconomically dominant language. The "post" prefix is usually dropped in more contemporary publications (Patrick 2009).

While it is possible to describe creole forms using these terms (e.g., basilectal Pidgin vs. mesolectal Pidgin), it is not possible to identify any of these lects as comprising a discrete or invariant grammar (Wassink 1999). It is similarly difficult to identify speakers as occupying any single point along the creole continuum because speakers often exhibit a range of linguistic abilities. Speakers are therefore often described as exhibiting a 'variable grammar' (Patrick 1999) where change in structural linguistic form is more-or-less expected, depending on the speaker's linguistic ability. To reflect this gradience and variability, variation along the creole continuum is often measured based on whether certain linguistic features of the creole are present in the speech of a speaker (DeCamp 1971). DeCamp argues that while speakers differ in their choices regarding which creole features (or how many features) they use in a given context, linguistic features of the creole can generally be arranged on a scale from "basilectal creole" to "acrolectal creole" relatively uncontroversially. Crucially, this scaling is non-discrete; the "creole" and "standard" (insofar as they represent discrete linguistic forms) represent polar varieties, between which there is more-or-less continuous variation, but there is not a series of any number of discrete social dialects that exist between these polar varieties (Rickford 1987). It is this purported continuous variation that has contributed to claims of extreme inter- and intra-speaker variation in Pidgin (see e.g., Bickerton & Odo 1976; Purcell 1979; Sakoda & Siegel 2008), and creoles more generally (DeCamp 1971; Rickford 1987).

The vast majority of studies of Pidgin assume DeCamp's (1971) creole continuum model as representative of the linguistic situation in Hawai‘i (see, e.g., Sato 1991). Much of this work has also accepted that decreolization, the diachronic increase of acrolectal (i.e., English-like) variants, is taking place in Hawai‘i at the societal level (e.g., Day 1972, Odo 1975, Bickerton 1977, 1981; Purcell 1984), but that decreolization is not as clearly manifested in individuals over their lifespan (Sato 1993). Importantly, decreolization need not affect all members of the community equally to still be occurring at the societal level (Sato 1991: 650). Many studies have looked at decreolization of certain linguistic features in Pidgin, ranging from syntactic elements like zero-copula (Day 1972), the tense-mood-aspect system and relativization (Bickerton 1977), to phonological features such as /r/ vocalization (Odo 1975). These studies have discovered that decreolization affects linguistic elements in different ways. Morpho-syntactic elements (e.g., anterior *wen* and *bin*) are generally more susceptible to decreolization than either discourse markers (e.g., clause-final *ae*) or phonological features (e.g., /r/ vocalization) (Sato 1991, 1993). In DeCamp's (1971) framework, these linguistic features may be stratified across the creole-continuum as in (1) (modified from Tsuzaki 1971: 333) and (2) (modified from Odo 1970: 238).

(1)	basilect:	I *ste* eat/*kaukau*.[29]
	mesolect$_1$:	I *ste* eating.
	mesolect$_2$:	I Ø eating.
	acrolect:	I am eating.

(2)	basilect:	Robert *get wan* book I *gon* read.
	mesolect$_1$:	Robert has *wan* book I *gon* read.
	mesolect$_2$:	Robert has a book I *gon* read.
	acrolect:	Robert has I book I'm going to read.

These sets of sentences ostensibly represent four different ways of 'saying the same thing' along the Pidgin basilect-acrolect continuum. The acrolectal form most closely approximates English, while the basilectal form exhibits the syntactic elements that are available to native creole speakers. In each set, the mesolectal examples demonstrate the implicational patterning of the morpho-syntactic elements in question. For example, Odo (1970) demonstrates an implicational hierarchy for the linguistic features in (2): the presence of Pidgin possessive *get* implies both indefinite article *wan* and *be*-less, non-past progressive *gon*; *wan* implies the

[29] The word *kaukau* is likely derived from Chinese pidgin *chowchow*, meaning 'food' (Bickerton 1983: 65).

presence of *gon*; and *gon* implies neither of the other two features in question. This ordering renders sentences which violate this implicational hierarchy (e.g., *Robert get wan book I'm going to read*) as less grammatical than those forms in (2) (Odo 1970: 238).[30] Importantly, the examined features are nearly always morpho-syntactic in nature (cf. Escure 1981; Sato 1993).

Despite the widespread use of the creole continuum model to describe linguistic variation in creoles, there have been claims that the model over-simplifies the amount of variation in creoles by positing unidimensional, hierarchical differences between two polar varieties. Rickford (1987), for example, suggests that linguistic variables in creoles can vary based on a single dimension (i.e., creole-ness to standard-ness), rather than varying heterogeneously across several dimensions (e.g., young to old, or rural to urban). However, others argue that social factors are interconnected across creole/standard lines, thus rendering unidimensional social variation in the creole highly unlikely (LePage 1980; LePage & Tabouret-Keller 1985). For example, while the creole may vary on a continuum with the superstrate language, that variation may be conditioned by additional interacting social factors, such as age, gender, ruralness, and the speaker's attitude towards the creole/superstrate language. Rickford (1987) suggests that these multidimensional approaches to creole variation may be separated into more simple, unidimensional continua, and then judged empirically to determine whether they differ from the variation described by the creole continuum model. With respect to acoustic phonetic variation, however, this has not yet been done in the existing literature.

The current study attempts to unpack the relationship among these social and structural factors, as well as assess whether the "degree" to which a speaker is basilectal can be an effective predictor of phonetic and phonological variation. In other words, the current study tests whether speakers who are more basilectal (or, exhibit more Pidgin morpho-syntactic features) behave

[30] Odo (1970) suggests these forms may be judged as completely ungrammatical by some speakers.

differently with respect to phonetic language change than speakers who are more acrolectal. This is done by formulating a Pidgin Density Measure (PDM) score based on Dialect Density Measures, which are sometimes used to quantify the more "basilectal" forms of African American English in sociolinguistics (Van Wofwegen & Wolfram 2010) and speech pathology (Craig & Washington 2006).

In the current study, the PDM is expressed as a ratio of the number of Pidgin morpho-syntactic forms to all words produced by each speaker during the analyzed portion of their interview (see §3.1). For the sake of the current study, this is preferable for several reasons. First, the PDM score is calculated using linguistic variables that are not the test variables (i.e., PDM variables are not vowels), and so it is possible to ensure that the test variables are independent of the PDM score. This is not possible with researcher-assigned categories which label speakers as, for example, basilectal or mesolectal, because it is quite likely that phonological variables might contribute to a researcher's characterization of the lect exhibited by a speaker (e.g., Bickerton & Odo 1976).[31] Second, the PDM score treats the basilect-acrolect continuum as continuous, rather than categorical, which is desirable from a research standpoint because it more accurately reflects the behavior of creole languages (see, e.g., DeCamp 1971; Wassink 1999, 2001; Sakoda & Siegel 2008). Third, it is possible to test how phonological features behave differently than morpho-syntactic variables as is suggested by work like Escure (1981) and Sato (1993). Fourth and finally, the PDM score can be included in an analysis of Pidgin, just like any other independent variable (e.g., age or gender), and it helps capture the nuances of language use in Pidgin. The derivation and implementation of the PDM is discussed more fully in §3.3.

[31] In the discussion of the phonology of Pidgin for example, Bickerton and Odo (1976) choose a single speaker (Marianne) who is basilectal and characterized as being a "generally representative speaker" of many Local speakers.

The creole continuum model is relevant to understanding the way some phonological work on Pidgin has been addressed. Sakoda and Siegel (2008), for example, make explicit reference to basilectal and mesolectal varieties in their analysis of the phonological structure of Pidgin. With this in mind, this dissertation now turns to a discussion of the literature that has focused on describing the phonological system of Pidgin based on auditory analysis.

2.4.2. The phonology of Pidgin vowels

As described in §2.4, an assessment of the existing research on the phonological structure of Pidgin vowels is a vital part of establishing a baseline expectation of how vowels in Pidgin vary acoustically. Several studies have used auditory analysis to describe the phonology of Pidgin (Bickerton & Odo 1976; Odo 1977; Wells 1982), but Sakoda and Siegel (2008) provides perhaps the best reference point for a large-scale acoustic phonetic study, as it is the most complete existing description of Pidgin phonology.[32] Unlike other phonological accounts of Pidgin (e.g., Bickerton & Odo 1976), Sakoda and Siegel (2008) provide a description of differences that arise in the vowel system of both basilectal Pidgin speakers and mesolectal Pidgin speakers.[33] This makes it a key publication to consider, as variation is considered in the current study as a function of a speaker's use of Pidgin morpho-syntactic features. In the following section, the relevant existing literature that addresses the vowel system of Pidgin is discussed. While Sakoda and Siegel (2008) is heavily relied upon to characterize the phonology of Pidgin vowels, this section also relies on other phonological studies of Pidgin to provide as complete a picture of Pidgin vowels as is possible using existing descriptions (Bickerton & Odo 1976; Odo 1977; Wells 1982). Importantly, each of these accounts of Pidgin vowels identifies a

[32] This work is based on interviews conducted with both Pidgin and non-Pidgin speakers from 1973 to 2004.
[33] Presumably, acrolectal speakers were not addressed separately because of the purported similarity between acrolectal Pidgin and Hawai‘i English.

significant amount of inter- and intra-speaker variation, due to nature of the creole continuum (Sakoda & Siegel 2008: 218) and the fact that most speakers are bilingual in English.

2.4.2.1. A note on the representation of vowel classes

Before discussing Pidgin phonology, it is necessary to address the issue of how vowels will be represented in this dissertation. Linguists who study English vowels vary in the terminology they use to discuss categories of vowels, and this often correlates quite well with where (or in what school) the linguist was trained. There are two common methods of representing vowels in the existing literature that deals with variation in English. The first is the Wells (1982) system of representation, which is commonly used by non-American linguists. This system uses words in which a particular word is found to illustrate the vowel sound itself (e.g., GOOSE refers to the vowel /u/, and TRAP refers to the vowel /æ/). These words are represented in small caps to make it clear that the lexical set is being referenced, not the word itself. Table 2.1 shows the Wells lexical sets along side IPA transcriptions of vowel realizations in Hawai‘i English (these realizations are based on observations made in Drager et al. 2013 and Kirtley et al. forthcoming). Example words are also provided for each lexical set in table 2.1. The second common method of vowel representation is the Labovian method (used commonly by American linguists), where short vowel phonemes are represented as unary (e.g., /e/ refers to a mid front lax vowel with no offglide) and long vowel phonemes are represented as vowel-offglide sequences (e.g., /iy/ refers to a high front tense upgliding vowel) (see, e.g., Trager & Bloch 1941; Labov et al. 1972; Labov et al. 2006). While both of these systems are more transparent when discussing variation than using IPA symbols (which often refer to broad categorical dimensions that are too coarse to accurately describe variation), they have been formulated for English, not creole systems. Therefore, the vowel categories are biased towards the historical sound changes that took place in English and may not apply equally well (or, in fact, may even be ill-suited) to the creole in question (see Wassink 1999). For Pidgin, an English-based system of representation might also be ideologically problematic because Pidgin exists in socio-ideological opposition with English. Despite these potential difficulties, English is the main lexifier language for Pidgin, and it is therefore quite likely that sound changes in Pidgin would parallel those found in English.

Table 2.1. Wells (1982) lexical sets for English, along with IPA representations of these lexical sets in Hawai‘i English, and example words.

Wells (1982) Lexical Sets	**Hawai‘i English IPA representation**	**Example words**
FLEECE	[i]	eat, cheese, beam, peel
KIT	[ɪ]	ship, kid, dim, bill
FACE	[e̞]	late, fade, pain, mail
DRESS	[ɛ̞]	step, bread, tent, sell
TRAP	[a]	tap, bad, man, valley
GOOSE	[ʉu̯]	boot, fruit, room, rule
FOOT	[ʊ̈]	book, good, put, pull
GOAT	[o]	soap, road, home, toll
THOUGHT	[ɑ]	hawk, broad, lawn, fault
STRUT	[ʌ]	cup, rub, hum, pulse
LOT	[ɑ]	stop, sob, mom, solve
PRICE	[aɪ̯]	ripe, side, fine, mile
MOUTH	[aɔ̯]	out, loud, sound, towel
CHOICE	[öɪ̯]	voice, noise, coin, spoil

As a middle-ground, this dissertation devises and employs a modified lexical set system (based on Wells 1982), where Pidgin words take the place of their English counterparts. To help represent Pidgin’s status as a language separate from English, the Odo orthography (see Appendix A) is used in each representative lexical set (e.g., CHRAEP is a representation of the English word ‘trap’ in Pidgin using Odo orthography). A similar system is implemented in Sakoda and Siegel (2008), but they use English words and English orthography to represent the lexical sets.[34] The system used in this dissertation is represented in table 2.2. Each word denoting a lexical set was selected in part based on the words selected by Sakoda and Siegel (2008), and in part based on what the author felt constituted a more appropriate lexical item based on language use in Hawaiʻi. It is also worth noting that though these lexical sets are meant to be analogs of those created by Wells (1982), some of the lexical sets are not useful in Pidgin; hence, these lexical sets are not included as separate vowel classes. Example words in Pidgin are also included for each lexical set.

Table 2.2. Correspondence of IPA vowel symbols to Wells (1982) and the lexical sets discussed in this dissertation.

Vowels (IPA)	Wells (1982)	Grama (2015)	English Transliteration	Example Pidgin words
/i/	FLEECE	SHCHRIT	street	*kip* ‘keep’, *nid* ‘need’, *klin* ‘clean’
/e/	FACE	FES	face	*plet* ‘plate’, *afred* ‘afraid’, *dren* ‘drain’
/ɪ/	KIT	STIK	stick	*niko* ‘nickel’, *rib* ‘rib’, *fin* ‘fin’
/ɛ/	DRESS	JRES	dress	*step* ‘step’, *sed* ‘said’, *ten* ‘ten’
/æ/	TRAP, BATH[35]	CHRAEP	trap	*taep* ‘tap’, *baed* ‘bad’, *maen* ‘man’
/u/	GOOSE	SHUTS[36]	shoots	*but* ‘boot’, *frut* ‘fruit’, *rum* ‘room’
/ju/	FEW[37]	FYU	few	*nyuz* ‘news’, *yus* ‘use’, *fyum* ‘fume’

[34] Sakoda and Siegel (2008) provided the inspiration for the system described in this dissertation.
[35] Wells (1982) describes the BATH lexical set thusly: "…BATH words belong phonetically with TRAP in GenAm [(i.e., they are realized as /æ/)], but with PALM and START in RP [(i.e., they are realized as /ɑː/)]" (134). Though it is merged with TRAP in most mainland American varieties, certain regions (e.g., the Mid-Atlantic region of the U.S.) exhibit a split-TRAP/BATH system (for more, see Labov et al. 2006: 171-179).
[36] The Pidgin word *shuts* can be used either to express consent or agreement, as in (a), or to mean "see you later", as in (b) (often used with *den*):

(a) gai: *yu laik wan bia?*
aDa gai: *shuts!*

(b) grl: *ho so leit! ai get wrk sun!*
aDa grl: *shuts den!*

[37] FEW contrasts with GOOSE in post-apical position in some English varieties (e.g., *toon* /tun/ vs. *tune* /tjun/), which is relevant when discussing Pidgin.

/o/	GOAT	JOK	joke	*sop* 'soap', *rod* 'road', *hom* 'home'
/ʊ/	FOOT	FUT	foot	*put* 'put', *gud* 'good', *buk* 'book'
/ʌ/	STRUT	STAF	stuff	*fas* 'fuss', *tab* 'tub', *ham* 'hum'
/a/	LOT, PALM[38]	LAT	lot	*stap* 'stop', *nad* 'nod', *swan* 'swan'
/ɔ/	THOUGHT, CLOTH[39]	TAWK	talk	*hawk* 'hawk', *broad* 'brawd', *lawn* 'lawn'
/ai̯/	PRICE	PRAIS	price	*raip* 'ripe', *said* 'side', *fain* 'fine'
/au̯/	MOUTH	HAUS	house	*aut* 'out', *laud* 'loud', *saund* 'sound'
/ɔi̯/	CHOICE	BOIZ	boys	*vois* 'voice', *noiz* 'noise', *koin* 'coin'

In this dissertation, Pidgin vowel classes are referenced using the lexical sets proposed in table 2.2 in the column headed "Grama (2015)". When English lexical sets are referenced, they take the Wells (1982) form. Vowels before /r/ are not considered in this dissertation, and so no Pidgin lexical sets are proposed for them.[40]

2.4.2.2. Phonology of Pidgin vowels based on auditory analysis

Sakoda and Siegel (2008) describe basilectal Pidgin as having a seven-vowel system with three diphthongs, PRAIS, HAUS, and BOIZ. Basilectal Pidgin does not distinguish high lax vowels from high tense vowels, so there is no distinction between SHCHRIT and STIK, nor is there a distinction between FUT and SHUTS (222). They describe what might be called a SHCHRIT-STIK

[38] PALM is described as comprising only a few high frequency words in English (e.g., *father*, *ma*, *pa*); it is otherwise comprised of borrowings into English (e.g., *Bach*, *façade*, *spa*, *sonata*, *legato*) (Wells 1982).
[39] Wells (1982) describes the CLOTH lexical set thusly: "…CLOTH words belong phonetically with THOUGHT in GenAm [(i.e., they are realized as /ɔ/)], but with LOT in RP [(i.e., they are realized as /ɒ/)]" (136). As with U.S. LOT and THOUGHT, there is regional and idiosyncratic variation in the pronunciation of CLOTH.
[40] /r/ influences the realizations of vowels substantially, so much so that Wells (1982) often uses different lexical sets to refer to vowels before /r/. While the behavior of certain vowels before /r/ is certainly a topic of interest, a consideration of time made it difficult to incorporate vowels in this environment. In Pidgin, post-vocalic /r/ is described as being vocalized in word-final position (e.g., 'store' [stoɑ]) or not generally found in basilectal varieties (e.g., 'hard' [hɑd]) (Sakoda & Siegel 2008: 226). The only /r/-colored vowel in basilectal Pidgin is [ɜr], found in stressed positions in lexemes like 'bird' [bɜrd] (see also the discussion of /r/ realized across basilectal and mesolectal speakers in Odo 1975).

lexical set as occupying a large space in the high, front area of the vowel space, from relatively tense [ɪ] to laxer [i]. Likewise, what might be called the SHUTS-FUT lexical set ranges from a relatively tense [ʊ] to a laxer [u]. Raised and tensed productions of STIK and FUT are most evident in stressed syllables and monosyllabic words (222), and SHCHRIT is described as being generally laxer than the FLEECE typical of English speakers. These observations are corroborated by Bickerton and Odo (1976: 63), who state that the phonetic sequences [bit] and [bɪt] may refer equally to the words *beat* or *bit* in Pidgin.[41] However, Bickerton and Odo suggest that this raising is context-free for both high front and high back vowel tense/lax pairs. Sakoda and Siegel (2008) report that mesolectal speakers of Pidgin exhibit generally distinct high vowel pairs (i.e., STIK is generally distinct from SHCHRIT and FUT is generally distinct from SHUTS) (224). Furthermore, they report that raising and tensing of STIK and FUT are both salient markers of basilectal Pidgin speech (224).

Sakoda and Siegel (2008) note that the mid vowels FES and JOK may be realized as monophthongal or diphthongal depending on phonological environment. FES is monophthongal word-internally before a voiceless consonant (e.g., [mek] 'make'), whereas JOK is monophthongal preceding [m] (e.g., [hom] 'home'). Sakoda and Siegel report that both mid vowels are realized as monophthongal word-finally (e.g., [de] 'day', and [no] 'know'). In all other environments, Sakoda and Siegel (2008) suggest that FES and JOK are diphthongal. Bickerton and Odo (1976) corroborate that FES and JOK are monophthongal word-finally, and further suggest that monophthongal realizations of these mid vowels are more common as speech rate increases (80-81).[42] Sakoda and Siegel do not report mesolectal Pidgin as exhibiting any

[41] Incidentally, these words are both written *bit* in Odo Orthography (see Appendix A).
[42] Both Sakoda and Siegel (2008) and Bickerton and Odo (1976) observe that Pidgin speakers produce less centralized vowels in unstressed syllables that many English varieties would reduce to [ə] or [ɨ]. This feature has

differences in comparison to basilectal Pidgin. Wells (1982: 650) observes that Pidgin may lack a distinction between FES and JRES, though this finding is not corroborated by the rest of the literature on Pidgin.

There is no distinction between the short front vowels JRES and CHRAEP in basilectal Pidgin, as both are realized as [æ̝]; however, JRES may be raised to [ɛ] in all environments (Sakoda & Siegel 2008: 222). In mesolectal Pidgin, these two vowels are described as more closely approximating their English counterparts; that is, JRES can be realized as [ɛ] and CHRAEP can be realized as [æ] (225). However, Sakoda and Siegel also suggest that some mesolectal speakers may not exhibit a distinction between JRES and CHRAEP, but they do not describe any factors that might motivate this lack of a distinction. In addition, Bickerton and Odo (1976) observe that JRES lowers in the presence of /l/ (e.g., [læt] 'let', [wæl] 'well'), and that some Local speakers have generalized this lowering to include any non-obstruents (e.g., [fræ̃n] 'friend', [ræs] 'rest', [sæ̃n] 'send') (78).

The low back vowels STAF, LAT, and TAWK are described as being in one of several relationships. For both basilectal and mesolectal speakers, Sakoda and Siegel (2008) state that STAF varies freely between [ɑ] and [ʌ], so that *gut* would be homophonous with *got*. Sakoda and Siegel also report that LAT and TAWK may both be pronounced as [ɔ],[43] suggesting that LAT and TAWK may comprise a single lexical set in Pidgin (222-223). On the other hand, mesolectal speakers may pronounce LAT and TAWK as either [ɒ] or [ɔ]. Sakoda and Siegel contend that this neutralization occurs for people in Hawaiʻi who speak varieties of English with the LOT-THOUGHT merger (224-225). Odo (1977) corroborates the variable nature of the LAT and TAWK lexical sets, observing that some speakers exhibit variable pronunciations even within the same

also been noted for Hawaiʻi English (Sato 1993: 135). This dissertation does not focus on unstressed vowels, but this phenomenon merits further inquiry.

[43] [ɔ] is perhaps an ill-suited representation of TAWK (Donegan p.c.); I reproduce the symbols here for consistency.

lexical items. With this in mind, there are three logically possible systems involving the three low back vowels in Pidgin.[44]

1) A two-way distinction, where LAT-TAWK form a single lexical set that is realized as [ɔ] or [ɒ], and STAF is realized as [ɑ].
2) A two-way distinction, where LAT-STAF form a single lexical set that is realized as [ɑ], and TAWK is realized as [ɔ].
3) A three-way distinction, where TAWK is realized as [ɔ] or [ɒ], LAT is realized as [ɑ], and STAF is realized as [ʌ].

These observations are corroborated by Bickerton and Odo's data, which suggests a general distinction between LAT and TAWK in Pidgin. However, their data does not suggest that LAT and STAF may be realized as overlapping.

The diphthongs PRAIS, HAUS, and BOIZ are not described by Sakoda and Siegel as differing in their realizations from English, except that BOIZ varies freely in pronunciation between [ɔɪ] and [oɪ] in both basilectal and mesolectal Pidgin. However, Bickerton and Odo (1976: 63) observe that diphthongs in Pidgin are characterized by more centralized offglides than what is found in English (e.g., [ae̯] 'I', [hao̯] 'how', [boe̯] 'boy').[45]

A summary of the findings from the existing literature on the phonology of Pidgin can be found in table 2.3 below.

[44] Sakoda and Siegel also make reference to the PALM lexical set, which they describe as invariably realized as [ɑ]. For the purposes of this discussion, PALM is considered as the same lexical set as LAT in Pidgin (see §6.1.1).

[45] The transcriptions provided by Bickerton and Odo (1976) are potentially misleading, as centralized offglides are not atypical of English dialects (cf. Donegan & Stampe 2009). It is possible that what Bickerton and Odo notice has at least somewhat based on claims that Pidgin is a syllable-timed language (compare English, which is a stress-timed language; Vanderslice & Pierson 1976: 157). This means that in Pidgin, diphthong nuclei and offglides likely exhibit more similar durations than what is observed in English, which might lead to the percept of centralization.

Table 2.3. Summary of vowel phonological system of Pidgin (based on Bickerton & Odo 1976; Odo 1977; Wells 1982; Sakoda & Siegel 2008) with IPA symbols and lexical sets proposed in this dissertation.

Vowel	Basilect	Mesolect
SHCHRIT	i , ij (lax)	i , ij
STIK	i	ɪ
FES	eɪ , e	eɪ , e
JRES	æ̝ , ɛ , e	ɛ , æ̝
CHRAEP	æ̝	æ̝ , æ
SHUTS	u	u
FUT	u	ʊ
JOK	oʊ̯ , o	oʊ̯ , o
TAWK	ɔ	ɔ , ɒ
LAT	ɔ	ɔ , ɑ , ɒ
STAF	ɑ , ʌ	ɑ , ʌ
PRAIS	ɑɪ̯ , ae̯	ɑɪ̯ , ae̯
HAUS	ɑʊ̯ , ao̯	ɑʊ̯ , ao̯
BOIZ	oɪ̯ , ɔɪ̯ , oe̯	oɪ̯ , ɔɪ̯ , oe̯

No vowel length distinctions are reported for Pidgin in the existing literature; that is, overlapping pairs (e.g., SHCHRIT-STIK) are not described as exhibiting different vowel lengths. Therefore, the claim in phonological descriptions of Pidgin appears to be that overlapping vowel classes are a single phoneme. However, as work by Sabino (1996) and Wassink (1999, 2001, 2006) have shown, there might be good reason to expect that vowel length would be a variable of interest in creoles that are lexified by languages with tense-lax distinctions (e.g., English and Dutch). In fact, the current study demonstrates that vowel length is an important variable to consider when discussing the spectral overlap exhibited by vowel classes. This is a point that will be returned to in §2.5.

2.4.3. Acoustic phonetic variation in Hawai‘i English vowels

Hawai‘i English and Pidgin are closely linked. Hence, it is important to describe phonetic variation in Hawai‘i English vowels when considering what kinds of variation will arise in Pidgin. In comparison to other regional dialects (e.g., the Northern Cities; see Labov 2001), less work has been done on variation in Hawai‘i English; however, a large enough body of research exists to facilitate a discussion of variation in Hawai‘i English vowels.

Ongoing work by Drager and colleagues demonstrates several patterns of variation in the vowels of Hawai‘i English. First, FACE is realized as largely monophthongal, similar to what is observed in the North Central region of the mainland U.S. (e.g., Minnesota and the Dakotas) (see Gordon 2004), and it is realized in a lower and slightly backer position relative to FLEECE.[46] In the short front vowels KIT, DRESS, and TRAP, the vowel realizations of younger speakers differ markedly from those of older speakers. Drager et al. (2013) report that TRAP is retracted for younger speakers (see table 2.1), and it exhibits no pre-nasal diphthongization that is characteristic of other dialects, like California English (Eckert 2008).[47] They also find that males produce lower, backer variants of KIT and DRESS in comparison to females, but no gender effect is found for TRAP. Additionally, Drager at al. (2013) demonstrate that short front vowel realizations vary based on whether a young speaker self-reports an ability to speak Pidgin. For young speakers who report an ability to speak Pidgin, Drager and colleagues find that KIT is higher in comparison to young non-Pidgin speakers, DRESS is realized with a backing offglide, and TRAP has a higher onset with a low-backing offglide (compare with realizations noted in table 2.1).

Hawai‘i English also exhibits variation in back vowels. LOT and THOUGHT, two vowels that are variably distinct throughout the mainland U.S., are merged for young speakers of Hawai‘i English (Hay et al. 2013; Kirtley et al. forthcoming), though older speakers are reported to have a clear distinction between the two vowels (Wells 1982: 650). Furthermore, GOOSE

[46] These findings are from spontaneous data from Kirtley et al. (forthcoming). They also report wordlist data, where they find that midpoint values of FACE and FLEECE are quite overlapping.
[47] Despite this, the midpoint of TRAP before nasals is fronter and higher relative to other phonological contexts in Hawai‘i English speakers (Drager et al. 2013: 43).

exhibits a relatively fronted nucleus in post-coronal environments for younger speakers (Kirtley et al. forthcoming), and young females exhibit a fronted midpoint in GOOSE relative to older speakers, indicating a change in progress in apparent time (Simpson et al. 2014). Both old and young females also exhibit a preference for fronted pronunciations of GOAT in post-coronal environments, and GOAT is lowering in apparent time (Simpson et al. 2014).[48] However, GOAT does not exhibit fronting in apparent time, and the vowel is realized as back and monophthongal (Kirtley et al. forthcoming). The apparent lack of fronting of GOAT corroborates Sato's (1993: 135) observation that GOAT is more monophthongal than mainland English varieties (see also Odo 1977). The high back lax vowel FOOT is centralized in all phonological contexts for young speakers (Kirtley et al. forthcoming), similar to its realization in California (Eckert 2008).

Finally, diphthongs in Hawai‘i English exhibit variation in their realizations. PRICE is realized with a raised nucleus and offglide when preceding voiceless segments (Kirtley et al. forthcoming), similar to what is observed in other English varieties (e.g., Canada) (Labov et al. 2006). However, MOUTH is realized quite differently from what is found in mainland U.S. dialects. The nucleus of MOUTH is located in a low central area of the vowel space and terminates in the space occupied by LOT and THOUGHT over its duration (i.e., the vowel sounds something closer to [ɐ̹ɔ] rather than [aʊ] or [æʊ] of the North American mainland) (Kirtley et al. forthcoming). Compared to /aw/ in the Atlas of North American English, MOUTH in Hawai‘i appears much backer relative to other dialects. There is no marked difference in realizations of CHOICE in Hawai‘i relative to other North American dialects (Kirtley et al. forthcoming).

[48] Post-coronal environments also have a lowering effect on the midpoint of GOOSE and GOAT in female speakers of Hawai‘i English (Simpson et al. 2014).

2.5. Acoustic gradience and vocalic variation

While studies have described the phonology of Pidgin and there is some work addressing the acoustic variation exhibited by Hawai‘i English, there is no variationist account of Pidgin vowels that uses acoustic phonetic analysis. It may be the case that auditory analysis alone is sufficient when identifying phonological trends over time; however, the current study argues that more sensitive measures are required when investigating vowels (and indeed all phonetic segments) for three reasons. First, vowels themselves are characterized by acoustic energy that is distributed over time. Therefore, they are by definition acoustically non-discrete, though they are perceptually categorical (Fry et al. 1962). Second, the ever-growing body of variationist research has shown that speakers exhibit principled variation in vowels that is measureable through the lower two formants,[49] where F1 is correlated with vowel height and F2 is correlated with vowel frontness (see e.g., Labov 2001; Clopper et al. 2005; Labov et al. 2006; Hall-Lew 2009). These changes in vowels are often only detectable when measuring formant values, and thus require sufficiently sensitive tools to capture smaller-scale variation. Furthermore, gradient measures can be applied to other acoustic characteristics of the speech stream, such as vowel duration. While no existing work on Pidgin describes the language as exhibiting phonemic vowel length, work by Sabino (1996) and Wassink (1999, 2001, 2006) suggest that vowel length is a feature which creoles can employ to distinguish vowel categories. That is, even if vowels exhibit spectral overlap in F1/F2 space, they can still exhibit temporal differences which might serve to distinguish the vowel categories. The current study shows that vowel length is an important feature to consider when analyzing variation in vowels. This kind of variation, however, is most effectively characterized using quantitative acoustic measures.

[49] By principled variation, I mean variation that is distributed across test categories (e.g., gender, social class, phonological context) in predictable ways. This term can be contrasted with random variation, where test categories do nothing to help explain why speakers exhibit the variables they exhibit.

Third and finally, regardless of the prowess and experience of the linguist, the human ear and mind will always exhibit a certain bias when perceiving the relative articulatory position of a vowel (Lisker 1988; Kent 1996). Rigid acoustic measures, such as those used in this dissertation, are a way to create a relatively unbiased, objective account of the way vowels are realized for any speaker. Acoustic analysis of this kind is common practice in sociolinguistic research; however, it is much less prevalent in creole studies. Despite this, studies of creoles which have focused on acoustic phonetic variation (Veatch 1991; Sabino 1996, 2012; Wassink 1999, 2001) have been successful in explaining some of the complex variation that has been alluded to in phonological studies of creoles based auditory analysis. Wassink (1999, 2001), for example, demonstrates that despite obvious influence from the main lexifier language on vowel quality, acrolectal Jamaican Creole speakers exhibit significantly different vowel spaces in certain ways (e.g., in vowel length) from Jamaican English speakers. Thus, attention must be paid to this acoustic gradience in order to describe vocalic variation in Pidgin over time, gender, phonological context, and with respect to a speaker's use of Pidgin morpho-syntax. The specific methods of acoustic phonetic analysis that were used for the study reported in this dissertation are presented in Chapter 3.

The goal of the preceding chapter is to establish that there is a significant void in the literature regarding the acoustic variation exhibited by Pidgin. It is the goal of this dissertation to fill that void to some extent. The following chapter describes the methods used to address the question of acoustic variation in Pidgin over age, gender, phonological context, and a speaker's use of Pidgin morpho-syntactic features.

CHAPTER 3

METHODOLOGY

The main questions this study seeks to address are how vowels have changed in Pidgin over time, as a function of gender, phonological environments, and to what extent Pidgin morpho-syntactic items influence the production of vowels. To explore this, the study uses both real and apparent time data taken from archived data from two corpora that were collected for other studies.[50] This data was appropriate to answer questions of language change over time because they represented two independent samplings of the community 30 years apart. That the data was already in existence was also preferable, as the author was not a native speaker of Pidgin and therefore would not have been able to reliably conduct an interview in Pidgin. Finally, the data offered a broad range of interviews with Pidgin male and female speakers of many different ages. This made it likely that a balanced data set could be created from these corpora, with even numbers of speakers across age group and gender.

Despite this, there were several challenges that organizing the data for analysis presented. Because the data were not designed to address the current research question, they were often not digitized, and they were not fully transcribed or time-aligned, all of which are required for the methods outlined in this chapter.[51] Thus, it was necessary to spend a great deal of time preparing the existing data and putting it in a form that was both analyzable and, importantly, that would

[50] The focus of the research associated with the 1970s corpus (referred to here as the BC corpus; see §3.1 for a discussion of the corpora) was describing the linguistic structure of Pidgin, including an in-depth look at the phonology and morpho-syntax of the language. For work based on the BC corpus, see Bickerton and Odo (1976) and Odo (1975, 1977). The 2000s corpus (referred to here as the IV corpus; see §3.1) sought to update the knowledge gained from research born out of the BC corpus for a more contemporary look at the structure of Pidgin. For work based on this data, see Sakoda and Siegel (2003, 2008).

[51] Kent Sakoda has informed the researchers working on the Language Variation and Change in Hawai‘i project that some interviews from the IV corpus had previously been transcribed, but we have been unable to locate the transcripts.

produce a reliable estimation of the vowel spaces of the speakers in question. This meant constructing a dataset from existing data as if the intent of the original studies had been to conduct variation-focused acoustic phonetic analysis. In this chapter, I will describe how this was achieved (see also workflow chart in Appendix C). First, I describe the corpora that were available for analysis and how I selected interviews from these corpora for analysis (§3.1). Then, I address how each interview was transcribed and prepared for acoustic analysis (§3.2), and I discuss how the Pidgin Density Measure (PDM) was calculated, and focus on some of the insights the score provides as a data point itself (§3.3). Following this, I discuss how the findings of this study will be represented, focusing specifically on how vowel distributions are graphed (§3.4) and how inferential statistics are implemented (§3.5).

3.1. Interviews, their content and selection criteria

Interviews were selected from two corpora: the Bickerton Collection (BC) corpus and the Influences and Variation in Hawai‘i Creole English project (IV) corpus. Both corpora were accessed through Kaipuleohone, the University of Hawai‘i’s digital archive for audio and video recordings. The BC corpus consists of a wide range of recordings with Hawai‘i-born and non-Hawai‘i-born L1 speakers of various languages across the Hawaiian Islands. These interviews were mostly conducted between 1970 and 1980.[52] In contrast, the IV corpus consists mainly of recordings with Hawai‘i-born Pidgin speakers from O‘ahu, Big Island, Kaua‘i and, to a lesser extent, Maui. Interview styles also differed between the two corpora. In the BC corpus, the interviewer tended not to be previously acquainted with the interviewee. BC interviewers also tended to ask about Pidgin and its perceived role in Hawai‘i much more often than interviewers in the IV corpus. IV interviewers, in contrast, tended to be previously acquainted with the people

[52] A later batch of recordings (the Sato recordings) was collected from many of the same male participants interviewed in the BC corpus to provide longitudinal data to address issues of decreolization. These recordings were conducted in the 1990s, and they are not analyzed here.

they were interviewing.[53] Furthermore, metalinguistic discussions of Pidgin were often (though not categorically) avoided. For both corpora, however, a strong focus was placed on getting the interviewee to *tawk stawri* 'talk story', that is, discuss his/her life experiences, tell stories, construct narratives, and (especially in the case of relatively older speakers) describe life as it was in the past.

Selecting analyzable interviews from both of these corpora proved challenging. While many of the interviews were traditional, one-on-one interviews, many others (especially in the BC corpus) were recordings of television and radio programs. After narrowing down only those recordings which involved interview or conversation data across both corpora, there were approximately 320 potentially analyzable recordings available. However, a great many of these recordings were unfit for acoustic phonetic analysis for a variety of reasons. First, many recordings were made in non-ideal conditions; wind, background noise, static and feedback made it difficult (and in some cases, impossible) to extract reliable acoustic speech data. Second, not all recordings were long enough to provide enough speech to reliably map a speaker's vowel space.[54] Third, recordings were often made involving more than two interlocutors, and overlapping speech can be problematic when attempting to measure and extract formants. Many of the interviews had an additional issue where certain speakers would feature prominently for some stretches and then not speak again for the remainder of the interview. This made it difficult to gauge ahead of time how much speech could be reliably extracted from any one speaker.

---

[53] On more than one occasion, the interviewer was dating or was good friends with the interviewee.

[54] It is somewhat tricky to establish exactly how many vowel tokens is "enough" to accurately map a speaker's vowel space. This depends on how many vowels there are in the language, what phonological environments these vowels appear in, how frequent the vowels are, among other considerations. Following Labov et al. (2006: 36), approximately 300 vowel tokens per speaker was the target number of vowel tokens for the current study. For this study, approximately 340 vowel tokens per speaker were analyzed (see §3.2). This meant that certain recordings (e.g., those under 10 minutes in length) would not have provided enough speech from which to extract the requisite number of vowels to reliably map a speaker's vowel space. These recordings were eliminated as possible interviews for the current study based on this criterion.

Additionally, it was often the case that appropriate metadata was not available for speakers who may otherwise have been analyzable.[55]

Outside of these constraints, there were several issues that arose that further limited the number of available recordings. Because of this study's focus on the development of Pidgin, it was important that every speaker be born and raised on the islands (i.e., Local).[56] However, many of the recordings were of people who immigrated to Hawaiʻi later in life, and it was unclear whether the Pidgin they spoke would be comparable to Pidgin spoken by Locals born and raised in Hawaiʻi. Therefore, these recordings were not included in this dissertation. Additionally, many recordings contained speech that was not discernibly Pidgin.[57] Another constraining factor was the desire to create roughly equivalent age pairings between the two corpora. This proved difficult, as speakers in the BC corpus tended to be 10-15 years older than speakers in the IV corpus (see average breakdown in table 3.1). Perhaps the most constraining factor, however, was that interviewers did not speak Pidgin uniformly across the recordings. This was especially the case in the BC corpus, where many of the interviewers were themselves not Pidgin speakers. The speech of the interviewer is an important variable to consider, as work on speech accommodation has demonstrated (see, e.g., Giles et al. 1991), and an interviewee is less likely to speak Pidgin if his/her interviewer speaks English (see findings by Marlow & Giles 2008, 2010). Ultimately, this constraint proved to be difficult to completely account for, as the list of available recordings with appropriate metadata and a Pidgin speaking interviewer was

[55] This was particularly problematic when the speaker's age was not listed. Prior to the work conducted for this dissertation, the archive contained very little metadata for these corpora, so I listened to the interviews and coded the metadata, when available, from the interview's content. The speaker's age was not always a topic that was discussed, and it is not something that can reliably be extrapolated based only on speech.
[56] See §2.1 for a definition of "Local".
[57] If interviews were not Pidgin, they often were in English, Japanese or, in at least one case, Hawaiian. Interviews that may have been construed as English (e.g., had few morpho-syntactic markers of Pidgin; see §3.3) were generally avoided, even if the interviewees sounded like they were speaking Pidgin.

small (approximately 30) relative to the total number of viable recordings. In order to create a balanced dataset, three speakers, Malia (old BC female), Victor (young BC male), and Eddie (young BC male), were chosen who were interviewed by a non-fluent Pidgin speaker.[58] As a result of these constraints, a total of 35 speakers over approximately 80 recordings were available for analysis. From this, 32 speakers (16 from each corpus) were chosen that best fit the above constraints. A general breakdown of the groups can be found in table 3.1, and a specific breakdown can be found in table 3.2.

Table 3.1. General breakdown of corpus data demographics.

Speaker	Gender	Mean Age	Mean D.O.B.
old BC	4M, 4F	63	1912
young BC	4M, 4F	36	1937
old IV	4M, 4F	48	1958
young IV	4M, 4F	22	1985

Table 3.2. The demographics of speakers used in the current study; all names are pseudonyms; age reflects approximate age at the time of recording; all other information interpreted from interviews or listed in interview metadata.

Speaker	Age & Corpus	Gender	Rec. Age	D.O.B.	Island	Ethnicity	Highest Education Attended	Occupation
Joseph	old BC	m	69	1906	Big Island	Portuguese	no high school	retired plantation worker
Kawika	old BC	m	79	1896	Kaua‘i	Hawaiian	not known	retired motel owner, fisherman
Kimo	old BC	m	54	1921	O‘ahu	Part Hawaiian	high school	retired roofer, plantation worker
Manny	old BC	m	58	1922	Big Island	Filipino	high school	farmer, real estate
Kaimana	old BC	f	57	1918	O‘ahu	Hawaiian Haole[a]	high school	retired
Keiko	old BC	f	55	1918	Kaua‘i	Japanese	high school	home management

[58] In each case, it was clear from the interview that the interviewee and interviewer had a comfortable relationship with one another that was established prior to the recording itself.

Malia	old BC	f	64	1911	Kauaʻi	Hawaiian	high school	housewife
Miki	old BC	f	68	1907	Kauaʻi	Japanese	high school	retired barber
Danny	young BC	m	30	1942	Oʻahu	Filipino	high school	floorer
Eddie	young BC	m	39	1936	Oʻahu	Part Hawaiian	high school	construction worker
Glen	young BC	m	25	1944	Big Island	Japanese	high school	contract laborer
Victor	young BC	m	37	1938	Kauaʻi	Portuguese	high school	not known
Delia Jane	young BC	f	35	1940	Big Island	Filipino	high school	adult education instructor
Leilani	young BC	f	42	1933	Kauaʻi	Hawaiian	high school	housewife, retired entertainer
Mona Lisa	young BC	f	48	1927	Kauaʻi	Filipino	high school	not known
Teresa	young BC	f	35	1940	Kauaʻi	Filipino	college	air national guard
Grant	old IV	m	56	1951	Oʻahu	Japanese	college	government worker
Keoni	old IV	m	40	1967	Big Island	Part Hawaiian	high school	not known
Kevin	old IV	m	52	1955	Big Island	Hawaiian	not known	unemployed, ex-military/farmer
Palani	old IV	m	44	1963	Big Island	Part Hawaiian	not known	shop-owner
Carla	old IV	f	46	1961	Big Island	Portuguese	high school	unemployed
Kahea	old IV	f	42	1965	Kauaʻi	Part Hawaiian	high school	ranch worker
Lani	old IV	f	49	1958	Oʻahu	Part Hawaiian	high school	housewife
Pua	old IV	f	58	1949	Oʻahu	Part Hawaiian	high school	not known
Eric	young IV	m	21	1986	Big Island	Chinese, Filipino, Hawaiian	college	student
Kaleo	young IV	m	22	1985	Maui	Hawaiian, Korean, Haole	college	student
Alika	young IV	m	21	1986	Big Island	Japanese	college	student
Myko	young IV	m	22	1985	Kauaʻi	Portuguese	college	student
Lena	young IV	f	19	1988	Kauaʻi	Filipino, Japanese	college	student

Mina	young IV	f	21	1986	Kaua‘i	Japanese, Haole, Chinese, Hawaiian	college	student
Sarah	young IV	f	24	1983	O‘ahu	Chinese	college	M.A. student
Starla	young IV	f	23	1984	Big Island	Hawaiian, Chinese, Japanese	high school	not known

a. *Haole* is a Hawaiian word that means ‘foreign’, though it is also commonly used in Hawai‘i to mean ‘White’. In each of the cases reported here, Haole was used in the existing metadata to describe the interviewee. It is not known if the interviewees themselves identified as Haole.

3.2. Transcription and acoustic analysis

All interviews were transcribed and time-aligned using Transcriber.[59] Between 1,500 and 2,800 words per speaker were transcribed, depending on how much speech was available for that speaker; just over a mean 22 minutes were transcribed per speaker. Great pains were taken to ensure that the amount of transcribed speech was uninterrupted. This was desirable because it increased the likelihood that an interviewee would use roughly the same speech style with the same interlocutor, thus potentially reducing the amount of variation across interviews. However, the nature of the data sometimes made it difficult to transcribe 20 minutes of continuous speech. External noise (e.g., wind, traffic), sensitive material, overlapping speech, and recording imperfections (e.g., static, feedback) often made it necessary to skip a (sometimes significant) portion of the interviews until conditions became more appropriate for data collection. Transcribing overt discussions about Pidgin was avoided, as this often resulted in the speaker code-switching into English.[60] Table 3.3 is a summary of the total words transcribed, the

[59] Though the interviews were in Pidgin, all interviews were transcribed using English orthography. This was done in order to ensure proper forced-alignment (or, the automatic alignment of segmental information and transcribed orthographic information), as the HTK forced-aligner (Young 1994) on SOLIS (Drager, in prep) is not formatted to recognize Odo orthography (see Appendix A).
[60] There are exceptions to this tendency to code-switch (e.g., in the interview with Alika), but these instances were avoided so as to create as uniform a dataset as possible.

duration (in minutes) of the transcribed portion, and the words per minute (WPM) transcribed for each speaker.

Table 3.3. The duration of time in minutes, the total number of words, and the words per minute for each transcribed speaker.

Speaker	Age, Corpus, & Gender	Total Time Transcribed	Word Count	WPM[a]
Miki	old BC female	26:14	1,669	64
Keiko	old BC female	15:13	1,689	111
Kaimana	old BC female	18:45	2,324	124
Malia	old BC female	27:56	2,766	99
Kimo	old BC male	30:30	1,508	49
Kawika	old BC male	19:42	2,358	120
Joseph	old BC male	21:16	2,744	129
Manny	old BC male	32:06	2,831	88
Mona Lisa	young BC female	18:40	1,858	100
Teresa	young BC female	26:58	1,930	72
Delia Jane	young BC female	18:17	2,099	115
Leilani	young BC female	22:59	2,311	101
Danny	young BC male	19:36	1,735	89
Glen	young BC male	19:15	1,777	92
Victor	young BC male	14:42	2,045	139
Eddie	young BC male	19:23	2,245	116
Pua	old IV female	28:50	1,707	59
Lani	old IV female	14:05	1,727	123
Carla	old IV female	13:32	1,927	142
Kahea	old IV female	15:09	2,201	145
Kevin	old IV male	18:36	1,910	103
Keoni	old IV male	14:11	1,952	138
Grant	old IV male	17:06	1,976	116
Palani	old IV male	30:05	2,063	69
Mina	young IV female	33:42	1,840	55
Lena	young IV female	27:30	1,941	71
Starla	young IV female	24:09	1,966	81
Sarah	young IV female	20:24	1,984	97
Eric	young IV male	27:37	2,018	73
Myko	young IV male	21:48	2,038	93
Kaleo	young IV male	17:23	2,230	128
Alika	young IV male	11:55	2,142	180

a. The WPM value is rounded to the nearest whole integer.

These transcripts were uploaded to the Sociolinguistics Server (SOLIS) at the University of Hawaiʻi at Mānoa and force-aligned at the segment level by HTK forced-aligner (Hidden Markov Model Toolkit) via LaBB-CAT (Fromont and Hay 2012), a web-based tool that allows concurrent access to transcribed data in Praat (Boersma 2001)—an open source speech analysis program—and Transcriber (Barras et al. 2000), a speech annotation program. The forced-aligner bases its alignment by pairing the waveform signal data (and, secondarily, spectrogram information) in the uploaded *.wav* file with the orthographic transcripts from Transcriber (see Appendix D). The forced-aligner then creates smaller *.wav* files (corresponding to breaks made in Transcriber) and aligns phonetic information stored in a remote English dictionary with orthographic information. The phonetic information can then be searched for in each of the smaller files, as in figure 3.1. Each of these aligned segments also resulted in an annotated Praat TextGrid (figure 3.2), which could be used to analyze and evaluate the data in Praat. These TextGrids were downloaded and all of them were checked by hand in Praat to ensure the alignment was accurate. For every analyzed vowel, the identity of the vowel was labeled with its lexical class so that it could be easily searched for later (see also figure 3.2). Only prosodically prominent (i.e., stressed) vowels were coded and prepared for analysis in this way. In cases where the forced-aligner was not accurate (e.g., in the case of post-vocalic nasals, initial glottal consonants, and intervocalic laterals), the TextGrids were fixed to accurately fit the segments in question. These changes were made following a strict set of rules:

1) The information carried in the waveform was treated as paramount to information in the spectrogram; the waveform is more temporally accurate than the resulting spectrogram (Francis et al. 2003).
2) For vowels after voiced or voiceless stops, the burst and aspiration were included in the preceding consonant segment, not the vowel.

3) For vowels after /r/, the vowel was marked at the first point where F3 could be described as relatively steady-state (that is, unchanging).[61]

4) For vowels before and after fricatives, the beginning of the vowel was marked at the point immediately following the cessation of aperiodic energy. For voiced fricatives, the boundary between the vowel and fricative was determined using the increased amplitude in the waveform typical of vowels.

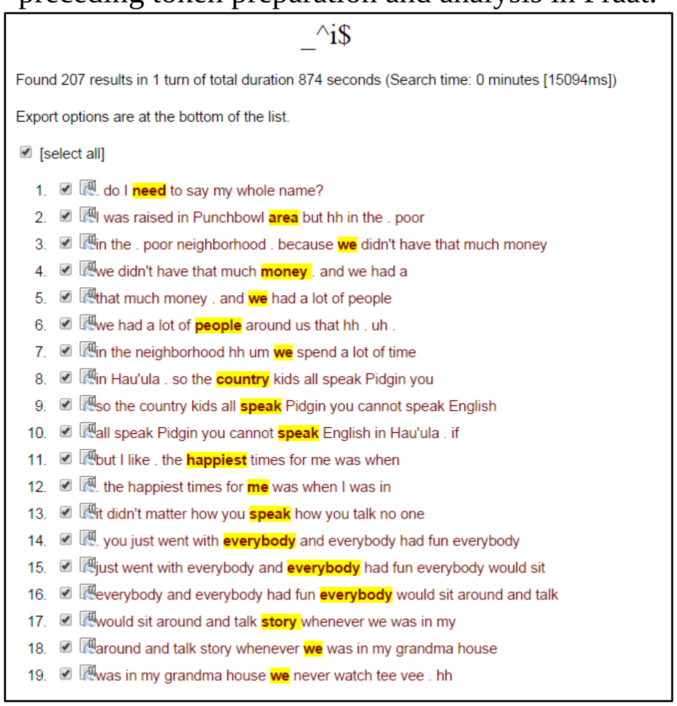
5) For vowels bordered by silence (or a glottal stop), the starting point was marked as the first high-amplitude vocal pulse evident in the waveform. The endpoint of the vowel was marked at the last high-amplitude vocal pulse evident in the waveform.

6) For vowels followed by oral and nasal stops, the end of the vowel was marked at the first evidence of the dampening of pulses in the waveform. In the case of nasals, a dampening of formants was also used to determine consonant production.

7) For vowels bordered by /l/, the endpoint of the vowel was marked at the last relatively high-amplitude vocal pulse; F2 blasting in the spectrogram was used as a secondary cue.

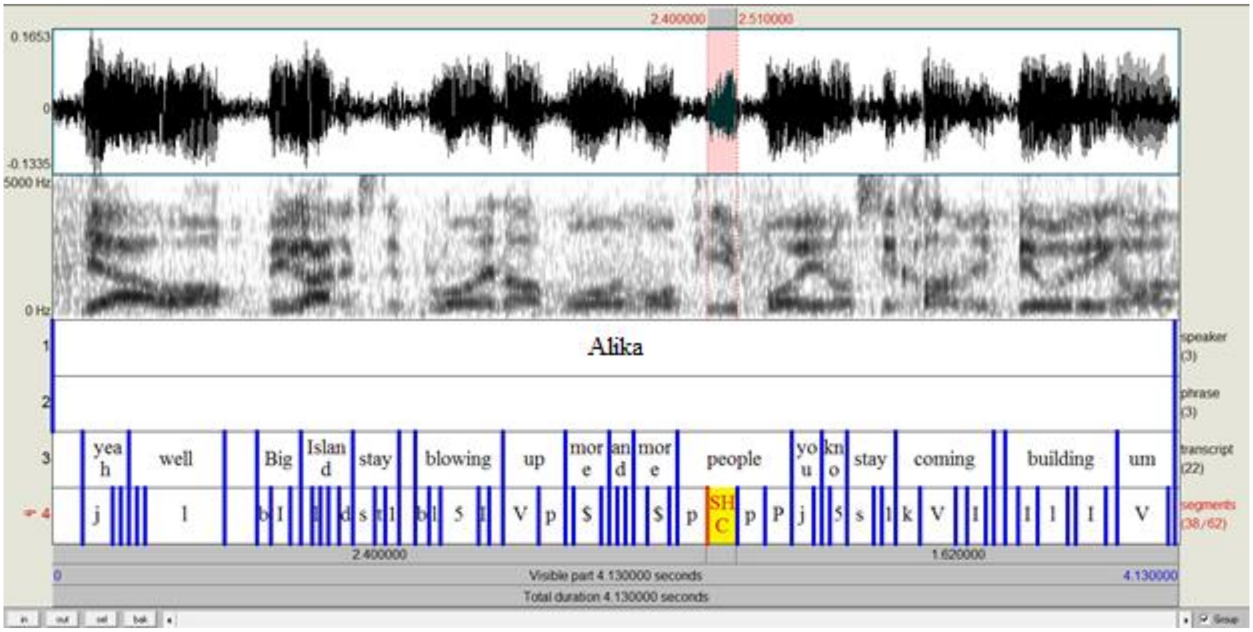
8) All new segments were made at the zero-crossing of the waveform.

Figure 3.1. Output from SOLIS of a queried vowel (here, "_^i$", or SHCHRIT; see §2.4.2.1) for Lani (old IV female) following accurate forced-alignment (only the first 19 examples shown), preceding token preparation and analysis in Praat.



[61] This terminology makes a somewhat faulty assumption that formants, which are inherently dynamic, can be classified as steady-state (see Harrington & Cassidy 1999: 59-60). In this case, "steady-state" is meant to refer to the relative point at which F3 ceases to dramatically rise due to the relative cessation of lip rounding, tongue bunching/raising, and/or pharyngeal constriction commonly associated with /r/ production (see, e.g., Johnson 2012: 139-140).

Figure 3.2. Example of aligned TextGrid for Alika (young IV male) with vowel marked (here, SHCHRIT).



The process of transcription, forced-alignment, extraction and checking for accurate alignment was done according to vowel identity for each speaker individually.[62] After it was established that the variables in question were accurately aligned, formants were checked in Praat to ensure that formant information would be accurately extracted from each vowel.[63] Use of Praat for phonetically analyzing speech in this way is considered standard practice in linguistics, and using Praat for phonetic analysis has several advantages over other programs designed to analyze sound, such as Audacity. Most importantly, Praat is specifically designed to analyze human speech, while programs like Audacity are often designed to process and manipulate sound files more generally. Furthermore, LaBB-CAT and HTK forced-aligner interface with Praat, meaning that Praat is the most efficacious program to use to analyze large amounts of acoustic phonetic data.

[62] This was done by using LaBB-CAT to search for individual segments (in this case, vowels); this process was executed for the full range of vowels for every speaker. This means that over 8,000 lines of transcribed data were processed in total.
[63] Each vowel has a formant signature associated with it; in order to optimize Praat's reading of these formants, the appropriate formant range for each vowel must be specified by the user. See appendix E for the information used during formant extraction.

After checking each vowel, a Praat script was used to extract information from the audio files and TextGrids.[64] See appendix E for a breakdown of the speaker preference information input to the Praat script used to guide formant extraction. The information extracted using the Praat script included: the identity of the vowel, the word in which the vowel appeared, the preceding and following phonological environments, the vowel's duration, the mean fundamental frequency, and readings of the first three formants, F1, F2 and F3 from seven equidistant points from 20% to 80% of the vowel's duration. This yielded two different types of data assigned to each vowel: midpoint data and transition data. Extracting formant values from multiple points makes it possible to observe the formant contour over the vowel's duration, rather than treat the vowel as a single, static midpoint value. For a breakdown of the mean formant values in hertz for each speaker's vowels from 20%-80%, see appendix F.

All formant measurements were normalized for vocal tract length in order to eliminate variation caused by physiological (rather than social) differences among the speakers. In doing so, sociolinguistic and phonological differences in vowel quality are preserved, and any conclusions derived from data analysis can be confidently assumed to arise as a result of the social or phonological factor in question (e.g., age, gender, post-coronal environment). Values were normalized using the Lobanov method (Lobanov 1971; Nearey 1977), a vowel-extrinsic method which compares formant values of different vowels from a given individual during normalization. This normalization method is among the most adept at factoring out physiological differences while retaining sociolinguistic differences among vowels (Adank et al. 2004). It converts hertz values to values that are centered on an estimated vowel-space centroid (at 0, 0), meaning that vowel data is largely represented as a series of values between 2.5 and -2.5 on the

[64] This is based on a script by Mietta Lennes (11/25/2004); it was modified by Abby Walker and Katie Drager to extract additional information (distributed under the GNU General Public License).

x-axis, and 2.5 and -2.5 on the y-axis. Though this method differs from traditional plots that display formant values in hertz, it creates consistently representative and readable vowel plots. The formula used in this study is listed in (1) (Lobanov 1971; Neary 1977):[65]

$$(1)\ {F_{n[V]}}^{N} = \frac{\left(F_{n[V]} - mean_n\right)}{S_n}$$

$F_{n[V]}$ is formant n of vowel V, $mean_n$ is the mean value for formant n for the speaker in question and S_n is the standard deviation for the speaker's formant n. ${F_{n[V]}}^N$ is the normalized value for formant n of vowel V.

The data extracted was then compiled into a spreadsheet. This spreadsheet was populated with all available data from the speakers (see §3.1). This yielded 11,544 vowel instances over all speakers. This data was then analyzed using the statistical program R (R Core Team 2013), and each vowel identity was checked for outliers. All formant readings were first checked over the duration of each vowel to ensure that accurate readings had been taken by the Praat script.[66] Outliers were then determined by plotting all instances of a single vowel at the group level and identifying those which fell outside the distribution of observed tokens.[67] In total, 353 vowels were removed as a result of bad extraction and outlier correction, yielding a total of 11,191 analyzable vowels. All of the remaining analysis was done in R, including the creation of vowel plots and running of inferential statistics. See Appendix C for a workflow summary of the

---

[65] In Lobanov (1971), root mean square is used instead of standard deviation in the denominator of the equation. However, Neary (1977) and Adank et al. (2004) report Lobanov's formula using standard deviation. To the author, it is unclear why this is the case, but in following recent practice (cf. NORM's Vowel Normalization Methods, http://ncslaap.lib.ncsu.edu/tools/norm/norm1_methods.php), I also use the standard deviation.

[66] Radical deviations from expected formant patterns (e.g., an F1 measurement of 300 Hz at 20% through the vowel followed by measurement of 600 Hz at 30%) constituted inaccurate readings and were treated as outliers and immediately removed.

[67] This was often easily done by visually inspecting the data, as most outliers were up to five or six standard deviations outside a given vowel's distribution.

methodology discussed in §3.1-3.2. See Appendix G for the mean Lobanov normalized formant values from 20%-80% across age group, gender, and vowel identity.

3.3. Deriving Pidgin Density Measure score

As is well-established by the literature (see §2.2.3 and §2.4), the relationship between Pidgin and English is less a dividing line and more a sliding scale. Pidgin is intrinsically tied to English in terms of linguistic development. Many words that often occur in Pidgin are also commonly used in Hawaiʻi English to convey the same meaning (e.g., *pau* ‘finish/finished’, *aenti* ‘relatively older female figure’, *anko* ‘relatively older male figure’, and *dakain*, a referent to a previously established or contextually known lexeme or topic).[68] Socially, the interconnectedness of these two linguistic systems is complex and extremely nuanced, as “speakers of HC [Hawaiʻi Creole] are able to enlarge the stylistic resources of the creole by switching to a co-existent English system” (Labov 1971[1990]: 36). This nuance is sometimes captured by describing Pidgin as basilectal, mesolectal, or acrolectal (see, e.g., Odo 1970; DeCamp 1971; Reynolds 1999; Sakoda & Siegel 2008), in an attempt to characterize the variety spoken by how structurally similar it is with the main lexifier language. However for the purposes of this study, it is problematic to characterize Pidgin as “basilectal” or “mesolectal” for a number of reasons. First, it would not have been prudent or practical to simply assign a speaker the label of, for example, “basilect”, as it would have been unclear what features of Pidgin were being used to justify this assignment. Furthermore, it is very likely that some features would be more likely to motivate a rating of “basilectal” than others, and it would have been very difficult to avoid circularity in using certain Pidgin features to characterize basilectal and not others.

[68] Wong (1999) suggests *dakain* can be used to add vagueness to an interaction and force interlocutors to rely on shared knowledge to interpret intended meaning. In this way, *dakain* can be used strengthen a sense of solidarity in an interaction by establishing and/or strengthening social ties between interlocutors.

Second, research has demonstrated that the scaling between basilect and acrolect is non-discrete, and that speakers may exhibit substantial variation even within a single lect (e.g., DeCamp 1971; Rickford 1987; Sato 1991, Wassink 1999). Therefore, there may be a range of ways for any Pidgin speaker (or group of Pidgin speakers) to exhibit basilectal or mesolectal speech. Third, it would not be possible to verify which lect the interviewee was speaking from the interviewer's perspective, and it was not feasible or practical (given that this study exclusively uses existing data) to ask a person what they speak (or what they are speaking at a particular moment). Furthermore, speakers may not realize or admit that they are speaking Pidgin (or Pidgin speakers) because of the history of language hegemony in Hawai'i.[69] Additionally, people in Hawai'i often have different ideas as to what "counts" as Pidgin, making it even more difficult to rely on a self-reported ability to speak Pidgin.[70]

Given the nature of the data used in this study, it stands to reason that a metric should be established that captures the nuance of what language people are speaking. The nature of the collection of this data prevents follow-up access to a majority of the speakers and makes it quite impossible to control the types of questions asked during the interviews. Therefore, it was necessary to operationalize an objective metric to quantify the "degree" to which a speaker's speech was Pidgin. One way that this problem has been approached in other areas that exhibit this type of potential for code-switching is by establishing a vernacularity index, or Dialect Density Measure (DDM) (Van Hofwegen & Wolfram 2010).[71] This is a metric that weighs

[69] In fact, while no speakers openly stated that they were not speaking Pidgin on the recordings, only a handful of the 32 speakers analyzed reported they were currently speaking Pidgin.
[70] Despite this, self-identification as a Pidgin speaker may well be one salient social factors that correlates with linguistic behavior (see Drager et al. 2013). To some extent, it may be less important that a person is able to speak Pidgin and more important to some extent that a person identifies as a person who *does* speak Pidgin.
[71] The use of the term "dialect" here merely serves to reproduce the terminology used in other publications that address the issue of multiple languages/lects used fluently by a single speaker. The existing research on Pidgin casts no doubt on the fact that Pidgin is a language separate from English.

elements in the language/dialect as relative indicators of the language being used. Van Hofwegen and Wolfram (2010) warn that this is sometimes a criticized tactic, as objectors raise the point that it reduces “vernacular varieties…to a simple inventory of unrelated features” (433);[72] however, there is precedent for the use of such a metric in both speech pathology and linguistics. Odo (1970), for example, chiefly uses syntax in her attempt to describe the processes of decreolization in Pidgin by establishing a hierarchy of what grammatical constituents can co-occur. Furthermore, work in speech pathology (e.g., Craig & Washington 2006) discusses the applicability and practicality of DDMs in the diagnosis of speech disorders. Furthermore, Van Hofwegen and Wolfram demonstrate that patterns in their own longitudinal African American English data were just as clear when using the DDM as when using individual variables, such as copula absence. Finally, it is possible that the variables individuals employ when they speak Pidgin are not strictly “an inventory of unrelated features,” but features that work together in the construction of a speaker’s style. Thus, a DDM is an attempt to operationalize a single measure of overall dialect use, but it crucially “does not seek to address the underlying causes for what features are exhibited at a certain time,” though it can be “a useful tool for quantifying vernacularity” (Van Hofwegen & Wolfram 2010: 434).

The current study appropriates the concept of the DDM to the linguistic situation in Hawai‘i and establishes a Pidgin Density Measure (PDM). In this study, PDM stands in place of terms such as ‘basilect’ or ‘mesolect’ to some extent, as these terms represent polar, local varieties, between which there is more-or-less continuous variation (see, e.g., Rickford 1987). The PDM, instead, treats the “degree” to which Pidgin is spoken as a continuous variable, thus offering a useful metric for quantifying the extent to which a speaker’s speech is basilectal.

[72] Vernacularity here refers not to non-standardness of a lect, but rather to the least self-conscious style of speech typical of people in relaxed conversation (see, e.g., Labov 1972).

While the specifics of establishing a successful PDM are not straightforward, as less research has been done on variation in Pidgin than on African American English, there is a sufficient base from which to construct a model for creating a PDM. As with the density measure established by Van Hofwegen and Wolfram (2010) for African American English, there are a large number of morpho-syntactic items that contribute to the calculation of the PDM score. Crucial to the purposes of this research, no feature is purely phonological in nature. The inclusion of phonological features would likely bias the PDM score, as the focus of the current research is on the phonetic realizations of phonological variables. In fact, variables that are operationalized in other DDMs are typically not phonological anyway. Van Hofwegen and Wolfram (2010) use 35 total variables to assess vernacularity, only two of which are phonological, and Wolfram and Van Hofwegen (2012) use 44 variables, only three of which are phonological.[73] Additionally, no feature used in the calculation of PDM score can simultaneously contribute to the PDM score and be available as an analyzable feature for vocalic analysis. This was done in order to ensure the independence of the test variable and the PDM score, drawing as sharp a line as possible between the analyzed phonological variables and the external metric used to evaluate Pidgin-ness. The full list of features is listed in table 3.4 including where the feature is described. Table 3.4 also provides the median and range of counts for each feature in each corpus. For a list with examples of the features included in the calculation of the PDM, see Appendix H.

[73] In both of these studies, the only phonological variable that arose as significant in their statistical analysis was nasal fronting (i.e., fronting alveolar nasal /ŋ/ to alveolar [n] in progressive verbal forms—for example, *swimming* becomes *swimmin'*). This is a widespread feature of English (Labov 2001), and also a feature which is tied to the addition of a morpheme (e.g., *sing* is not realized as *sin*). This form could therefore be classified as a morpho-phonological alternation, rather than a purely phonological one, which further underscores the degree to which morpho-syntactic items are used in traditional DDMs.

Table 3.4. List of features used to calculate Pidgin Density Measure score, an example of where these features are described, the relative frequency of each of the features overall and across corpora, and the percent change in feature frequency across corpora.

Feature	Described (for examples, see Appendix H)	Mean count	BC mean	IV mean	% change across corpora[a]
Present tense/copula features					
Ø-copula in predicate	Day (1972)	6.19	6.14	6.25	2
Ø-auxiliary in present progressive	Odo (1970)	5.03	4.58	5.55	21
ste	Bickerton & Odo (1976)	2.33	1.60	3.19	99
Anterior/past tense forms					
wen	Bickerton & Odo (1976)	3.75	1.53	6.36	316
haed	Sato (1993)	1.58	0.85	2.44	187
bin	Sato (1993)	0.23	0.15	0.32	113
Irrealis/future/hypothetical forms					
go	Reinecke (1969)	0.71	0.84	0.57	-32
gon	Bickerton (1981)	2.27	0.25	4.65	1,760
goin (no velar nasal)	Sakoda & Siegel (2003)	0.81	1.21	0.35	-71
Existential forms					
get	Odo (1970)	1.88	1.06	2.85	169
haed	Siegel (2000)	1.57	1.38	1.80	30
nomo	Sakoda & Siegel (2008)	1.75	1.32	2.26	71
Negative forms					
no	Siegel (2000)	5.15	3.39	7.23	113
nat	Sakoda & Siegel (2003)	1.84	0.58	3.33	474
neva	Odo (1970)	3.08	1.79	4.58	156
Clause final forms					
ae?	Sato (1993)	4.46	4.13	4.84	17
laiDat	Sakoda & Siegel (2003)	2.18	2.62	1.66	-37
bat	Sakoda & Siegel (2003)	0.89	0.91	0.87	-4
aeswai	Sakoda & Siegel (2003)	0.44	0.18	0.74	311
no?	Tonouchi (1998)	0.72	1.30	--	-100
awredi	Sakoda & Siegel (2008)	1.70	2.10	1.23	-41
Quantifiers/approximators					
dakain	Sakoda & Siegel (2003)	1.67	1.75	1.56	-11
kain	Sakoda & Siegel (2003)	3.22	2.54	4.03	59
Miscellaneous forms					
Possessive *get*	Sakoda & Siegel (2003)	6.13	5.10	7.35	44
Complement *fo*	Odo (1970)	3.49	0.95	6.50	584
Indefinite *wan*	Bickerton & Odo (1976)	8.79	4.47	13.88	211
Desiderative *laik*	Siegel (2000)	3.49	2.04	5.20	155
Ø-preposition in *kam/go* constructions	Sakoda & Siegel (2003)	2.67	1.59	3.94	148
Stative *kam*	Sakoda & Siegel (2003)	0.42	0.36	0.50	39
Hortative *chrai*	Sakoda & Siegel (2003)	0.57	0.71	0.43	-39
Object *em*	Bickerton & Odo (1976)	2.85	1.78	4.16	133

Verbal/adverbial *pau*	Bickerton & Odo (1976)	0.06	--	0.13	UNDEF
Adverbial *bambai*[b]	Bickerton & Odo (1976)	--	--	--	--
Inclusive *dem/gaiz/foks*	Sakoda & Siegel (2003)	0.80	0.60	1.03	72

a. The percent change was rounded to the nearest whole integer.
b. Despite its attested existence in Pidgin (see, e.g., Bickerton & Odo 1976), *bambai* was not exhibited by any speakers.

The rationale behind each of these features was based on a number of factors.[74] Oft reported grammatical markers of Pidgin were heavily relied upon, including aspect markers (e.g., *wen*, *gon*, *ste*), the absence of the copula, and existential markers (e.g., *get*). Discourse markers, post-clausal tags, and general extenders (see Overstreet 2005) were also used because they are reported to carry important meanings (most of which, with the exception of *ae*, are poorly understood and not well documented by linguists; see Da Pidgin Coup 1999);[75] there is also precedence for using tags to evaluate patterns of decreolization (see Sato 1993). Lexical items with limited grammatical function were generally avoided, with the notable exception of *dakain* and *kain*; these terms were included in the PDM score due to their ideological connection to Pidgin as a linguistic system (see, e.g., Wong 1999; Simonson et al. 2005; Drager 2012). Finally, certain patterns were excluded from the PDM calculation due in large part to the difficulty associated with measuring them without additional coding.[76] For more detail, see appendix H.

Each speaker's score was derived by counting the number of tokens within each of the features and then dividing that sum by the total number of words, as in (2) (Oetting & McDonald 2002).[77] This way, no single Pidgin feature was weighted more heavily than another, allowing

[74] The list in table 3.4 does not represent an exhaustive list of Pidgin features. Certainly, there are forms that have been excluded from this list that some native speakers of Pidgin would deem important when considering whether a person was speaking Pidgin.
[75] One common tag that was not included is *yae*, which carries largely the same meaning as 'you know?' or 'is that right?' in English. This was left out, as it is a common feature of Hawai'i English as well (see Drager 2012).
[76] For example, subject-predicate inversion (e.g., *kyut da bebi* 'the baby is cute!') is an oft reported feature of Pidgin, but it is quite difficult to search for without grammatical coding in place (something that Transcriber is not particularly well-suited for).
[77] There are, in fact, three recognized ways of calculating DDM scores that Oetting and McDonald (2002) compare; each method was determined to produce reliable (and highly consistent) measures.

the metric to produce a simple ratio of counted Pidgin forms to total words in the interview. Additionally, the metric was tailored to the speakers analyzed in this study so as to produce a relevant metric of Pidgin or Pidgin-like speech for the data in question.

$$(2)\ PDM\ score\ = \frac{(\sum Pidgin\ Forms\ )}{Total\ Word\ Count}$$

Several observations can be made from the data in table 3.4. First, the vast majority of features used to calculate PDM scores are more common in IV speakers than they are in BC speakers. When PDM features are more common in BC speakers, the feature generally occurs relatively infrequently in the IV corpus. In fact, the largest percent decrease in use over time is found with the discourse particle *no,* which is completely absent from the IV corpus. Perhaps most noteworthy is the increase in features that are barely attested in the BC corpus, but relatively frequent in the IV corpus (e.g., *wen*, *gon*, *nat*, *fo*), as well as the sharp increase in exemplars of *wan* from a relatively frequent 4.47 times per interview in the BC corpus to nearly 14 times per interview in the IV corpus. This same trend is evident in table 3.5, a summary of each speaker's PDM score, ordered by age, corpus and gender. This sharp uptick in feature count and overall PDM score is most likely a product of the way in which data was collected in each of the corpora. As discussed in §3.1, BC speakers were recruited and interviewed by researchers, meaning that some of these interviews consisted of two people who had not met each other ever before. Furthermore, more of the content of the BC interviews centers around Pidgin as the topic of discussion, which has a tendency to cause people to shift to using English. In contrast, IV speakers were interviewed largely by friends, friends of friends, or family members. This familiarity is likely the single greatest reason for why IV speakers exhibit higher PDM scores. Because of the wide discrepancies in PDM across the corpora, the use of PDM as a predictor of phonetic variation is restricted to examining inter-speaker variation within (rather than across) the corpora.

Table 3.5. List of speakers and their PDM scores (along with means and standard deviations), organized by relative age, corpus and gender; each PDM score is represented as a percent.

Speaker	Age, Corpus, Gender	PDM Score	Speaker	Age, Corpus, Gender	PDM Score
Malia	*old BC female*	1.01	Kawika	*old BC male*	1.27
Miki	*old BC female*	1.32	Joseph	*old BC male*	2.55
Kaimana	*old BC female*	1.89	Manny	*old BC male*	5.16
Keiko	*old BC female*	2.13	Kimo	*old BC male*	6.76
Standard deviation		**0.51**	**Standard deviation**		**2.48**
Mean		**1.59**	**Mean**		**3.94**
Teresa	*young BC female*	0.62	Victor	*young BC male*	2.64
Leilani	*young BC female*	0.78	Eddie	*young BC male*	3.92
Delia Jane	*young BC female*	1.57	Glen	*young BC male*	5.01
Mona Lisa	*young BC female*	1.99	Danny	*young BC male*	7.49
Standard deviation		**0.65**	**Standard deviation**		**2.05**
Mean		**1.24**	**Mean**		**4.78**
Pua	*old IV female*	4.98	Grant	*old IV male*	1.21
Kahea	*old IV female*	5.09	Kevin	*old IV male*	4.71
Carla	*old IV female*	6.12	Palani	*old IV male*	6.83
Lani	*old IV female*	6.14	Keoni	*old IV male*	9.07
Standard deviation		**0.63**	**Standard deviation**		**3.34**
Mean		**5.58**	**Mean**		**5.46**
Sarah	*young IV female*	5.04	Kaleo	*young IV male*	2.56
Lena	*young IV female*	6.03	Eric	*young IV male*	4.96
Starla	*young IV female*	6.71	Myko	*young IV male*	5.01
Mina	*young IV female*	7.34	Alika	*young IV male*	7.75
Standard deviation		**0.98**	**Standard deviation**		**2.12**
Mean		**6.28**	**Mean**		**5.07**

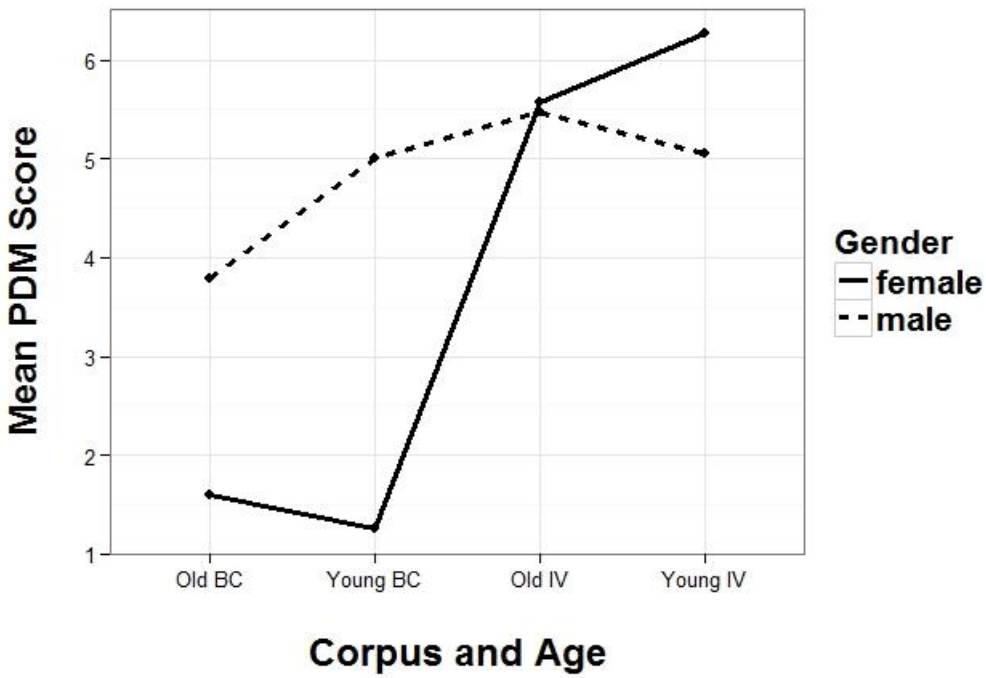
Another trend emerges from the analysis of PDM scores; as figure 3.3 demonstrates, females exhibit lower mean PDM scores than males in the BC corpus, and in the IV corpus there is much less of a difference between male and female PDM scores for IV speakers. Females, however, produce the highest mean PDM scores in the young IV group. Looking at the ranges of PDM scores across age group and gender in table 3.5, it is also evident that males exhibit a wider range of PDM scores within corpus than females. These gender differences across corpora may have something to do with the different ways speakers were interviewed and recruited, as it is unlikely that BC females simply used fewer morpho-syntactic markers of Pidgin.[78] In the BC corpus, interviews were conducted by people who were very often not acquainted with the interviewee prior to the recording.[79] When the interviewer and interviewee were already relatively well-acquainted, the interviewee was almost always male. In comparison, IV speakers were interviewed in all cases by people they already knew (see §3.1). The increased familiarity between interviewer and interviewee would also explain why speakers exhibit higher PDM scores in the IV corpus, and as such, seems a very likely reason for the observed variation in PDM score. However, there is also the possibility that the gender difference in BC speakers is not purely a result of interviewee-interviewer familiarity. It is certainly possible that BC females in an interview setting were simply less likely to use Pidgin morpho-syntactic variants due to the formality associated with an interview. Why this would only affect females might have to do with the potential interplay between familiarity with the interviewer and an increased access to English. By the turn of the 20th century (around the birthdates of most old BC speakers), schooling in English had become commonplace in Hawaiʻi, and "standard English" gained a strong foothold as the language of overt prestige (Tamura 1993: 54-55). It is possible that as this access to English increased, more female speakers who might have spoken Pidgin as their primary language growing up would have largely adopted English instead. That females would be more likely to do this than males is potentially linked to a tendency for females to adopt

[78] It is of course possible that there is a gender-based distinction with respect to the use of morpho-syntactic items in Pidgin, especially as gender differences were not a focus of Bickerton and Odo (1976), nor was their analysis quantitative in the same way this dissertation is. Even given this, I find an explanation that takes interview style into account more felicitous.

[79] Importantly, interview-interviewee gender was not systematically matched, so this effect is likely not the direct result of the gender of the interviewer. Furthermore, the current study did not code for interviewer gender during analysis, but there was a tendency for the interviewer in both corpora to be male. Without a study that investigates accommodation to interviewer gender, this is not a question that can be answered using the current data.

prestige forms at a higher rate (cf. Labov 2001: 274). To some extent, both of these explanations likely have something to do with the gender split in the BC corpus. However, the fact that IV speakers do not show the same difference across gender suggests that familiarity with the interviewer may be the most robust predictor of whether (and to what extent) Pidgin is spoken. These data points will be discussed further throughout chapters 4-7, where the PDM score findings will be placed in the context of the vowel findings.

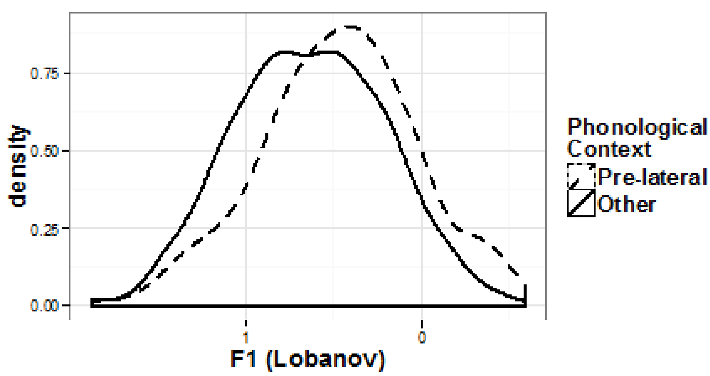
Figure 3.3. Mean PDM score over relative age, corpus and gender (female=solid, male=dashed).



3.4. Representation of vowel distributions

This study makes use of several different ways of representing vowel distributions. Whenever possible, the behavior of the entire lexical class or vowel distribution will be represented in lieu of presenting each individual data point. While it is important to consider each data point to ensure no single point alters the mean behavior of the group, the overall behavior of the vowel class (and how this behavior is conditioned by certain contexts) is generally the primary target of interest when discussing language change.[80] As such, vowel distributions will often be represented using any one of (or a combination of) kernel density plots, local polynomial regression fitting (with smoothed means lines across groups), two-dimensional kernel density plots, and ellipses at 95% confidence intervals. The `ggplot2` package (Wickham 2014) was used to create density plots in R, and ellipses plots were created using `stat_ellipse` (Evanini et al. 2012) in `ggplot2`. Density plots (figure 3.4), or probability density functions, are representations of the relative likelihood that a variable falls within a particular range. Density, mapped on the y-axis, is roughly equivalent to raw number counts typical of a histogram. These graphs are used in this study when only a single variable is the focus of interest (e.g., only F2 of a particular vowel).

Figure 3.4. Example of kernel probability density function.

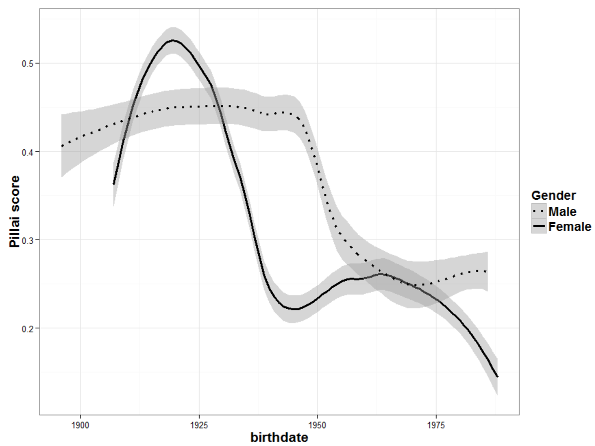


Local polynomial regression fitting is another way the current study represents the behavior of a single dimension of a vowel against a continuous variable (e.g., Pillai score, PDM score or birthdate). Smoothed means were derived using `geom_smooth`, a function which fits a polynomial function based on one or more predictors. Fitting in this model is done locally; this means that "for the fit at point *x*, the fit is made using points in a neighbourhood of *x*, weighted

[80] The exception to this would be abrupt lexical diffusion (e.g., Wang 1969), where one phoneme is substituted for another in all words with that phoneme (Labov 1994: 542). Lexical diffusion may also arise in gradual phonetic changes, though this change is often of a more subtle nature (Phillips 1984; Bybee 2002).

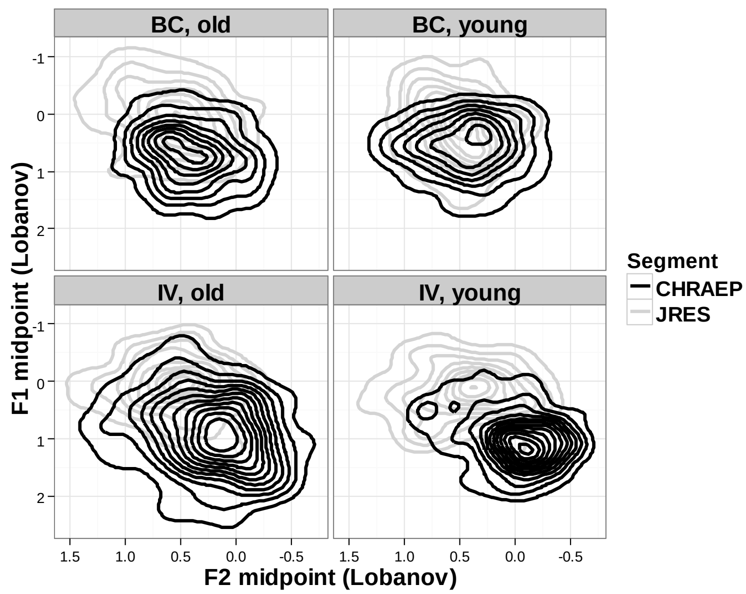
by their distance from *x*" (Ripley n.d.). This function produces a smoothed mean with standard errors (or, standard deviation) based on the data provided. Figure 3.5, for example, shows how males and females differ in their LAT-TAWK Pillai scores as a function of birthdate (for a more in-depth discussion of Pillai scores, see §3.5.3).

Figure 3.5. Example local polynomial regression (smoothed mean) with standard errors.



Two-dimensional density plots (figure 3.6) are excellent ways of representing non-parametric data such as vowel distributions because they do not assume a symmetrical distribution of values, and at the same time, they are able to clearly reflect the central tendencies of the observations in question (see discussion in DiCanio 2013). These plots can also represent distributions that are clearly multi-modal (e.g., distributions that are significantly affected by phonological environment), as well as more naturally exclude outliers. Craioveanu (2011) makes a similar argument for the usefulness of two-dimensional boxplots in comparison to representing only mean formant values. In reading these plots, the highest concentration of vowel realizations is located in the center-most geometric shape, and the concentric geometric shapes which surround this point represent the density of points in that area. Most vowel distributions are represented using two-dimensional density plots in the current study, and each age group (e.g., young IV speakers) is presented as a plot. In this way, each age group can be thought of as representing a single timeline, across which changes take place.

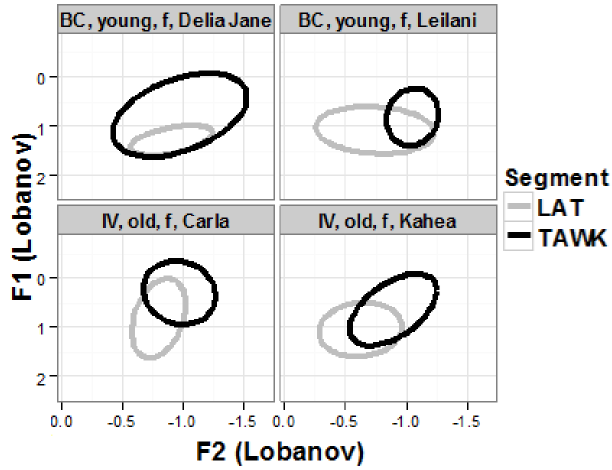
Figure 3.6. Example of two-dimensional kernel density plot.



In addition to these non-parametric measures, ellipses (figure 3.7) drawn at 95% confidence intervals will also be used to represent vowel spaces.[81] Ellipses were calculated using `stat_ellipse` (Evanini et al. 2012). Ellipses have the benefit of representing the distribution of data (in comparison with simple mean vowel representation) and are often more easily interpretable than density plots; however, they do not give as clear an impression of the concentration of data points, nor are they able to represent non-linearities of the distribution of vowels as easily.

[81] The 95% confidence interval is a statistical claim that the data would reflect the same tendencies 95% of the time were the population sampled repeatedly.

Figure 3.7. Example of ellipses at 95% confidence intervals used to represent vowel distributions.



Another important point is that the vowel plots presented in the current study are plots of normalized data; that is, the data values are not presented in hertz values, as is common when discussing vowels. Instead, the Lobanov normalization process (§3.2) centers the vowel space on a relative, derived midpoint value and plots vowels with respect to this midpoint value. Therefore, relatively backer vowels are represented by relatively smaller (often, negative) values, and relatively fronter vowels are represented by relatively larger (and more positive) values. By the same token, higher vowels are represented by relatively smaller (or more negative) values, and lower vowels are represented by relatively larger (or more positive) values.[82]

3.5. Statistical modeling

3.5.1. Linear mixed-effects regression models

Throughout the study, linear mixed-effects regression (`lmer`) models are used to corroborate patterns and make inferences from the data. The `lme4` (Bates et al. 2014) package in R was used to perform linear mixed effects analysis. These models are statistically rigorous and

[82] Backer, fronter, higher and lower are relative terms used to describe the position of a vowel relative to other vowels (or other instances of the same vowel). We can therefore describe JOK, for example, as being backer than FES, by virtue of the fact that JOK is articulated further back in the vowel space than FES. In this way, raw values need not be referenced when referring to the way vowels are distributed with respect to each other.

are increasingly common in linguistic research because of their ability to make reliable inferences about complex systems. Like other types of regression analysis, linear mixed-effects models are useful for estimating the relationships between a dependent variable (e.g., formant value) and one or more independent variables.[83] More specifically, regression analysis helps model how a dependent variable changes when any number of independent variables are varied. The difference between simple regression analysis and mixed-effects regression analysis is that mixed effects models also include random effects. In simple regression analysis, there is an assumption that the data points are independent of one another; that is, the occurrence of an event (or, data point) gives us no information about whether another event (or data point) will occur (e.g., a coin flip is an independent event). Simple regression often necessitates taking no more than a single data point from a speaker, as multiple data points from the same speaker cannot be said to be independent of each other (e.g., inherent pitch differences between speakers would bias every data point for every speaker and make these data points non-comparable). However, mixed effects models are able to deal with this issue, as they assume different baseline values for each speaker (or, for each word or vowel token).

The design of the current study is such that multiple formant measures are taken from a single speaker, and speakers must be compared to one another. This means that simple regression models are inappropriate for comparison (in most cases; see §3.5.2 for a discussion of statistical modeling and Pillai scores). Therefore, mixed effects models are employed to help statistically evaluate the data. Speaker and word are included as random effects (intercepts) in each of the models reported in this study unless otherwise noted. The output of a linear mixed-effects model (table 3.6) can be summarized as follows:

[83] For the purposes of this research, independent variables are factors like age, gender, phonological context, and other traditional factors that condition variation.

a) The intercept in the first row approximately represents the mean value of the dependent variable if all the independent variables are set to their default values.[84] In this case, this is the mean value of normalized midpoint in the F2 of TAWK for old BC males.

b) The column 'estimate' represents the estimated value of the dependent variable with the independent variable in mind. Each independent variable is listed on the left hand side of the table. The sign (+, -) of the estimate indicates the direction of the effect. In this case, the age group old BC is the default. Young IV speakers exhibit an estimate of approximately 0.19, meaning that this group exhibits a normalized F2 that is larger by 0.19 Lobanov normalized units than old BC speakers.[85] In this case, a higher estimate means that young IV speakers exhibit fronter TAWK (as F2 is directly correlated with frontness). By contrast, young BC speakers exhibit an estimate of approximately 0.05, indicating that there is very little difference between young BC and old BC speakers. If we wish to interpret how multiple independent variables may influence the data, we simply add their estimates. So, the model reports that young IV females produce a normalized F2 midpoint value of TAWK approximately 0.23 (or, 0.19+0.4) larger than old BC males.

c) The *t*-value is the effect size, or (loosely) how different the estimate of the dependent variable is given the independent variable.[86]

In the example in table 3.6, this means that the normalized F2 of TAWK is larger (i.e., fronter) for both old IV speakers and young IV speakers, but that young IV speakers exhibit TAWK that is frontest. The t-values inform us that both of these effect sizes are large, but again, largest for young IV speakers. Because these effect sizes are quite large (roughly at or larger than |2|), the model indicates that there is a significant effect of age group on the F2 of TAWK. Young BC speakers barely differ at all from old BC speakers, and females exhibit only slightly (and non-significantly) fronter TAWK vowels than males. Speech rate is also included in this model as a control. A discussion of the rationale behind including speech rate, as well as how speech rate was calculated, is included in §3.5.2.

[84] This is generally true if and only if the dependent variable is continuous. For the purposes of this study, the dependent variable is continuous because the variables being measured (i.e., F1, F2, vowel duration, and Pillai score) are continuous.
[85] These units might also reliably be described as *z*-scores, as this is what the Lobanov normalization process converts hertz into.
[86] Mathematically, this is derived by dividing the estimate by the standard error.

Table 3.6. Example of linear mixed-effects model (here, fit to normalized F2 midpoint values of TAWK for all speakers, with age group, gender and speech rate as predictors (see table 6.2)).

	Estimate	Std. Error	t-value
(Intercept)	-1.23698	0.07545	-16.395
age=young BC	0.04757	0.06046	0.787
age=old IV	0.12886	0.06116	2.107
age=young IV	0.19027	0.06257	3.041
gender=female	0.04443	0.04331	1.026
speech rate	0.02236	0.01600	1.398

It should be noted that for all the statistical models discussed in this dissertation, age group is treated as a single, multi-tiered category, where old BC speakers represent the oldest group, and young IV speakers represent the youngest group. In the author's viewpoint, this is preferable to running models where age is treated as a continuous variable because it is possible to see which age groups exhibit the described changes (which is not possible when age is treated as continuous). However, separate models were also run with age as a continuous predictor of variation to verify some of the trends. Models where age was treated as continuous returned the same observations (albeit with the aforementioned limitation), but are not reported here.

As a final note on interpretation, phonological environment in this study is often treated as a single column in the data; in other words, vowels can be categorized as post-coronal or pre-lateral, but not as both. This is done to avoid collinearity in the model, or the situation where two or more independent variables are highly correlated so that one independent variable can be accurately predicted from the other. When dealing with situations where collinearity is likely (e.g., dealing with preceding and following phonological environments for a single lexical set), phonological environment will be reduced to a single column in the data frame.

In addition to using linear mixed-effects models to corroborate patterns in the vowel system, these models will also be used when testing for effects of vowel duration (see §2). As shown, for example, in work by Wassink (1999, 2001, 2006), even if vowels show spectral overlap there is a reasonable expectation that temporal differences may surface between segment types. In the subsequent chapters, vowel duration arises as a variable of interest when discussing some of the changes exhibited by speakers over time (see also §3.5.2).

Following Bates (2006), I do not report *p*-values for the linear mixed-effects models used in this study.[87] Instead, as Bates suggests, I take as paramount the size of the effect (or, the *t*-value) returned by the linear mixed-effects model, using *t*-values of |2| (roughly speaking) as indication of a significant effect size.[88] The difference between *p*-values and *t*-values is, in short, that the *p*-value reports that there is an effect, while the *t*-value reports the size of the effect. The paramount importance of effect size in relation to *p*-values is summarized by Sullivan and Feinn (2012: 279-280), who note that "[w]ith a sufficiently large sample, a statistical test will almost always demonstrate a significant difference, unless there is no effect whatsoever". In the current study, statistical models are used to describe a fairly large dataset, meaning that it is quite likely that relatively small effect sizes will yield statistically significant differences. While this may seem to fly in the face of the conventional practice of reporting *p*-values, Bates contends that calculating *p*-values derived from linear mixed-effects models is not trivial (or, simple). This is because calculating F ratios (or, the ratio of the explained variance to the unexplained variance) assumes potentially different degrees of freedom in the numerator, but assumes the same denominator for every F ratio. Summarized by Moore (2010), "with unbalanced, multilevel data, the denominator degrees of freedom used to penalize certainty are unknown (*i.e., we're uncertain about how uncertain we should be*)" [emphasis added]. Essentially then, *p*-values are to be used with caution in the best of scenarios and ignored in many other scenarios. Bates' (and

[87] It is worth noting that Douglas Bates designed `lme4`, the R package that the analysis reported in this dissertation relies upon.
[88] That being said, significance does not begin and end at *t*-values of |2|; relatively smaller effect sizes (e.g., ~|1.7|) are also worth noting, as they indicate some level of effect. Essentially, the interpretation of the effect size is a sliding scale, and the cut-offs are guidelines rather than hard-and-fast rules.

my own) viewpoint is also that analyzing data graphically is of the utmost importance, and statistical models should be fit sequentially based on graphical findings (cf. Bates 2008). Furthermore, I believe this approach frees the researcher from being tied to arbitrary lines of significance (e.g., diminishing or, at worst discounting, the effects that return a *p*-value of 0.08, but not 0.05), and attends to the more important issue of effect size rather than the (potentially non-trivial) likelihood that a fixed effect correlates with a greater-than-chance probability change in the data.

3.5.2. Accounting for differences in speech rate

As discussed in §2.5, much variationist work investigating vowels has relied on taking the values of the lower formants as an analog of position in the vowel space: F1 is an analog of vowel height, and F2 is an analog of vowel frontness. However, formant values are not static indicators of vowel identity; rather, a number of factors influence formant frequency besides tongue position, such as pharyngeal length (or, vocal tract length more generally), lip rounding, whether the nasal cavity adds additional resonance, or the phonological context of a vowel. Another factor to consider when measuring formants is speech rate. As would be expected, speech rate has an effect on the duration of vowels, in that a more rapid speaking rate yields vowels that are shorter in duration (Gay 1978; Kessinger & Blumstein 1998).[89] This shortening of vowels also has an effect on vowel formants, even when syllables are stressed. Higher rates of speech are correlated with a tendency for formant frequencies to undershoot their targets (Lindblom 1963; Gay 1968), which is primarily due to the shorter duration the speaker has to achieve the “bull’s-eye articulation” (Lindblom 1963: 1780). There is also evidence to suggest that during quicker rates of speech, there is motion in the formants earlier (that is, closer to the

[89] The decrease in vowel duration associated with faster speech rates also affects syllable duration as well (see Kessinger & Blumstein 1998).

articulation of an onset consonant), indicating that articulatory movement towards the vowel simply occurs earlier during more rapid speech (Gay 1978). The importance of vowel duration in characterizing the vowel system is attested in research on creoles as well. Wassink (1999, 2001, 2006), for example, has shown that long-short vowel oppositions in Jamaican patois are more robust in basilectal speakers than in acrolectal speakers, despite a greater amount of spectral overlap in basilectal speakers.

Given these findings, both vowel duration and formant frequencies vary systematically as a function of speech rate. It is therefore necessary to quantify speech rate and consider it in any discussion of differences in formant frequencies or vowel duration among target groups. Speech rate was quantified using de Jong and Wempe's 2010 update to their 2009 Praat script (see de Jong & Wempe 2009).[90] This script automatically detects syllable nuclei by identifying peaks in intensity, and uses this, along with information about speaker pauses, to calculate the number of syllables and speaking time.[91] The script then calculates speech rate as the number of syllables divided by the total duration (in seconds) of the utterance measured. The script was run on each extracted speech segment from each participant so that a value for speech rate could be derived for each analyzed vowel.[92]

Given the impact speech rate can have on vowel duration and formant frequencies, it is included as an independent variable in each of the linear mixed-effects and fixed-effects models. Speech rate is an especially important variable to consider when discussing vowel duration in Pidgin, as differences in vowel duration may arise even when there is complete or near-complete spectral overlap. In other words, duration and spectral overlap may be treated as variables that

[90] This script was written to calculate speech rate in a large-scale study on speaking proficiency. The script was found online at https://sites.google.com/site/speechrate/.
[91] These "dips" in intensity are expressed as lowered dB values.
[92] The syllables for given stretches of speech were spot-checked to ensure the script returned accurate estimates of the number of syllables.

are worth testing separately. Regarding speech rate effects on formant values, it is worth noting that the effect size of speech rate in models where formant values are the dependent variable is often well below |2|. This suggests that speech rate does not have as strong an effect on the data as other variables (e.g., phonological context, age group, and gender). Despite this, it is reported consistently in the models to control for the effect of speech rate statistically.

3.5.3. The Pillai score

This study also employs a test known as the Pillai-Bartlett statistic (here, Pillai score) (Olson 1976). The Pillai score is a type of multivariate analysis of variance (MANOVA) wherein, in the case of vowel distributions, F1 and F2 are dependent variables that can be compared across vowels to establish the degree of overlap between two vowel clusters. This overlap is quantified on a scale of 0 to 1. Broadly speaking, the Pillai score is useful in quantifying how overlapped the distributions of two lexical sets are in spectral space: the lower the Pillai score, the more the two vowels are overlapped. Given this, the lower the Pillai score, the more likely it is that two vowel classes are merged in spectral space. This model was introduced to sociophonetic research by Hay et al. (2006) as a way of quantifying merger between NEAR and SQUARE in New Zealand English, and has since been successfully used to quantify mergers between other vowels for speakers of other dialects of English (e.g., LOT and THOUGHT in the speech of San Francisco, California; see e.g., Hall-Lew 2009; 2010a). The Pillai score is superior to measures such as Euclidean distance because the Pillai score takes into consideration the degree of overlap of the distribution (Hay et al. 2006). While the Pillai score is a good way to gauge whether two vowel classes overlap, it does have limitations. Hall-Lew (2010b) explains that, for example, the statistic does not take into account the size of ellipses representing the vowel distribution (see §3.4) or the direction of a trend. The statistic assumes that the distribution is the same between two vowel clusters, and this is quite often not the case for changes in progress. The Pillai score also does not take into account differences in the offglide between two vowels, nor can it incorporate whether there is any difference in vowel duration between the lexical sets (Hall-Lew 2010b: 8). Finally, the Pillai score cannot distinguish between distributions that that are fully merged and nearly merged; the statistic can only identify to what extent two vowel classes are similar (Hall-Lew 2010b: 5).

Despite these drawbacks, the way that Pillai is used in the current study avoids some of the limitations of the score. First, the Pillai score is never used on its own as a measure of spectral overlap, meaning that the Pillai score is always put into context with other acoustic measurements. For example, while Pillai cannot take into consideration differences in the offglides between vowels, the current study plots the contour motion between overlapping vowel pairs. And while Pillai score does not take into consideration duration differences, duration is measured as a separate variable of interest in this study. Therefore, if differences arise between seemingly overlapped pairs, this different is highlighted by other acoustic measures. Second, Hall-Lew (2010b) identifies a significant drawback where the Pillai score is not able to represent the direction of a change. In her data, speakers with high LOT-THOUGHT Pillai scores occasionally exhibited patterns where instead of overlap, THOUGHT was realized as lower and fronter than LOT (displaying what she refers to as a ‘flip-flop’ pattern; Hall-Lew 2010b: 8). However, this issue does not arise in the current data, making the issue of directionality less of a weakness. Finally, the Pillai score is used in all but one case in this study to quantitatively highlight how overlap that speakers exhibit between vowel classes has decreased over time. In other words, the Pillai is most often used to corroborate the movement of vowel classes away from each other. In most cases, this movement is relatively apparent across groups, and thus the Pillai serves as a useful measure of change in addition to information gleaned from F1/F2 measurements.

To corroborate the effects that test categories (e.g., age group or gender) have on Pillai scores, all statistical models testing Pillai scores are fit using linear *fixed*-effects regression models. Because the Pillai score is itself a single value used to represent a distribution of each speaker's distribution of vowel tokens, speaker identity and word type cannot be reliably included in the model as random effects.

3.6. Conclusion

These methods were implemented in order to shed light on the question of how Pidgin has changed over time in Hawai‘i. The following chapters investigate the degree to which phonological and social variables predict realizations of Pidgin vowels. These chapters focus specifically on groups of vowels in Pidgin and how these vowels change across age, gender, phonological context, and PDM score. As a note, a summary of all the data discussed in chapters §4-7 can be found in appendix G. This is a list of the Lobanov normalized formant values (from 20%-80% of the vowel) across age group, vowel identity and gender.

CHAPTER 4

FRONT VOWELS SHCHRIT, STIK, FES, JRES, & CHRAEP

This chapter addresses the behavior of the front vowels: SHCHRIT, STIK, FES, JRES, and CHRAEP. Each front vowel is characterized by a high F2 relative to back vowels. Sakoda and Siegel (2008: 221-224) describe SHCHRIT and STIK as comprising a single lexical set in basilectal Pidgin which converges on [i], but is realized as two distinct lexical sets in mesolectal Pidgin (realized as [i] and [ɪ], respectively). Similarly, the CHRAEP vowel is described as overlapping with JRES in basilectal Pidgin, converging on [æ̞], but these two vowels may be variably distinct in mesolectal Pidgin (where CHRAEP is realized as [æ] and JRES is realized as [ɛ]). FES is described as underlyingly diphthongal, but subject to monophthongization word internally before a voiceless consonant and word-finally (Sakoda & Siegel 2008: 223). None of the front vowels are described as rounded. In total, this study analyzes data from 1,053 tokens of SHCHRIT, 1,093 tokens of STIK, 1,037 tokens of FES, 1,158 tokens of JRES, and 1,154 tokens of CHRAEP. Each vowel is discussed individually, with attention paid to the behavior of each front vowel relative to other front vowels. At the end of the chapter, a discussion of the findings places each vowel in context.

4.1. SHCHRIT

The existing literature describes SHCHRIT in Pidgin as occupying a high front position in the vowel space, characterized by a low F1 and a high F2 (Bickerton & Odo 1976; Sakoda & Siegel 2008). In American English, FLEECE is described as a high front tense vowel, derived from

Middle English /e:/ (Labov et al. 2006: 13), which has an offglide (sometimes an upglide).[93] These features serve to distinguish it from KIT, a member of the short front vowels in English, which lacks a prominent offglide (Labov et al. 2006: 12). Sakoda and Siegel (2008: 222) observe that SHCHRIT in Pidgin is generally laxer than FLEECE in English. However, it is unclear whether "laxer" in this context is meant to indicate that the vowel is backer, shorter, or whether the offglide is different than it is in many varieties of English. No other differences are noted between English FLEECE and Pidgin SHCHRIT (except its relationship to Pidgin STIK, see §4.2). The following discussion addresses the behavior of SHCHRIT using the data from the current study.

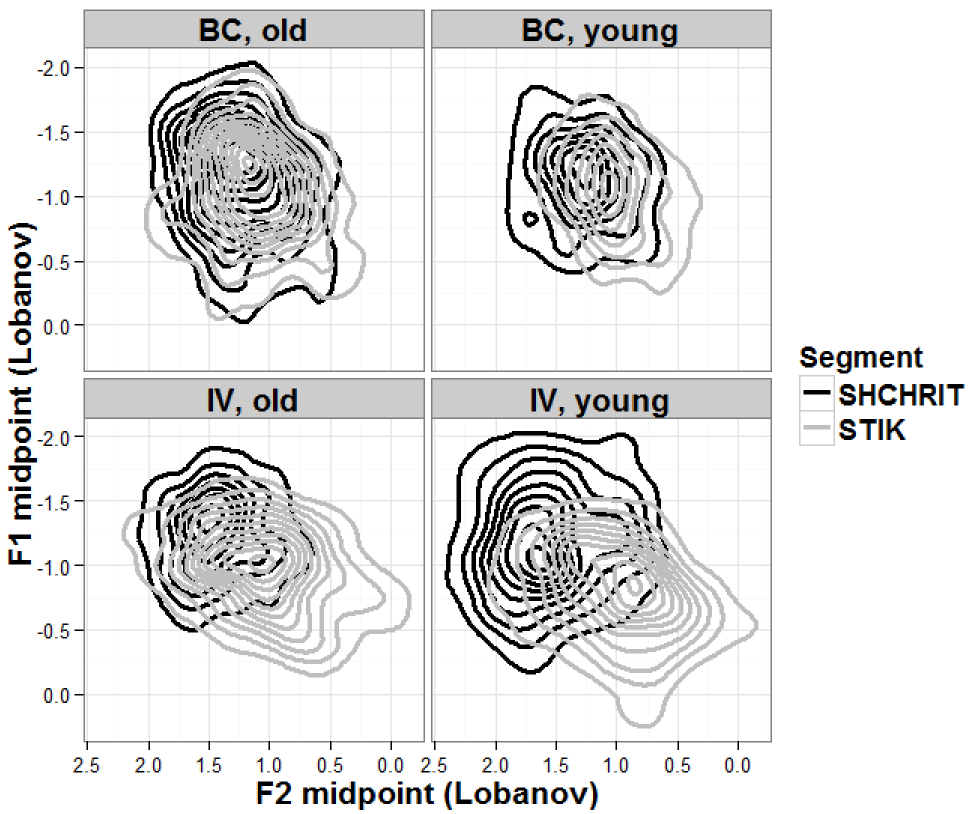
4.1.1. SHCHRIT fronting

The results from the current data demonstrate that the midpoint of F2 in SHCHRIT is conditioned by age group and two phonological contexts: pre-nasal position, and word-final position. Figure 4.1.1 is a two-dimensional density plot of the F1/F2 midpoint of SHCHRIT in relation to STIK, plotted by age group (here, STIK serves as a reference point). SHCHRIT and STIK begin as an overlapped class in old BC speakers (see further discussion of the behavior of STIK in §4.2), with both vowel clusters centering on 1.25 in the F2 dimension and 1.25 in the F1 dimension. Young BC speakers exhibit a reduction in the size of the distribution of SHCHRIT; however, the center of the distribution does not move radically in space. Though STIK has lowered slightly closer to 1.0 in the F1 dimension making it seem like SHCHRIT has changed position slightly, the midpoint values of SHCHRIT for old and young BC speakers is the same. In comparison to BCspeakers, the SHCHRIT of old IV speakers SHCHRIT is noticeably fronter, as the

[93] Labov et al. (2006: 12) contend that this upglide is the main way in which FLEECE differs from KIT. In their view, both vowels share a high front nucleus and may differ from each other across dialects in terms of quality, duration, peripherality, or tenseness; however, the difference between the two vowels can be phonologically generalized to presence or absence of an offglide.

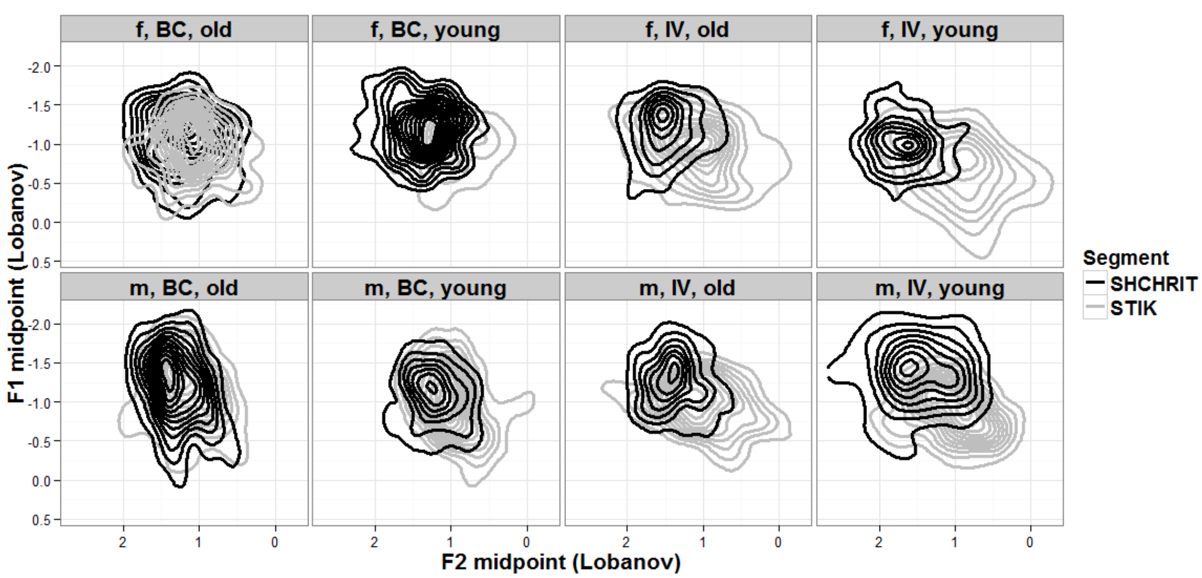
distribution is centered on a position in F2 closer to 1.5. In young IV speakers, SHCHRIT is realized as even fronter, and it is centered on a position around 1.5 in the F2 dimension. Additionally, the SHCHRIT of young IV speakers has widened its distribution considerably in comparison to old IV speakers. These findings indicate that SHCHRIT and STIK begin as a more overlapped vowel class, and over time, SHCHRIT moves away from STIK (see further discussion of the behavior of STIK in §4.2).

Figure 4.1.1. 2-d density plot of normalized midpoints of SHCHRIT (black) and STIK (gray), separated by vowel identity and age group.



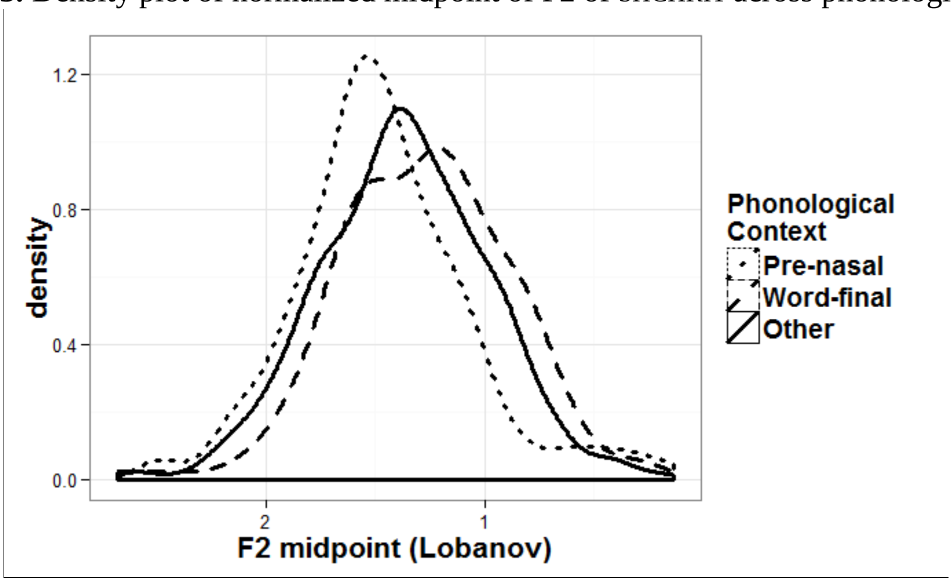
When considering these results across gender (see figure 4.1.2), no clear trends arise. No obvious differences arise between BC speaker males and females, as both males and females appear to exhibit the same pattern that is characteristic of all BC speakers. Old BC females exhibit a slightly lower distribution center for SHCHRIT than males, but the size of the distribution does not appear to vary across gender. There is a tendency for young BC females to exhibit a fronter distribution of SHCHRIT in comparison with young BC males. Young BC females also exhibit a larger distribution size than young BC males. Similar to young BC females, old IV females exhibit a SHCHRIT distribution that is slightly in front of old IV males; furthermore, the size of distributions of SHCHRIT are roughly the same for old IV males and females. Young IV females produce a more concentrated distribution of SHCHRIT in comparison to males, though young IV females do not exhibit the slightly fronter distributions of SHCHRIT that young BC and old IV females exhibit. Young IV male and female distributions exhibit very similar center tendencies in terms of F2. In terms of F1, BC speakers and old IV speakers exhibit virtually no differences across gender. However, there is a slight height difference across gender in young IV speakers, where females produce SHCHRIT centered on -1.0 in the F1 dimension, whereas males produce SHCHRIT centered slightly higher, at -1.5 in F1. In general, these differences across gender seem to be the result of expected individual variation, and it does not appear that gender is a robust predictor of the position of SHCHRIT.

Figure 4.1.2. 2-d density plot of normalized midpoints of SHCHRIT (black) and STIK (gray), separated by vowel identity, gender, and age group.



The midpoint of F2 in SHCHRIT is also conditioned by phonological environment, and the impact of phonological environment on F2 is consistent over age group. Two phonological environments can be shown to impact the F2 of SHCHRIT: pre-nasal position and word-final position.[94] Figure 4.1.3 shows a density plot of normalized F2 of SHCHRIT across phonological context. Pre-nasal SHCHRIT exhibits slightly more advanced realizations of the vowel than all other environments. Word-final SHCHRIT, in comparison, exhibits a slightly lower F2 midpoint relative to all other phonological environments. It is worth noting that if the midpoints of F2 in SHCHRIT are graphed against speaker birthdate, pre-nasal environments are consistently the frontest tokens of SHCHRIT across age group.

Figure 4.1.3. Density plot of normalized midpoint of F2 of SHCHRIT across phonological context.



These findings are corroborated by a linear mixed effects model fit to normalized F2 midpoints of SHCHRIT, with age group, phonological context and speech rate as predictors (table 4.1.1). There is a significant main effect of old IV and young IV speakers, indicating that these age groups exhibit fronter realizations of SHCHRIT in comparison to old BC speakers. There is

[94] It is worth noting that pre-lateral position motivates significant backing of SHCHRIT (~ lowering of F2); however, pre-lateral tokens are not frequent enough or distributed equally across age group to warrant inclusion in the present analysis.

also a significant main effect of pre-nasal environment, indicating that pre-nasal SHCHRIT motivates higher F2 values (~fronter SHCHRIT). There is also a significant negative main effect of word-final environment, indicating that word-final position decreases F2 values (~ backer SHCHRIT). Importantly, the estimate for each of the phonological environments is smaller than the estimate for either old or young IV speakers, indicating that change in the position of SHCHRIT over age group is larger than the effect of phonological environment. Gender does not significantly influence the midpoint F2 value of SHCHRIT, corroborating the observation that while females and males exhibit some variation in age group in the frontness of SHCHRIT, this difference is not statistically significant.

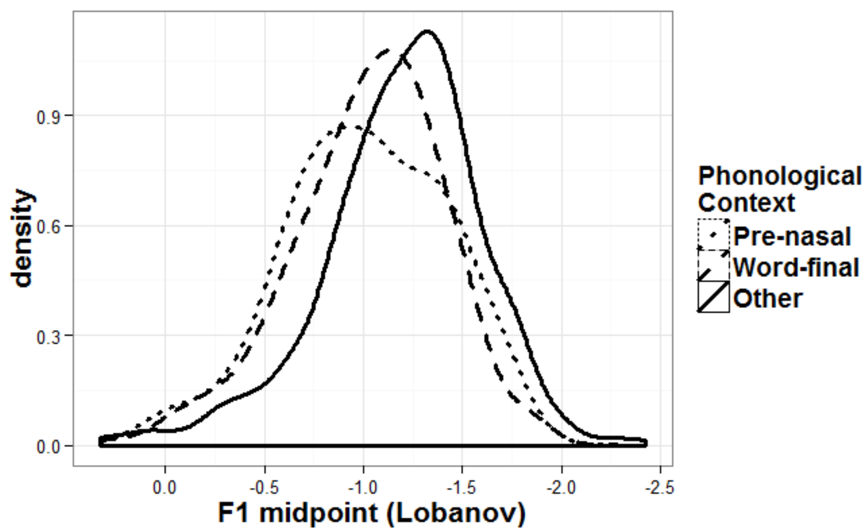
Table 4.1.1. Lmer model fit to normalized F2 midpoint values of SHCHRIT for all speakers, with age group, phonological environment, and speech rate as predictors.

	Estimate	Std. Error	t value
Intercept	1.17734	0.07692	15.305
phonological context=Pre-nasal	0.11771	0.03917	3.005
phonological context=Word-final	-0.06805	0.03094	-2.199
age=young BC	0.05476	0.08770	0.624
age=old IV	0.17443	0.08842	1.973
age=young IV	0.32477	0.08852	3.669
speech rate	0.01749	0.01304	1.342

4.1.2. Phonological effect on F1 of SHCHRIT

While no substantial changes take place over age group or gender in the F1 of SHCHRIT, the current study finds that two phonological environments affect the height of SHCHRIT in Pidgin: pre-nasal position and word-final position. Figure 4.1.4 shows a density plot of the normalized midpoint of F1 of SHCHRIT separated by phonological environment. It is evident that pre-nasal environments motivate lowering in SHCHRIT, as this group exhibits a peak around -0.8 and a distribution that is shifted to a slightly lower position. This lowering is not unexpected, as it is not uncommon cross-linguistically for high vowels to exhibit lower midpoints (that is, higher F1 values) in pre-nasal environments, (Beddor 1982; Beddor et al. 1986).[95] Word-final position contributes to a lowering effect in SHCHRIT, though this lowering appears to have a smaller effect in pre-nasal positions. Word-final environments exhibit a density peak centered on -1.2 as compared with the density peak of -1.4 exhibited by "other" phonological environments.[96] Furthermore, the distribution of word-final exemplars of SHCHRIT is shifted to the left, indicating that the F1 of SHCHRIT in word-final position is higher (~lower vowel realization) than SHCHRIT in "other" phonological environments.

Figure 4.1.4. Density plot of normalized midpoint in F1 of SHCHRIT across phonological environment.



The effect of phonological environment on the height of SHCHRIT is corroborated by a linear mixed effects model fit to the normalized midpoint of F1, with phonological context and

[95] Beddor (1982) and Beddor et al. (1986) observe patterns of pre-nasal vowel raising and lowering in, for example, Bengali, Swahili, Zapotec, Breton, Hindi, Portuguese, Mixtec, Dutch, and Basque, among other languages. Beddor et al. (1986: 199) observe that this lowering occurs regardless of whether vowels are nasalized phonemically or by phonological processes of assimilation. However, that Pidgin exhibits lower SHCHRIT before nasals may place it at odds with the behavior of English FLEECE. Carignan et al. (2010) cite that a higher tongue position is characteristic of nasalized /i/, potentially offsetting the acoustic effects of nasalization.

[96] In the current study, "other" refers to all realizations of the vowel in question that do not fall in the discussed phonological categories (e.g., pre-nasal).

speech rate as predictors. There is a significant main effect of pre-nasal and word-final environments, which both motivate significantly lower SHCHRIT.[97]

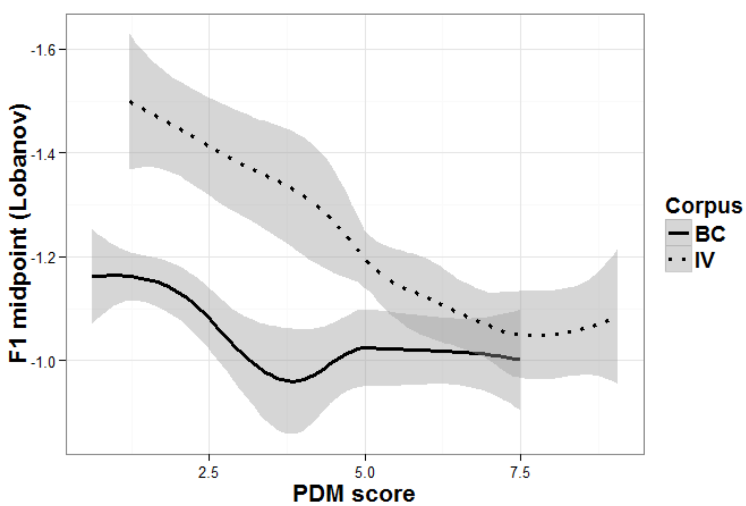
Table 4.1.2. Lmer model fit to normalized F1 midpoint values of SHCHRIT for all speakers, with phonological environment and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.155063	0.063027	-18.327
phonological environment=Pre-nasal	0.131132	0.040762	3.217
phonological environment=Word-final	0.156584	0.032664	4.794
speech rate	-0.003018	0.014573	-0.207

4.1.3. Effect of PDM on SHCHRIT

The results from the current data demonstrate that PDM score has an effect on the height of SHCHRIT. Figure 4.1.5 is shows the normalized midpoint of F1 of SHCHRIT plotted against PDM score for BC and IV speakers. While BC speakers show little difference in midpoint F1 value as a function of PDM score, higher PDM scores in the IV corpus increase the likelihood that SHCHRIT will be relatively low.

Figure 4.1.5: F1 of SHCHRIT plotted against PDM score for BC (solid line) and IV (dotted line) corpora.



[97] These environments do not differ significantly from one another.

A linear mixed effects model fit to normalized midpoints of F1 in SHCHRIT for IV speakers with PDM score and speech rate as predictors corroborates the observed lowering effect of PDM score (table 4.1.3). There is a significant main effect of PDM on normalized F1 midpoint, indicating that higher PDM scores motivate relatively lower instances of SHCHRIT for the IV speakers. Additional context for the effect of PDM score on SHCHRIT is provided in §4.2.3, as PDM score has a corresponding fronting effect on realizations of STIK. The relationship between SHCHRIT, FES and PDM score is discussed further in §4.3.3. PDM score has no effect on F2 for IV speakers, nor does PDM score have a significant effect in any formant dimension for BC speakers.

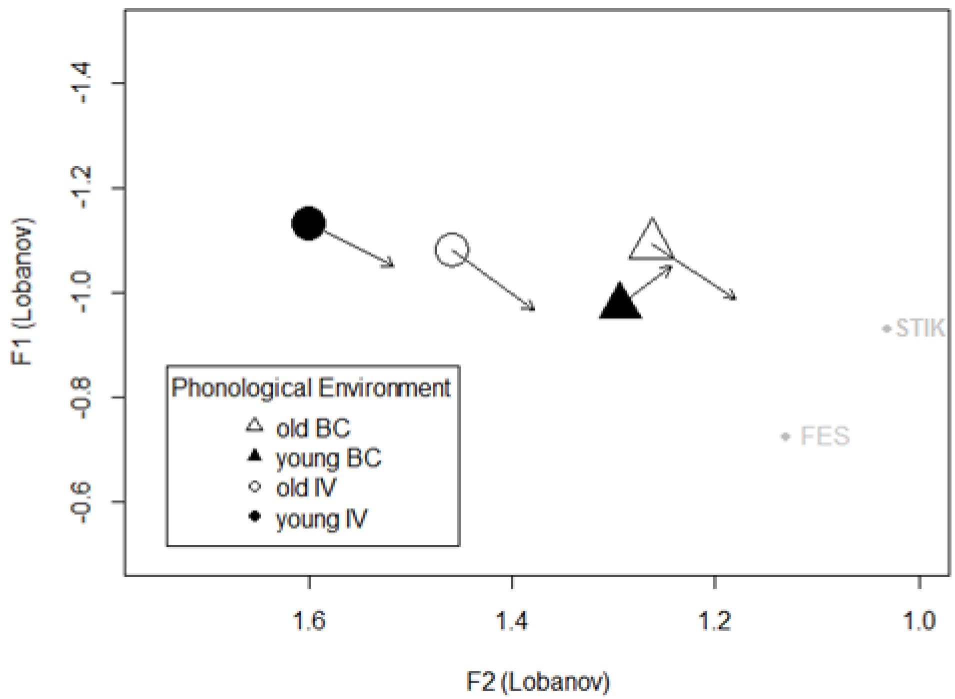
Table 4.1.3. Lmer model fit to normalized F1 midpoint values of SHCHRIT for IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.42550	0.14075	-10.128
PDM score	0.06312	0.01906	3.313
speech rate	-0.01924	0.02198	-0.875

4.1.4. Trajectory of SHCHRIT

The results from the current data demonstrate that the trajectory of SHCHRIT is relatively short and behaves consistently across age group. Figure 4.1.6 is a plot of the mean normalized formant contour from 30% to 70% through the vowel. These points were selected to minimize the effect of surrounding phonological context on the vowel, while still observing formant motion. The fronting that SHCHRIT exhibits in IV speakers (especially young IV speakers, see §4.1.1) is not accompanied by any change in the formant contour of SHCHRIT. The trajectory of SHCHRIT changes very little over time in terms of offglide target or the degree of contour motion. For all age groups, the offglide of SHCHRIT is predominantly in F2 and relatively short. The only discernable difference in offglide position is that young BC speakers exhibit what looks to be a slight upglide. However, this difference in offglide trajectory is small enough to where listeners probably do not hear it. SHCHRIT appears to be relatively monophthongal across speakers, exhibiting little motion between nucleus and offglide.[98]

Figure 4.1.6. Trajectory of SHCHRIT over age group from 30% to 70% through the vowel.



4.1.5. Summary of SHCHRIT findings

In sum, realizations of SHCHRIT are conditioned by age group, phonological context, and PDM score. SHCHRIT fronts over time, most notably in young IV speakers, though old IV speakers also show some degree of fronting. This fronting does not appear to have a strong effect on the trajectory of SHCHRIT, which exhibits a consistently short, backing offglide across age groups. Pre-nasal environments motivate fronter and lower realizations of SHCHRIT, while word-final environments show a tendency to motivate lower and more retracted realizations of SHCHRIT. Finally, PDM score is correlated with lower realizations of SHCHRIT for IV speakers;

[98] Hawai‘i English speakers reported in Kirtley et al. (forthcoming) report similar monophthongal productions of FLEECE in their data taken from spontaneous speech. However, FLEECE taken from wordlist data shows a more noticeable fronting offglide.

there is no effect of PDM score on BC speakers or the F2 of IV speakers. No differences arise in F1 or F2 of SHCHRIT as a result of gender.

4.2. STIK

The existing literature describes STIK as occupying a high front position in the vowel space, characterized by a low F1 and a high F2 (similar to SHCHRIT). In English, KIT is described as a short front vowel that is derived from Middle English short /i/ (Labov et al. 2006: 13). KIT is involved in many changes across the English speaking world, and sometimes moves with respect to the other short front vowels, DRESS and TRAP. In the western states (Kennedy & Grama 2012; Becker et al. 2015; Fridland et al. 2015) and Canada (Clarke et al. 1995), KIT is involved in the lowering and retraction of the short front vowels, and KIT centralizes in line with the raising of front vowels in New Zealand (Watson et al. 2000). Drager et al. (2013) demonstrate that KIT in Hawai‘i English does not move as the result of a chain shift with DRESS and TRAP, setting it apart from western U.S. states like California. However, they identify that KIT is lower for males than females, and that female speakers who report an ability to speak Pidgin exhibit higher realizations of KIT than female speakers who do not report speaking Pidgin. In basilectal speakers, Sakoda and Siegel (2008: 222) describe Pidgin STIK as being more similar to SHCHRIT (i.e., fronter or tenser than it is in English), especially in stressed monosyllables. Mesolectal Pidgin speakers produce the vowel as something closer in realization to KIT in English (Sakoda & Siegel 2008: 224). The following discussion addresses the behavior of STIK using the data from the current study.

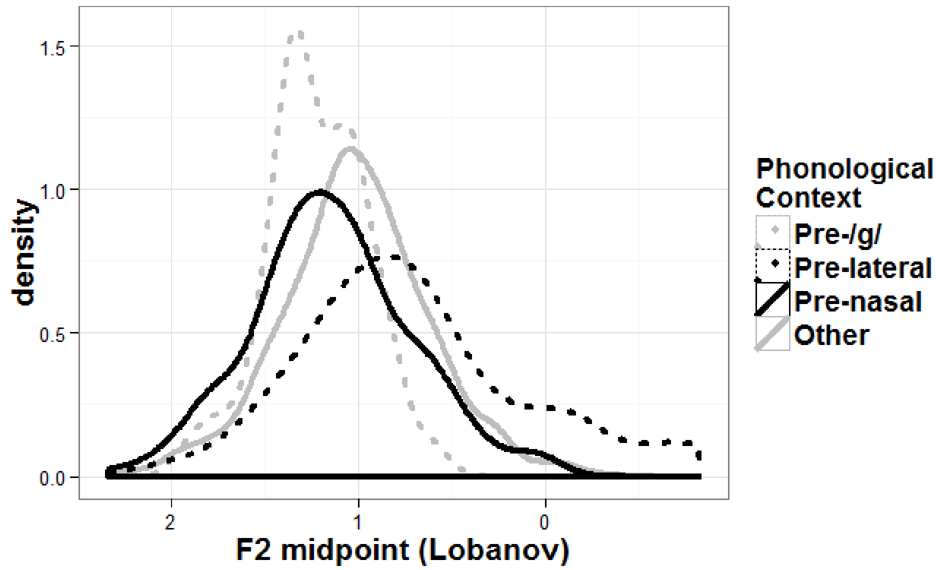
4.2.1. Phonological effects on F2 of STIK

The results from the current study demonstrate that the F2 of STIK is influenced by three phonological environments: pre-lateral position, pre-nasal position, and pre-/g/. Figure 4.2.1 shows the normalized midpoint of F2 of STIK in these environments as compared with other phonological environments. Relative to “other” phonological environments, pre-lateral STIK exhibits a smaller F2 value corresponding to a backer midpoint. This pre-lateral backing is well-attested in English, and especially motivates lowering and backing in front vowels (Bernard 1985; Cox & Palethorpe 2003). Paralleling the behavior of pre-nasal SHCHRIT, pre-nasal STIK exhibits higher F2 values, corresponding to fronter realizations of STIK. The midpoint of STIK also undergoes fronting before /g/. The fronting that occurs with STIK in Pidgin is reminiscent of what is reported for some English dialects for other, lower short front vowels DRESS and TRAP, for example, in the Pacific Northwest (see, e.g., Wassink 2011; Wassink & Riebold 2013; Freeman 2014).[99] No similar fronting effect is observed for STIK before /k/.[100]

[99] Though no pre-/g/ raising of KIT is cited in the Pacific Northwest, the pattern of fronting and raising (see §4.2.2) of STIK before /g/ in Pidgin is consistent with what is observed for other short front vowels. This raising may be due in part to the velar pinch (i.e., the raising of F2 and lowering of F3 that occurs when going into or out of velar constriction (Zeller 1997; Purnell 2008). The rising F2 is accompanied by a lowering of F1 (which is involved in upgliding), and that this motivates the reanalysis of the vowel as relatively higher in the vowel space (Freeman 2014).

[100] Tokens of STIK before velar nasal /ŋ/ were investigated to see if they behaved differently from other nasals (and more in line with STIK before /g/). Pre-/ŋ/ tokens exhibited no distributional differences from the group of nasal consonants.

Figure 4.2.1. Normalized F2 values of STIK in pre-lateral, pre-nasal, and pre-/g/ contexts, compared with other phonological environments.



These effects are corroborated by a linear mixed-effects model fit to normalized midpoint values of F2 in STIK, with phonological context and speech rate as predictors (table 4.2.1). To avoid collinearity, these contexts were treated as a single column in the data (see §3.5.1). There are significant main effects of pre-nasal and pre-/g/ environments, indicating that these environments exhibit significantly higher F2 values in STIK. These environments do not differ statistically from each other, suggesting that STIK exhibits relatively similar midpoints in both phonological contexts. There is also a significant main effect of pre-lateral position, indicating that F2 is significantly lower in tokens of STIK preceding /l/. No effects arise in the F2 of STIK as a function of gender or age group.

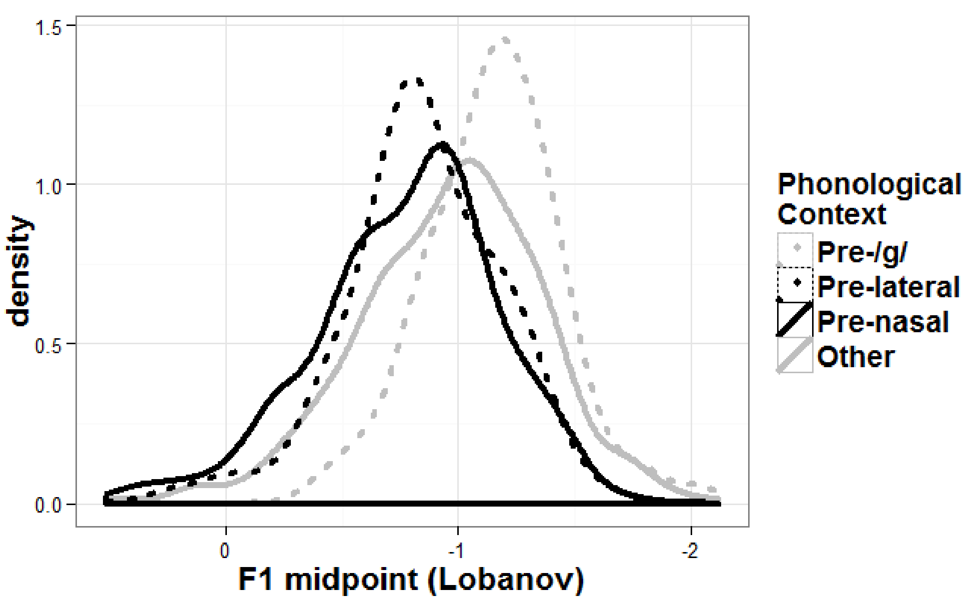
Table 4.2.1. Lmer model fit to normalized F2 midpoint values of STIK for all speakers, with phonological environment and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.10762	0.06635	16.693
phonological environment=Pre-lateral	-0.26338	0.05507	-4.783
phonological environment=Pre-nasal	0.12229	0.03655	3.346
phonological environment=Pre-/g/	0.16582	0.07514	2.207
speech rate	-0.02553	0.01536	-1.662

4.2.2. Change in F1 of STIK

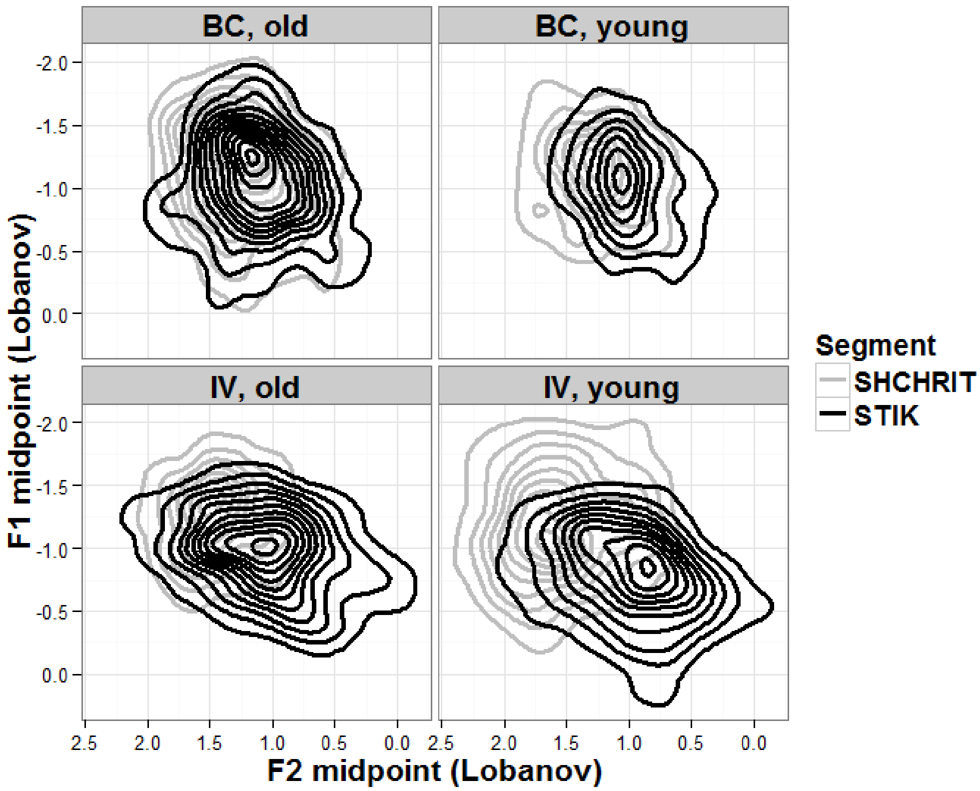
The results from the current data demonstrate that STIK exhibits significant changes in F1 as a function of age group, gender, and three phonological environments: pre-lateral position, pre-nasal position, and pre-/g/ position. Figure 4.2.2 shows the normalized midpoint of F1 in STIK in pre-nasal, pre-lateral and pre-/g/ environments, compared with other phonological environments. Relative to other phonological environments, both pre-lateral and pre-nasal positions motivate higher F1 values (~ lower realizations). This lowering might be expected as a corollary of the backing that occurs in pre-lateral positions (see §4.2.1) (Bernard 1985; Cox & Palethorpe 2003). Paralleling the behavior of pre-nasal SHCHRIT, pre-nasal STIK exhibits higher F1 values, corresponding to lower realizations of STIK. This lowering is likely due in part to the lowering effect nasals have on high vowels, cross-linguistically (Beddor 1982; Beddor et al. 1986).

Figure 4.2.2. Normalized F1 values of STIK in pre-lateral, pre-nasal and pre-/g/ contexts, compared with other phonological environments.



As discussed in §4.1.1, SHCHRIT and STIK exhibit substantial overlap in both F1 and F2 in old BC speakers. Over time however, SHCHRIT fronts to a position significantly in front of STIK, suggesting that STIK and SHCHRIT begin as a single lexical set, and become less similar over time. There is evidence to suggest that STIK exhibits changes across age group as well. Figure 4.2.3 is a two-dimensional density plot of the normalized midpoint of STIK in relation to SHCHRIT over age group. This plot displays STIK in all phonological environments, ignoring the differences that arise between pre-nasal, pre-/g/ and pre-lateral environments. This is due to the fact that the distributions remain largely unchanged if these phonological environments are excluded from the plots. Old BC speakers exhibit completely overlapped STIK and SHCHRIT distributions. The center of the distribution of STIK is located on 1.25 in the F2 dimension and -1.25 in the F1 dimension. Young BC speakers exhibit very little change in the center tendencies of STIK, despite exhibiting a slightly lower distribution in F1 at approximately -1.1 in comparison to old BC speakers. However, the area covered by STIK is considerably smaller in young BC speakers. Old IV speakers exhibit an even lower distribution of STIK, as the center of the distribution is located around -1.0 in F1. In comparison to young BC speakers, the area of the distribution in old IV speakers is noticeably larger, especially in F2, where the front-most extent of the distribution of STIK is equal to the frontest realizations of SHCHRIT, and the backest realizations are backer than the 0.0 mark in F2. This 'flattening out' of the distribution is also observed in young IV speakers, though STIK appears to occupy a very similar range in F2 in both old and young IV speakers. Young IV speakers also exhibit a lower distribution center of STIK, located approximately on -0.25 in F1. The lowering that takes place across corpus is quite striking when comparing the position in F1 of STIK in old BC speakers to that of young IV speakers.

Figure 4.2.3. 2-d density plot of normalized midpoints of STIK (black) and SHCHRIT (gray), separated by vowel identity and age group.[101]

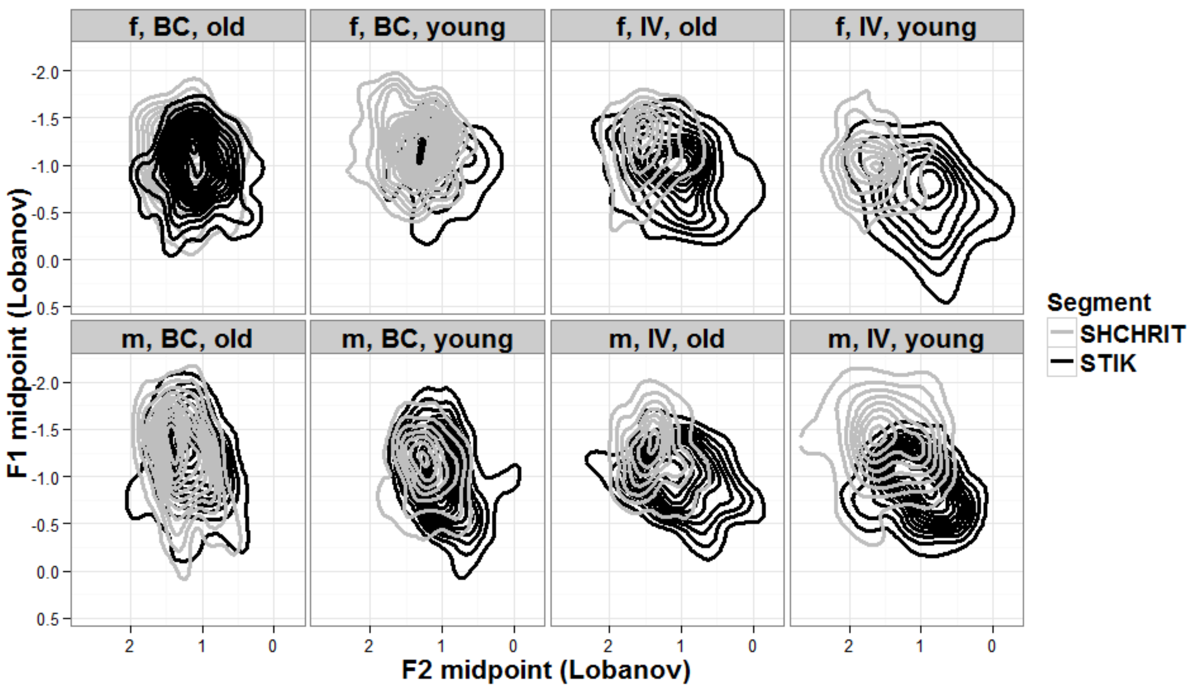


Females and males behave slightly differently with respect to their lowering of STIK. Figure 4.2.4 is a two-dimensional density plot of normalized midpoint realizations of STIK and SHCHRIT divided across age group and gender. Few differences arise in the old BC group, as male and female STIK appears to be centered on -1.25 in F1. Young BC speakers, however, show a pattern where female realizations of STIK occupy a larger range in F1 than the range of male realizations. While female realizations exhibit an F1 range between -1.75 and -0.25, young BC males extend from nearly -2.0 to just below 0.0. The result is that females appear to have a distribution more heavily concentrated in the lower end of the spectrum of STIK realizations than males. Old IV speakers, however, show roughly equivalent F1 ranges; however, the center of the female distribution appears positioned roughly on -1.0, whereas old IV males exhibit slightly

[101] This plot is identical to figure 4.1.1, but in this case STIK is labeled in black to make its position more easily readable.

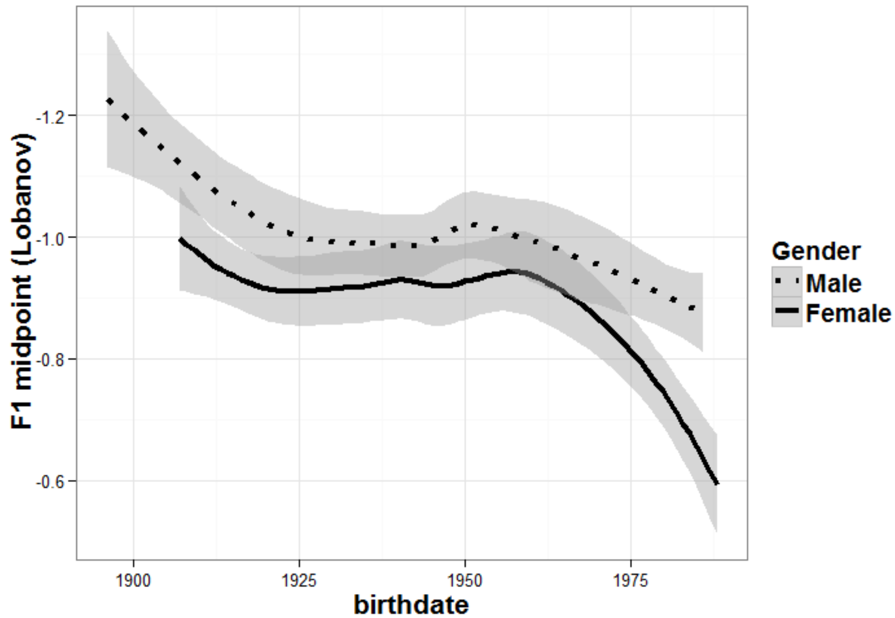
higher realizations of STIK. The difference between genders is much more apparent in young IV speakers. Females are centered on -0.25 in the F1 dimension, whereas males are situated very slightly lower than -1.0 in F1. The F1 range of STIK is also strikingly different across gender for young IV speakers. While F1 of STIK for both genders does not appear to extend much above -1.5, the lowermost end of the female distribution is nearly at 0.5 in F1. Males, on the other hand, exhibit a STIK distribution with a lowermost end of just beyond -0.25. This appears to indicate that females produce a range of F1 values for STIK, but that if a realization of STIK is low for young IV speakers, that realization is likely to be produced by a female.

Figure 4.2.4. 2-d density plot of normalized midpoints of STIK (black) and SHCHRIT (gray), separated by vowel identity, gender, and age group.



The difference in the height of STIK across gender is clearer when isolating the movement F1 exhibits over time. Figure 4.2.5 plots the mean normalized midpoint of F1 (with standard error) in STIK over time for both males and females. As suggested by figure 4.2.4, males exhibit a consistent tendency to produce higher realizations of STIK across all age groups. Furthermore, the difference in the height of STIK is clear in young IV speakers, where females demonstrate noticeably lower STIK tokens relative to their male counterparts.

Figure 4.2.5. Smoothed mean (with standard error) of normalized F1 of STIK for males (dotted) and females (solid) plotted against birthdate.



A linear mixed effects model fit to normalized midpoints of F1 in STIK, with age group, gender, phonological context and speech rate as predictors corroborates these claims (table 4.2.2). There is a significant main effect of young IV speakers on the F1 of STIK, indicating that these speakers exhibit lower realizations of STIK than all other age groups. Both young BC and old IV speakers exhibit lower realizations than old BC speakers, but these differences are not significant. There is also a significant main effect of gender, indicating that males exhibit higher realizations of STIK than females. Furthermore, there is a significant main effect of pre-lateral and pre-nasal environment on the F1 of STIK, indicating that F1 increases (~ STIK is lower in the vowel space) in pre-lateral and pre-nasal environments. Finally, there is a significant main effect of pre-/g/ environment on the F1 of STIK, indicating that STIK before /g/ is realized as higher in the vowel space than all other phonological environments.

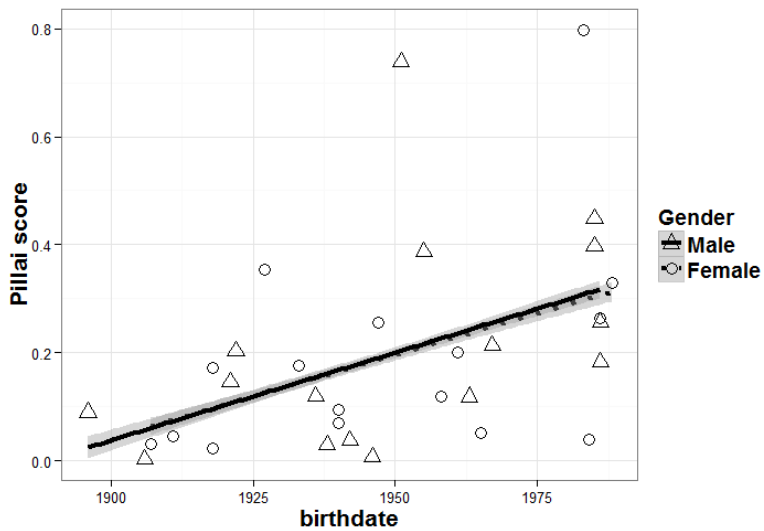
Table 4.2.2. Lmer model fit to normalized F1 midpoint values of STIK for all speakers, with age group, gender, phonological environment, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.03329	0.07559	-13.669
phonological environment=Pre-lateral	0.12164	0.04632	2.626
phonological environment=Pre-nasal	0.18969	0.03121	6.077
phonological environment=Pre-/g/	-0.17855	0.06102	-2.926
age=young BC	0.07310	0.07331	0.997
age=old IV	0.10131	0.07459	1.358
age=young IV	0.27951	0.07446	3.754
gender=male	-0.11711	0.05239	-2.235
speech rate	0.01054	0.01423	0.740

Despite the differences that arise across gender, males and females show relatively equal tendencies to differentiate STIK and SHCHRIT over time. Figure 4.2.6 plots STIK-SHCHRIT Pillai scores derived from a MANOVA on the y-axis against birthdate on the x-axis with a best fit line for both males and females. The best fit lines suggest that SHCHRIT and STIK exhibit higher Pillai scores (~less overlapped vowel distributions) as birthdate increases. Younger speakers exhibit higher mean Pillai scores than older speakers. Though this tendency to increase Pillai score over birthdate is not particularly strong, there is no evidence that any substantive difference arises across gender, despite the tendency for females to produce lower STIK than males. These observations together suggest that the similarity of SHCHRIT and STIK is somewhat tied to age (but not gender), but that additional factors (e.g., PDM score; see §4.2.3) may be conditioning the overlap exhibited by the two vowels.

In figure 4.2.6, there are two outliers, one old IV male with a Pillai score of 0.74 (Grant) and one young IV female with a Pillai score of 0.80 (Sarah). Grant exhibits the lowest PDM score at 1.21 of all old IV speakers (mean = 5.52). His behavior is therefore likely described by this low PDM score (see figure 4.2.7 in §4.2.3). However, Sarah's behavior does not appear to be conditioned by PDM score. This is potentially due to the fact that she has the highest level of education of any young IV speaker (she was pursuing her M.A. at the time of recording). It could be that her noticeably higher Pillai score is in some way tied to her education, as daily interaction with Pidgin speakers may be less common for her.

Figure 4.2.6. Pillai scores of SHCHRIT-STIK plotted against birthdate for males (triangles and dotted line) and females (circles and solid line).



A linear fixed-effects regression model fit to Pillai scores, with age group and speech rate as predictors corroborates this observation (table 4.2.3). There is a significant main effect of old IV and young IV speakers, indicating that both of these age groups exhibit higher STIK-SHCHRIT Pillai scores, signifying less spectral overlap between the two vowel distributions. This effect is much higher in young IV speakers, suggesting that this group exhibits the highest Pillai scores (or, the least overlapped STIK and SHCHRIT distributions) of all age groups. Gender is not a significant predictor of variation in STIK-SHCHRIT Pillai scores, and so it is not included in the final model.

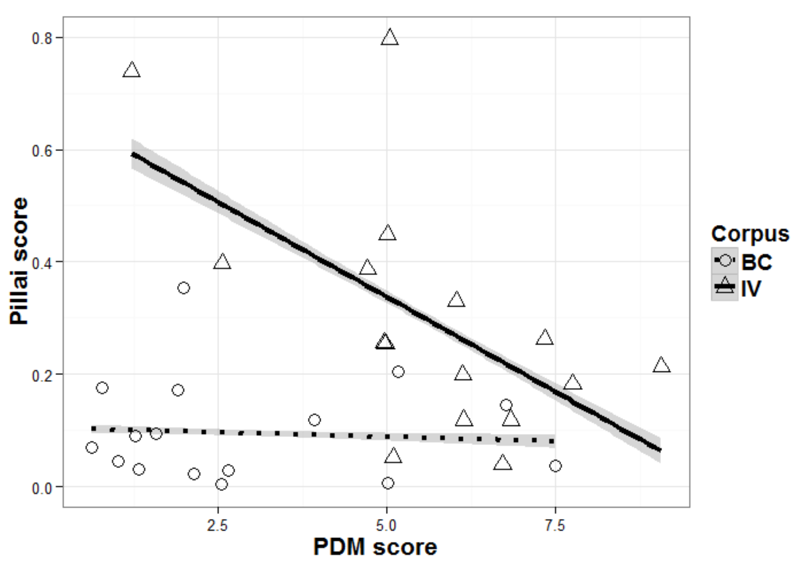
Table 4.2.3. Linear fixed-effects model fit to STIK-SHCHRIT Pillai scores for all speakers, with age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.0906100	0.0154118	5.879
age=young BC	0.0156033	0.0086732	1.799
age=old IV	0.1738020	0.0095378	18.222
age=young IV	0.2498041	0.0094795	26.352
speech rate	-0.0009597	0.0041759	-0.230

4.2.3. Effect of PDM on STIK-SHCHRIT split

The results from the current data demonstrate that one of the conditioning factors for overlap between STIK and SHCHRIT is PDM score, which manifests in two ways: an effect on Pillai score for IV speakers, and an effect on F2 for IV speakers. Figure 4.2.7 shows STIK-SHCHRIT Pillai scores plotted against PDM score for each corpus. BC speakers exhibit no change in Pillai scores across PDM score, and Pillai scores are relatively low for all BC speakers. However, Pillai score and PDM score for IV speakers are inversely correlated. This indicates that as PDM score increases, so does the likelihood that an IV speaker will exhibit more similar realizations of STIK and SHCHRIT.

Figure 4.2.7. Pillai scores of SHCHRIT-STIK plotted against PDM score for BC speakers (dotted) and IV speakers (solid).



These observations are corroborated a linear fixed-effects model fit to STIK-SHCHRIT Pillai scores for IV speakers, with PDM score and speech rate as predictors (table 4.2.4). There is a significant main effect of PDM score on STIK-SHCHRIT Pillai scores, indicating that as PDM score increases, the tendency to produce overlapped distributions of STIK and SHCHRIT also increases.

Table 4.2.4. Linear fixed-effects model fit to STIK-SHCHRIT Pillai scores of IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.643927	0.033078	19.467
PDM score	-0.067699	0.002872	-23.572
speech rate	0.008119	0.007374	1.101

PDM score also has an effect on the normalized midpoint of F2 of STIK, though this effect only manifests strongly in IV speakers. Figure 4.2.8 demonstrates this, and shows the smoothed means of normalized F1 and F2 midpoints of STIK and SHCHRIT plotted against PDM score separately for both corpora. The bottom right quadrant shows the PDM score plotted against the F2 of STIK for IV speakers. There is a clear tendency for IV speakers with higher PDM scores to exhibit fronter realizations of STIK. This finding is corroborated by a linear mixed-effects model fit to the midpoint of F2 of STIK for IV speakers, with PDM score and speech rate as predictors (table 4.2.5). There is a significant main effect of PDM score, suggesting that as PDM score increases, STIK is more likely to be articulated towards the front of the distribution of STIK tokens. The models fit to F1 of IV speakers, as well as F1 and F2 of BC speakers, failed to return any significant effects. Despite this, figure 4.2.8 demonstrates a more general tendency for speakers from both corpora to exhibit more similar formant values for SHCHRIT and STIK in both formant dimensions as PDM score increases. This tendency is much less evident in BC speakers, though this may have to do with the fact that F1 and F2 in STIK and SHCHRIT are already very close for speakers in this corpus (potentially representing a ceiling effect). For IV speakers, however, it is clear that while PDM affects different formants for the different vowels (i.e., a higher PDM score increases the F1 of SHCHRIT and increases the F2 of STIK), increased use of Pidgin morpho-syntactic features results in more similarity between the two vowel classes.

Figure 4.2.8. Smoothed mean of normalized F1 (top) and F2 (bottom) midpoints of STIK (dotted) and SHCHRIT (solid) plotted against PDM score for BC and IV speakers.

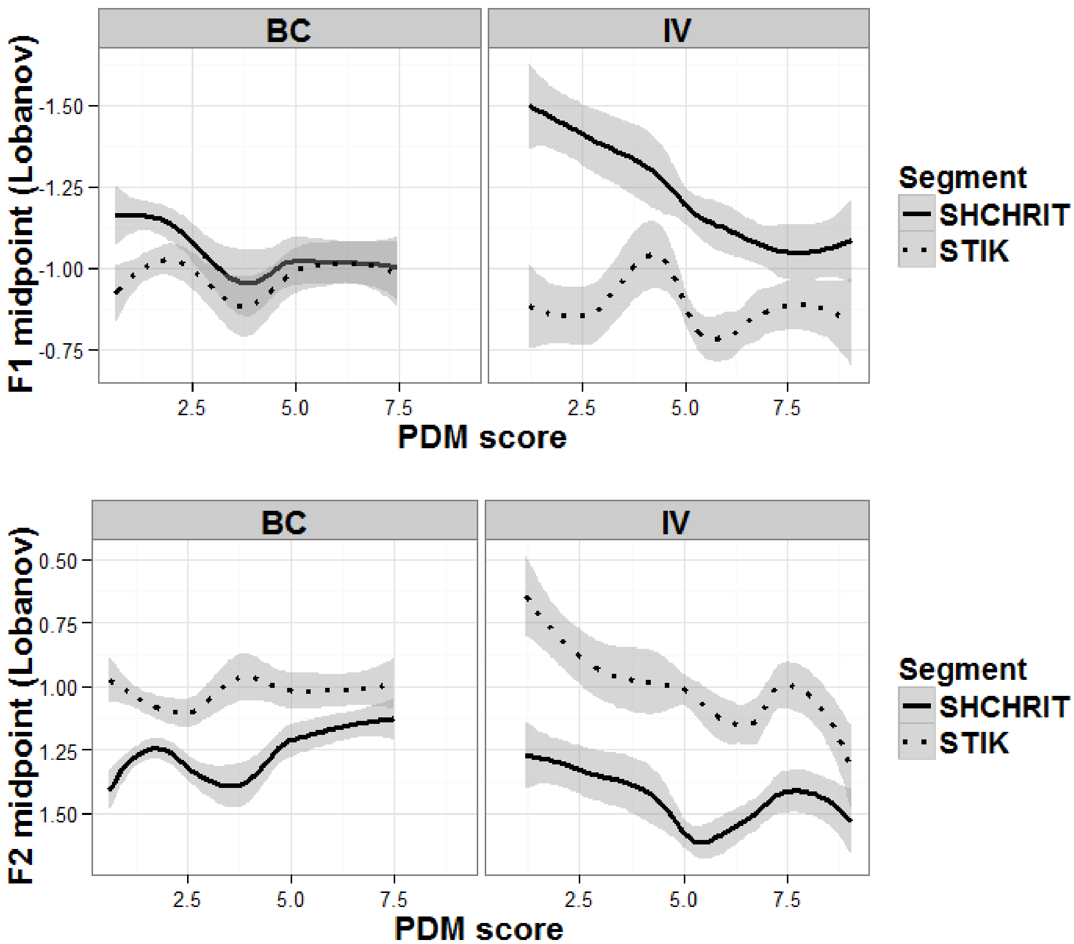


Table 4.2.5. Lmer model fit to normalized F2 midpoint values of STIK for IV speakers, with PDM score and speech rate as predictors.

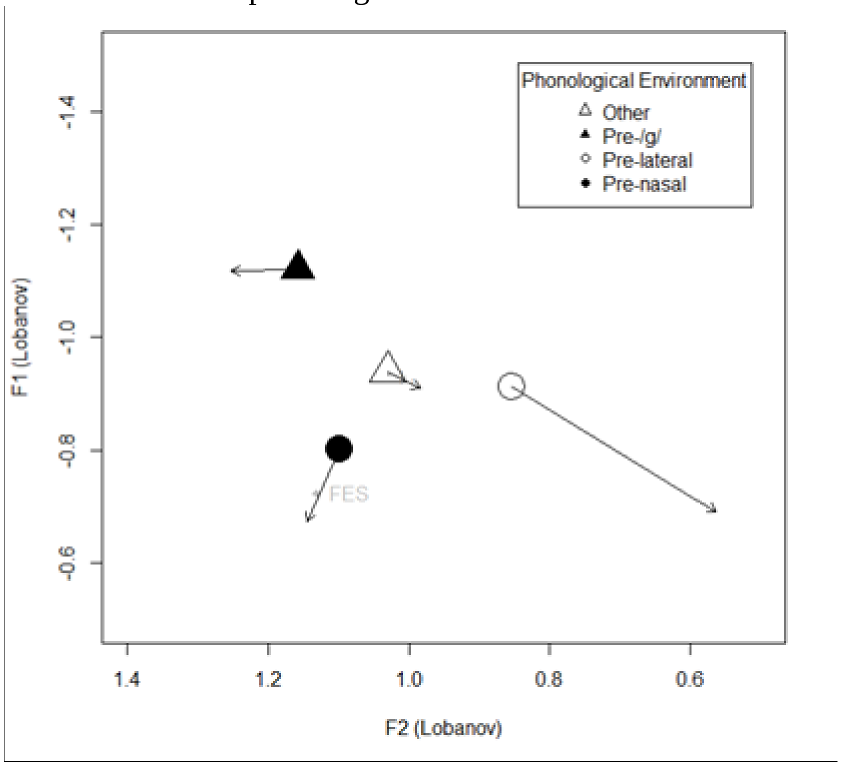
	Estimate	Std. Error	t value
(Intercept)	0.73002	0.19519	3.740
PDM score	0.06312	0.02782	2.269
speech rate	-0.01421	0.02741	-0.518

4.2.4. Trajectory of STIK

The results from the current data demonstrate that the formant trajectory of STIK does not vary over age group or gender, but shows differences over phonological environment. Figure 4.2.9 is a plot of the mean normalized formant contour from 30%-70% through STIK. These points were selected to minimize the effect of surrounding phonological context on the vowel, while still observing formant motion. In comparison to “other” phonological contexts, which exhibit monophthongal behavior, pre-/g/ and pre-nasal realizations of STIK exhibit small fronting offglides. While pre-/g/ offglides are largely in F2 and pointed towards the front of the vowel space, pre-nasal offglides are largely along F1. Neither of these contexts, however, appear to motivate much motion over the duration of the vowel in comparison to true diphthongs (§7). Pre-lateral contexts, on the other hand, appear to motivate much longer formant trajectories. There is a considerable backing offglide that is pointed towards the center of the vowel space.[102] Given the length of the trajectory of pre-lateral STIK, it is reasonable to conclude that this position motivates the most diphthongal realizations of the STIK vowel over the given phonological contexts.

[102] The IPA transcription for fit in pre-lateral position might best be represented as [ɪ̠ə̯] or [ɪ̠ə̯̈].

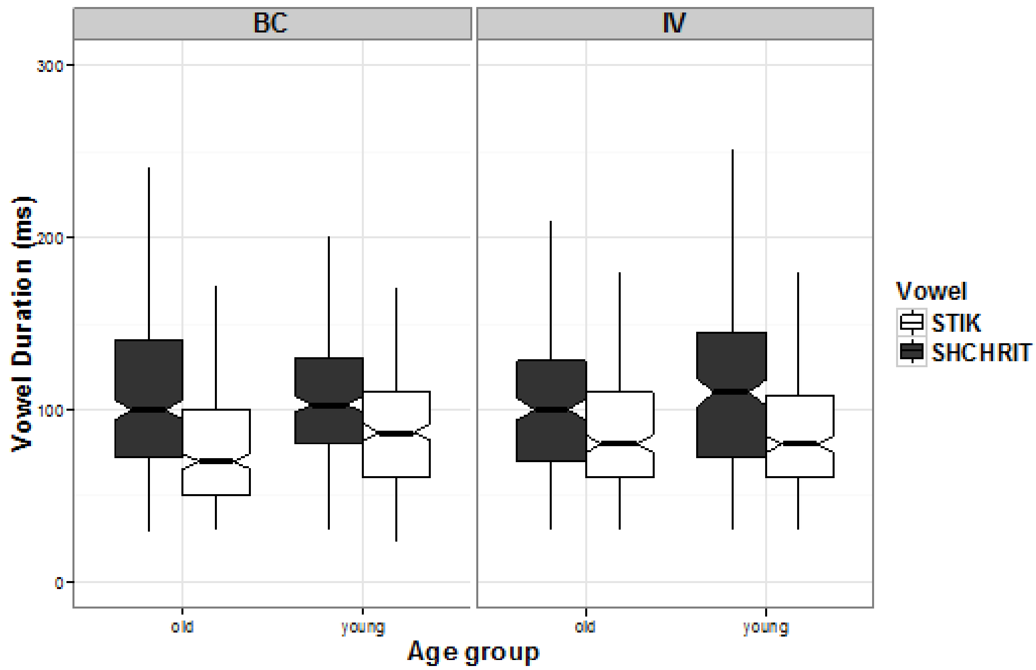
Figure 4.2.9. Trajectory of STIK from 30% to 70% of the duration of the vowel across phonological environment.



4.2.5. Role of duration in distinguishing STIK and SHCHRIT

As discussed in §2.5 and §3.5.2, it is reasonable to expect that even if lexical sets exhibit spectral overlap, there is still a possibility for vowels to exhibit temporal differences. Figure 4.2.10 shows boxplots representing vowel duration for STIK and SHCHRIT over age group for the current study. SHCHRIT exhibits a relatively consistent median vowel duration, with young IV speakers showing a slight increase in vowel duration, especially relative to old BC speakers. STIK exhibits relatively few differences across age group as well; only old BC speakers exhibit a noticeably shorter vowel duration for STIK in comparison to the STIK of any other age group. Importantly, STIK is shorter in duration than SHCHRIT across age group. This finding is noteworthy, given the significant spectral overlap STIK and SHCHRIT exhibit, especially in older age groups. Despite this spectral overlap, it appears that for both IV and BC speakers, STIK is held temporally distinct from SHCHRIT.

Figure 4.2.10. Vowel durations (ms) of STIK and SHCHRIT plotted against age group (outliers removed).



To corroborate these findings, a linear-mixed effects model was fit to the vowel duration (ms) of SHCHRIT and STIK realizations, with segment type, position before a voiced consonant, age group, and speech rate as predictors (table 4.2.6).[103] Speech rate was included as a predictor to control statistically for vowel duration, as vowel duration and speech rate have been shown to be linked (see, e.g., Lindblom 1963; further discussion in §3.5.2). Whether the vowel was before a voiced or voiceless consonant was also included, as the voicing of a coda segment influences the duration of the preceding vowel (see, e.g., House 1961; Delattre 1962; Chen 1970; Klatt 1976). Table 4.2.7 shows a significant main effect of segment type, indicating that STIK (~108 ms) is shorter in duration than SHCHRIT (~ 140 ms). There is also a significant main effect of voicing of the following consonant, indicating that vowels before voiced consonants are significantly longer than vowels before voiceless consonants. This is consistent with patterns of

[103] Because pre-voiced consonants was a predictor in this model, SHCHRIT and STIK tokens in word-final position and before other vowels were not included in the model.

vowel duration in several languages, including English, Spanish, French and German (see Mack 1982). There was a significant main effect of young IV speakers as well, indicating that this group produces longer vowel duration with respect to old BC speakers, corroborating observations made from figure 4.2.10. Finally, speech rate exhibits a predictable effect on vowel duration, where higher rates of speech produce significantly shorter vowels. It is worth noting that vowel duration for STIK and SHCHRIT does not appear to vary as a function of PDM, demonstrating that regardless of spectral overlap, these two vowel qualities are likely to be distinguishable by duration.

Table 4.2.6. Linear mixed-effects model fit to durations (ms) of STIK and SHCHRIT for all speakers, with segment, age group, position before a voiced consonant, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	139.599	6.934	20.132
Segment=STIK	-32.079	2.795	-11.479
pre-voiced=yes	9.468	2.757	3.435
age=young BC	1.133	5.865	0.193
age=old IV	9.589	6.036	1.589
age=young IV	16.794	6.037	2.782
speech rate	-8.373	1.533	-5.463

4.2.6. Summary of STIK findings

In sum, variation in the midpoint of STIK is conditioned by phonological context, gender, age group, and PDM score. In terms of phonological effects on STIK, pre-nasal environments motivate a fronter and lower midpoint, pre-/g/ environments motivate a fronter and higher midpoint, and pre-lateral environments motivate a lower and backer midpoint. Pre-lateral realizations of STIK also exhibit the longest vowel trajectory of all phonological contexts. In terms of gender, females exhibit lower midpoint values of STIK, most noticeably in young IV speakers. BC speakers exhibit the most overlapping distributions of STIK and SHCHRIT, while IV speakers exhibit relatively lower realizations of STIK, a tendency which is most evident in young

IV speakers. All this suggests a change over real time, where STIK has split away from SHCHRIT in F1/F2 space (while SHCHRIT has simultaneously fronted relative to both STIK and its position in the vowel space in old BC speakers, see §4.1.1). This split over time is also observable in STIK-SHCHRIT Pillai scores, which increase as a function of time, indicating that STIK and SHCHRIT are less overlapping in relatively younger age groups. However, the difference between STIK and SHCHRIT is moderated by PDM score. IV speakers with relatively higher PDM scores exhibit fronter realizations of STIK, which serves to decrease the distance in F1/F2 space between STIK and SHCHRIT. At the same time, SHCHRIT is more likely to be articulated lower in the vowel space for IV speakers with high PDM scores (see §4.1.3). This is part of a general tendency for speakers from the IV corpus who have high PDM scores to exhibit more similar STIK and SHCHRIT vowels. Finally, speakers use vowel duration to distinguish STIK from SHCHRIT, as all age groups demonstrate durational differences between the two vowels, regardless of their PDM score. This suggests that while STIK and SHCHRIT become less similar in spectral space over time, temporal cues distinguish the two vowels.

4.3. FES

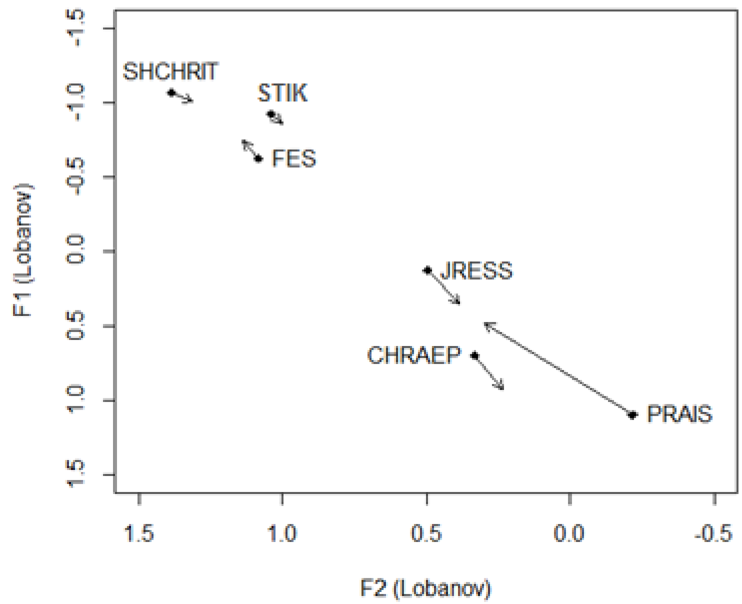
The existing literature describes FES as occupying a mid-front position, with an F2 and F1 generally lower than that of SHCHRIT. In English, FACE is derived from Middle English /ɑ:/ (Labov et al. 2006: 13), and in many varieties of English it is described as diphthongal with a high front offglide (see, e.g., Labov et al. 2006). However, FACE rarely exhibits the degree of formant motion associated with “true” diphthongs (Labov et al. 2006). Some dialects of English, such as the northern U.S. region including Minnesota and the Dakotas, exhibit a tense, conservative FACE which is realized as higher in the vowel space than other dialects (Labov et al. 2006: 92). The Southern U.S. states often exhibit lower, more retracted FACE midpoints, as a result of the Southern Shift (see Labov et al. 2006: 240-261). In Hawaiʻi English, FACE is described as having a relatively short trajectory, in line with what is seen in GOAT, especially in comparison to diphthongs PRICE, MOUTH, and CHOICE. In Pidgin, Sakoda and Siegel (2008: 222-224) describe FES as monophthongal word-finally and word-internally before a voiceless consonant;[104] elsewhere, Sakoda and Siegel describe the vowel as diphthongal with a high front offglide (see also description of FACE in Odo 1975).[105] The following discussion addresses the behavior of FES using the data from the current study.

4.3.1. Trajectory of FES

While FES is classified as a diphthong in at least some phonological contexts in Pidgin (Sakoda & Siegel 2008), the current study finds that there is very little motion over the duration of FES. Figure 4.3.1 is a plot of the mean normalized formant contour from 30% to 70% for the token number of FES tokens with respect to the other front vowels, as well as PRAIS for comparison (see §7.1). The 30% and 70% points were selected in order to reduce influence from the surrounding phonological contexts, while retaining information about the formant motion over the vowel. Looking at the plot, FES exhibits strikingly little motion over its duration, even in comparison to monophthongs like JRES and CHRAEP. By comparison, the "true diphthong" (Labov et al. 2006: 11) PRAIS exhibits much more formant motion over its duration. It is worth noting that the trajectory of FES behaves consistently across age group, where each age group exhibits monophthongal realizations.

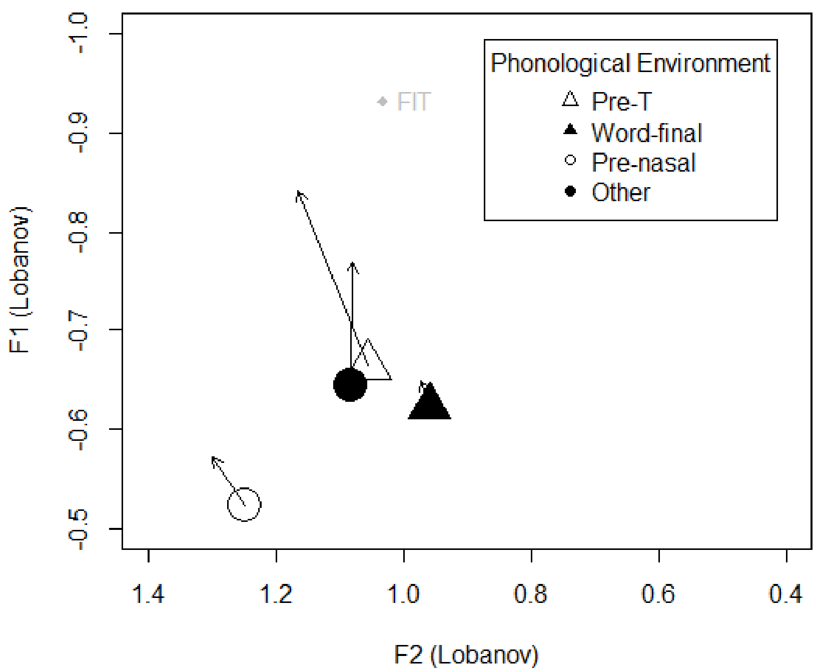
[104] Sakoda and Siegel (2008) transcribe this as [e], rather than the diphthongal [eɪ], which they observe occurs elsewhere.
[105] Sakoda and Siegel (2008) do not describe the offglide other than by transcribing the vowel in its entirety as [eɪ].

Figure 4.3.1. Trajectory of FES and all other front vowels and PRAIS (based on all realizations); nucleus represented by the measurement at 30% and offglide represented by the measurement at 70% of the vowel's duration.



The trajectory of FES changes across phonological environment. Figure 4.3.2 is a plot of the mean normalized formant contour from 30% to 70% of FES before voiceless obstruents (pre-T), in word-final environments, and pre-nasal environments in comparison to all other phonological environments. In line with claims by Sakoda and Siegel (2008: 223), FES is monophthongal in word final position, exhibiting a nucleus and offglide in virtually the same position in the vowel space. Pre-nasal position also exhibits very little trajectory motion. FES before voiceless obstruents (pre-T) exhibits the longest formant trajectory, contrary to claims by Sakoda and Siegel (2008: 223) that this is an environment that motivates particularly monophthongal realizations of FES. Despite this, no phonological context motivates a particularly long trajectory, indicating that FES in all environments is relatively monophthongal.

Figure 4.3.2: Trajectory of FES over age group from 30% to 70% through the vowel; pre-T signifies pre-voiceless obstruent



Given the short trajectory exhibited by FES in all environments, the remaining discussion of the behavior of FES across phonological environment, gender, and age group is based on midpoint values of the entire vowel, rather than midpoint values of the nucleus at 30% (like diphthongs are treated in §7). It is worth mentioning that the results reported in this chapter do not change if the 30% point through FES is chosen.

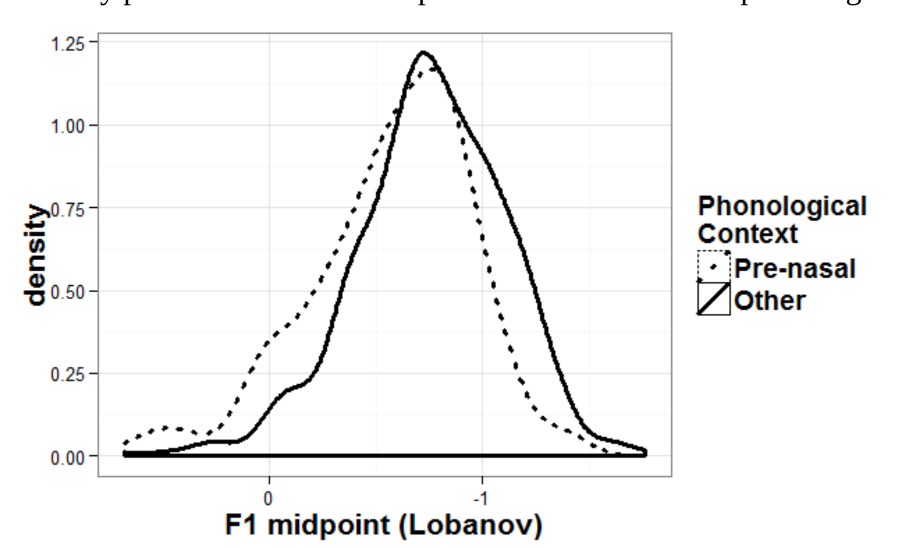
4.3.2. Phonological effect on F1 of FES

The results from the current study demonstrate that one phonological environment has an effect on the F1 midpoint of FES: pre-nasal position.[106] Figure 4.3.3 is a density plot, showing the normalized midpoint F1 in FES in pre-nasal position, in comparison to all other phonological environments. While pre-nasal environments motivate very similar density peaks, there are small

[106] There is also evidence to suggest that pre-lateral position motivates significantly lower realizations of FES; however, tokens in pre-lateral position were not frequent enough to be considered in the present discussion. Furthermore, there is no evidence that word-final tokens of FES behave differently in F1 than “other” realizations of FES.

differences in the distribution orientation across phonological context. Pre-nasal environments are shifted to the left, indicating that these phonological environments motivate slightly higher F1 values in FES (~ lower FES realizations).

Figure 4.3.3. Density plot of normalized midpoint in F1 of FES across phonological environment.



To corroborate these findings, a linear mixed-effects model was fit to normalized F1 midpoint values of FES, with phonological context and speech rate as predictors (table 4.3.1). The model returns a significant main effect for pre-nasal position, indicating that pre-nasal position is more likely to co-occur with higher F1 values (~ lower realizations of FES) The differences in estimate values of pre-nasal phonological environments suggest that while significant, pre-nasal tokens of FES in comparison to all other tokens of FES do not motivate a bimodal distribution.

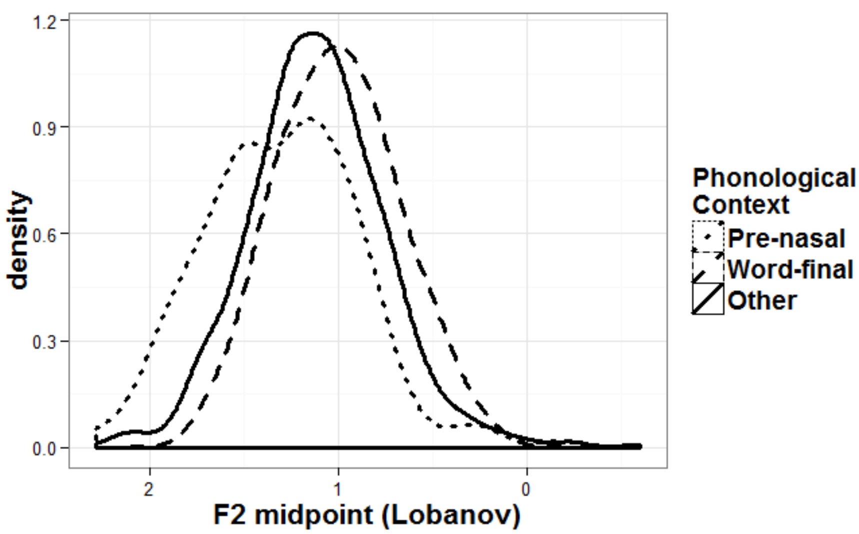
Table 4.3.1. Lmer model fit to normalized F1 midpoint values of FES for all speakers, with phonological environment and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.762532	0.057672	-13.222
phonological environment=Pre-nasal	0.177258	0.033716	5.257
speech rate	0.001663	0.014344	0.116

4.3.3. Fronting of FES

The results from the current data demonstrate that the F2 of FES is influenced by age group and two phonological contexts: pre-nasal position and word-final position.[107] Figure 4.3.4 is a density plot, showing the normalized midpoint F2 in FES in word-final position and pre-nasal position in comparison to all other phonological environments. Pre-nasal position motivates a clearly higher midpoint F2 value than FES in "other" phonological environments, as the distribution of pre-nasal FES tokens is shifted noticeably to the left. Word-final environments motivate some lowering of the midpoint F2 in FES, as the distribution and density peak of word-final tokens of FES are shifted to the right of "other" phonological environments. No differences arise in pre-T environments relative to "other" in midpoint values.

Figure 4.3.4. Density plot of normalized midpoint in F2 of FES across phonological environment.

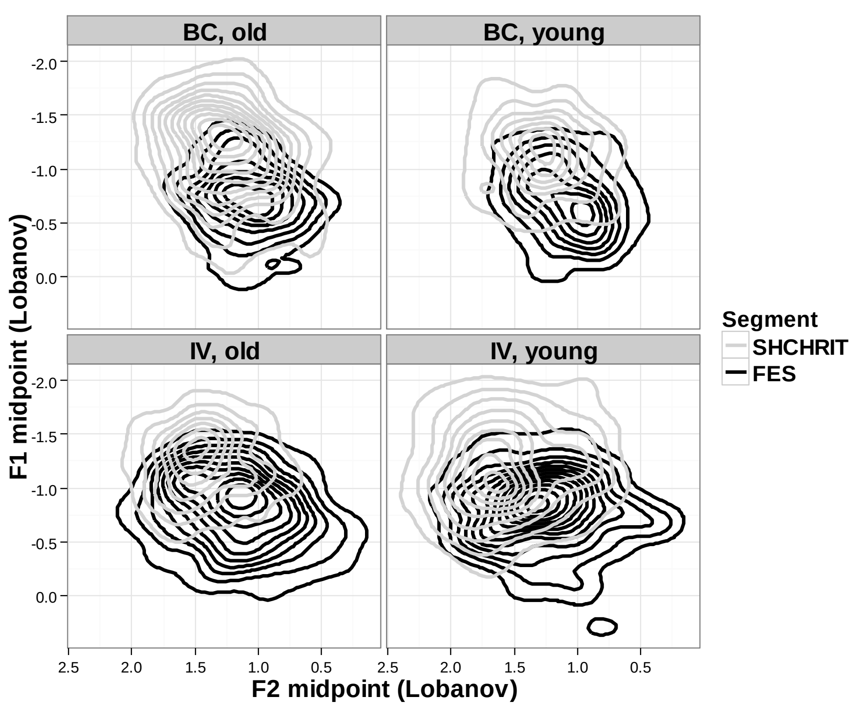


The F2 of FES also changes over time as a function of age group. Figure 4.3.5 is a two-dimensional density plot of normalized F1/F2 values of FES and SHCHRIT plotted for each age group. SHCHRIT is included in this plot as a reference point for FES. For each age group, FES is

[107] There is also evidence to suggest that pre-lateral position motivates significantly backer realizations of FES; however, tokens in pre-lateral position were not frequent enough to be considered in the present discussion. For this discussion, they are treated as "other".

located in a position lower and backer than SHCHRIT. Old BC speakers exhibit a relatively concentrated distribution of FES, with a distribution center located between -1.0 and -0.5 in the F1 dimension and 1.5 and 0.75 in the F2 dimension. Young BC speakers exhibit a very similar distribution size and center in comparison to old BC speakers. Old IV speakers, however, exhibit a more dispersed distribution with respect to BC speakers, which extends from approximately 0.25 to just beyond 2.0 in the F2 dimension. Young IV speakers exhibit the frontest realizations of FES. While the distribution range does not noticeably change in comparison to old IV speakers, young IV speakers demonstrate a fronter distribution center at approximately 1.4 in the F2 dimension. The relative frontness of FES for young IV speakers is especially apparent when compared to the FES distribution of either BC age group. That young IV speakers exhibit fronter midpoint values of FES suggests that the vowel is undergoing a change in progress in apparent time. No apparent differences arise across gender.

Figure 4.3.5. 2-d density plot of normalized midpoints of FES (black) and SHCHRIT (gray), separated by vowel identity and age group.



Across all speakers, the distribution of FES is remarkably close to the distribution of SHCHRIT. This is especially noteable when comparing the distribution of FACE and FLEECE in North American English dialects (see figure 20.1 in Labov et al. 2006: 283) to the distribution of FES and SHCHRIT in Pidgin in the current data.[108] The distributions of FES and SHCHRIT in Pidgin are rather closer and more overlapped (though not nearly completely overlapped) in comparison to the distributions of FACE and FLEECE across North American dialects.[109]

That phonological context and age group impact the F2 of FES is corroborated by a linear mixed-effects model fit to normalized midpoints of F2 in FES, with phonological context, age group, and speech rate as predictors (table 4.3.2). There is a significant main effect of pre-nasal environment, indicating that pre-nasal tokens of FES exhibit significantly larger F2 values (~ fronter FES realizations) relative to other phonological contexts. Furthermore, there is a significant effect of word-final position, indicating that word-final tokens of FES exhibit significantly smaller F2 values (~ backer FES vowels) relative to other phonological environments. Finally, there is a significant main effect of young IV speakers, indicating that the normalized midpoint of F2 in FES is larger (~ fronter FES vowels) relative to old (and young) BC speakers. No significant effects are reported for any other age group, though old IV speakers exhibit a tendency to produce fronter realizations of FES. This difference, however, is not significant. No significant differences arise across gender.

[108] This figure is not reproduced here for copyright reasons.
[109] It is worth noting that each point in figure 20.1 from Labov et al. (2006: 283) represents an entire dialect region, so some overlap is lost. Despite this, the two lexical classes in North American English are notably distinct in relation to FES and SHCHRIT in Pidgin.

Table 4.3.2. Lmer model fit to normalized F2 midpoint values of FES for all speakers, with phonological environment, age group, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.14854	0.06986	16.440
phonological environment=Pre-nasal	0.20974	0.03410	6.151
phonological environment=Word-final	-0.09091	0.03838	-2.369
age=young BC	-0.00237	0.06878	-0.034
age=old IV	0.09935	0.06941	1.431
age=young IV	0.15192	0.07005	2.169
speech rate	-0.02397	0.01463	-1.638

4.3.4. Effect of PDM on FES

The results from the current data demonstrate that PDM score has an effect on the height of FES. Figure 4.3.6 shows the normalized midpoint of F1 of FES plotted against PDM score for BC and IV speakers; SHCHRIT is also plotted on this graph for reference. While BC speakers show little difference in midpoint F1 value as a function of PDM score, higher PDM scores in the IV corpus increase the likelihood that FES will be relatively low. The lowering that FES exhibits strongly parallels the lowering that SHCHRIT exhibits as a result of high PDM scores, suggesting that these phenomena may be related. Further discussion that the lowering of FES and SHCHRIT occurs in parallel is given in §4.6. A linear mixed effects model fit to normalized midpoints of F1 in FES for IV speakers with PDM score and speech rate as predictors corroborates the observed lowering effect of PDM score (table 4.3.3). There is a significant main effect of PDM on normalized F1 midpoint, indicating that higher PDM scores motivate relatively lower instances of FES. PDM score has no effect on F2 for IV speakers, nor does PDM score have an effect in any formant dimension for BC speakers.

Figure 4.3.6. Smoothed mean of normalized F1 midpoint of FES (solid) and SHCHRIT (dashed) plotted against PDM score for BC and IV speakers.

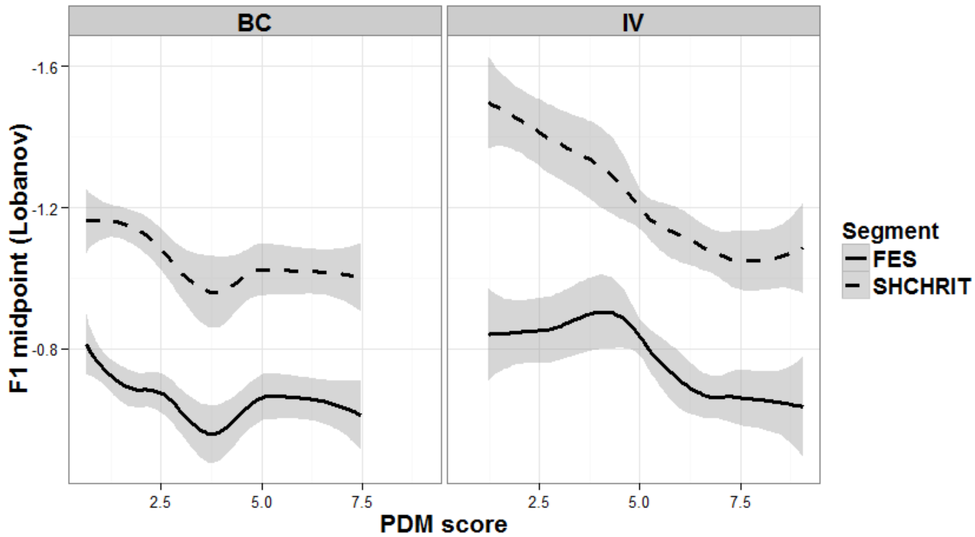


Table 4.3.3. Lmer model fit to normalized F1 midpoint values of FES for IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.89598	0.11962	-7.490
PDM score	0.03307	0.01372	2.411
speech rate	-0.01140	0.02274	-0.502

4.3.5. Summary of FES findings

In sum, variation in the midpoint of FES is conditioned by phonological environment, age group, and PDM score. In terms of phonological environment, pre-T environments motivate a slightly longer trajectory length. Word-final tokens of FES are realized as backer in the vowel space, and have a very short offglide associated with them. Finally, pre-nasal realizations of FES are realized as lower and fronter than other phonological contexts, in line with what is observed for the high front vowels STIK and SHCHRIT. In terms of age group, FES is realized as fronter for young IV speakers, suggesting a change in progress in apparent time. Finally, higher PDM scores motivate lower realizations of FES, which appears to parallel the behavior exhibited by SHCHRIT. No variation in FES is conditioned by gender, and the trajectory of FES does not change in any principled way as a result of age group or PDM score. Finally, no differences arise in terms of vowel duration.

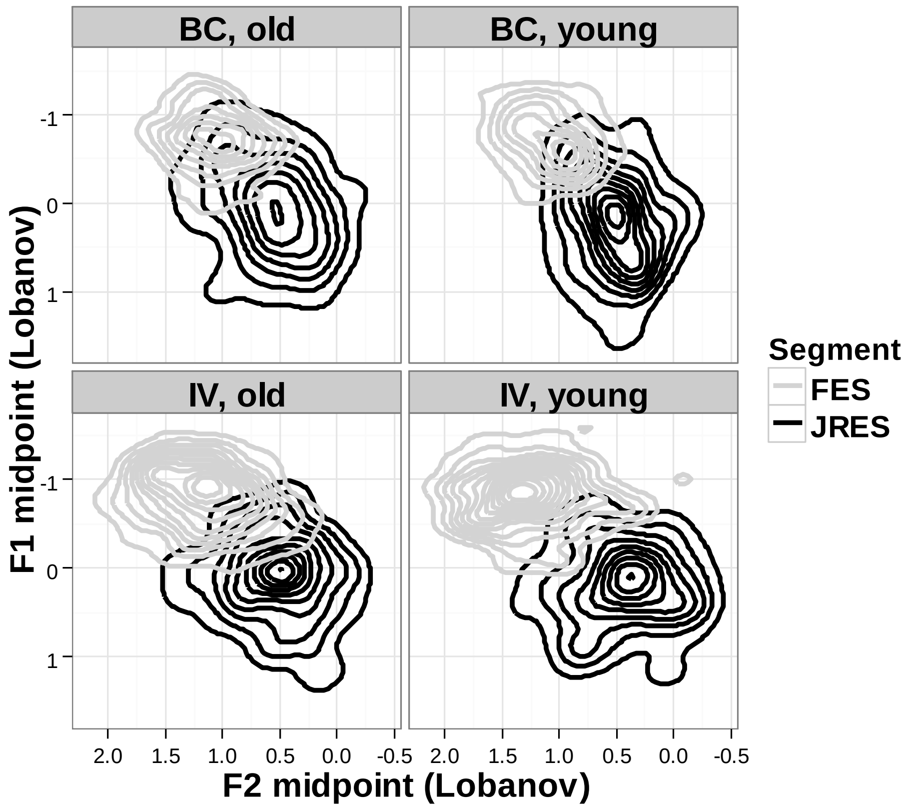
4.4. JRES

The existing literature describes Pidgin JRES as occupying a mid-front position, lower and backer than FES and STIK; it is characterized by a relatively higher F1 and lower F2 in comparison to STIK. In English, DRESS is derived from Middle English short /e/ (Labov e al. 2006: 13), and the vowel is involved in many changes across the English speaking world. In many areas of the United States (especially the Southern states), DRESS and KIT are contextually merged in pre-nasal position (Labov et al. 2006). The American South also sees DRESS front, raise, and diphthongize as part of the Southern Shift (Labov et al. 2006: 241-253). In some dialects of English, DRESS moves with respect to the other short front vowels, KIT and TRAP. DRESS lowers and retracts in the western states (Kennedy & Grama 2012; Becker et al. 2015; Fridland et al. 2015) and Canada (Clarke et al. 1995) along with KIT and TRAP in these varieties; DRESS also lowers and retracts in the Northern Cities (Labov et al. 2006: 185-203). The vowel also undergoes raising as the result of motion of the short front vowels, as in New Zealand, where DRESS occupies a high front position in line with the centralization of KIT and raising of TRAP (Watson et al. 2000). In Hawaiʻi English, DRESS is realized as lower in the vowel space in males than females, and the vowel has a fronting offglide in speakers who do not report an ability to speak Pidgin (Drager et al. 2013). In Pidgin, Sakoda and Siegel (2008: 222-224) have identified that JRES and CHRAEP are realized as variably overlapping on [æ̝], and JRES may be raised to [ɛ] optionally in all environments for basilectal and mesolectal speakers. Finally, Wells (1982: 649) suggests that JRES and FES are overlapping in Pidgin. The following discussion addresses the behavior of JRES using the data from the current study.

4.4.1. Stability of JRES

The results from the current data demonstrate that in comparison to other front vowels, JRES is strikingly stable across the variables discussed in this study. No variation in the behavior of JRES is observed as a function of age group, gender, or PDM score. Figure 4.4.1 demonstrates this stability by plotting normalized F1/F2 midpoints of JRES in comparison to FES over age group, with lateral tokens excluded (as JRES before /l/ is merged with CHRAEP; see §4.4.2). Despite the fronting that takes place in FES (§4.3.3), JRES remains largely stable, only exhibiting a slightly less dispersed distribution in young IV speakers relative to older speakers. However, the midpoint of the distribution in all age groups is centered on 0.0 in the F1 dimension and 0.5 in the F2 dimension. Separate linear mixed-effects models fit to normalized F1 and F2 midpoints of JRES, with age group and speech rate as predictors corroborate this stability, returning no significant or nearly significant effects of age group on the midpoint F1 or F2 of JRES. Finally, there is no substantive evidence to suggest that FES and JRES are overlapped, as claimed by Wells (1982: 649).

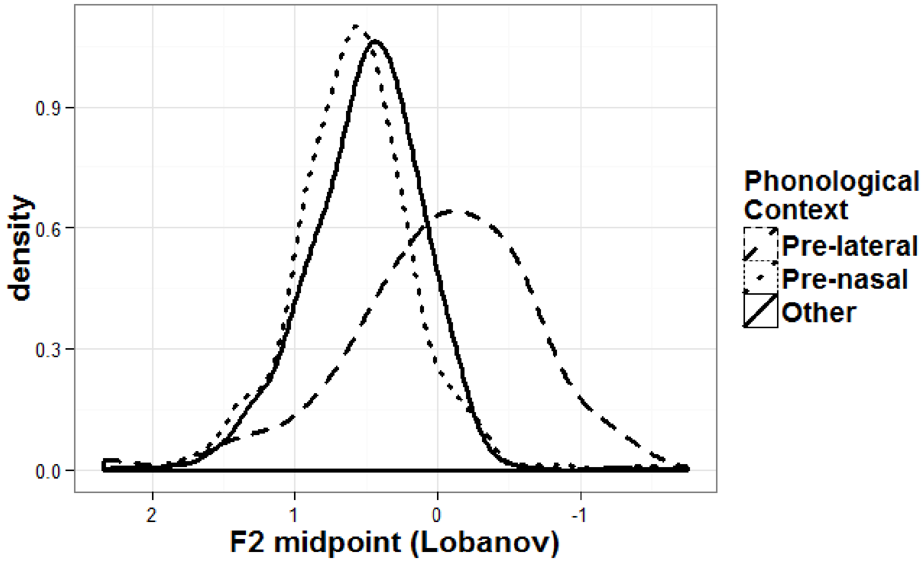
Figure 4.4.1. 2-d density plot of normalized midpoints of JRES (black; lateral tokens excluded) and FES (gray), separated by vowel identity and age group.



4.4.2. Phonological effects on JRES

Despite the stability JRES exhibits over age group, gender, and PDM score, this dissertation finds that two phonological contexts affect the position of JRES: pre-nasal position and pre-lateral position. Figure 4.4.2 is a density plot of normalized midpoint in F2 of JRES in pre-nasal and pre-lateral contexts, as compared with all other phonological environments. Pre-nasal environments exhibit both a density center and a distribution that is shifted slightly to the left, suggesting that this phonological environment motivates slight fronting of JRES. This fronting is consistent with the effect of pre-nasal environments on SHCHRIT, FES, and STIK (see §4.1.1, §4.2.1, and §4.3.2, respectively). Perhaps most striking is the bimodal distribution formed by pre-lateral environments in comparison to all other phonological environments. This position motivates noticeably lower normalized F2 midpoint values compared with other phonological environments.

Figure 4.4.2. Density plot of normalized midpoint in F2 of JRES across phonological environment.



These findings are corroborated by a linear mixed effects model fit to normalized F2 midpoint values of JRES, with phonological context and speech rate as predictors (table 4.4.1). There is a significant main effect of pre-nasal environment, indicating that pre-nasal JRES tokens exhibit significantly higher midpoint F2 values (~ fronter realizations) than other phonological environments. There is also a significant main effect of pre-lateral environment, indicating that pre-lateral JRES tokens exhibit significantly lower midpoint F2 values (~ backer realizations) in comparison with all other phonological environments.

Table 4.4.1. Lmer model fit to normalized F2 midpoint values of JRES for all speakers, with phonological environment and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.38164	0.07212	5.292
phonological environment=Pre-lateral	-0.52161	0.04499	-11.593
phonological environment=Pre-nasal	0.09488	0.03579	2.651
speech rate	0.02987	0.01601	1.866

Phonological context also has an impact on the F1 of JRES, though only pre-lateral tokens motivate a difference in F1. Figure 4.4.3 is a density plot of normalized midpoint in F1 of JRES in pre-lateral contexts as compared with all other phonological environments. Similar to the observed effect of pre-lateral environment on the F2 of JRES, there is a difference in the distribution formed by pre-lateral environments in comparison to all other phonological environments. Pre-lateral position motivates noticeably higher normalized F1 midpoint values (~ lower realizations of JRES), compared with other phonological environments. This finding is corroborated by a linear mixed effects model fit to normalized F1 midpoint values of JRES, with phonological context and speech rate as predictors (table 4.4.2). There is a significant main effect of pre-lateral environment, indicating that pre-lateral JRES tokens exhibit significantly higher midpoint F1 values (~ lower realizations) than other phonological environments.

Figure 4.4.3. Density plot of normalized midpoint in F1 of JRES across phonological environment.

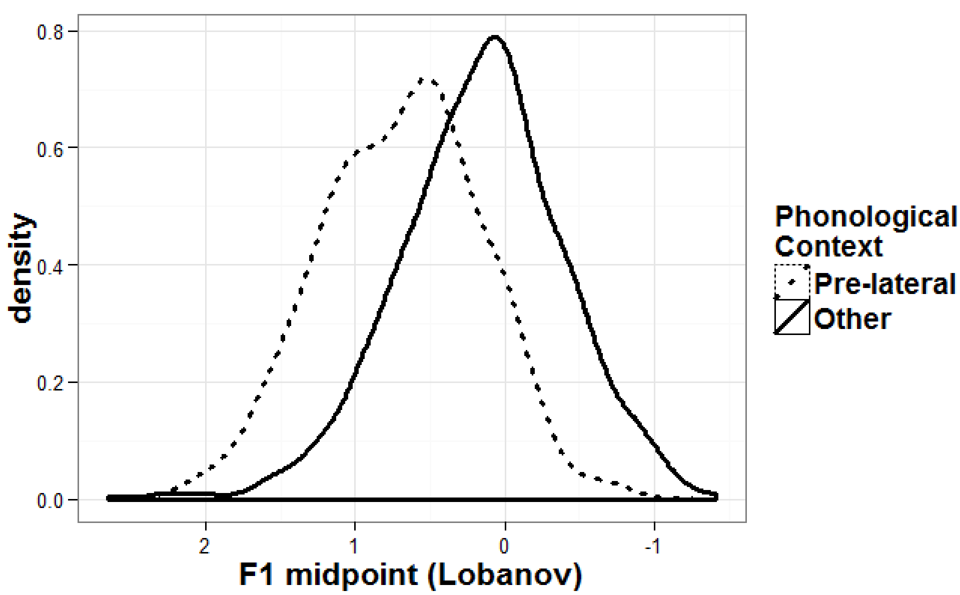
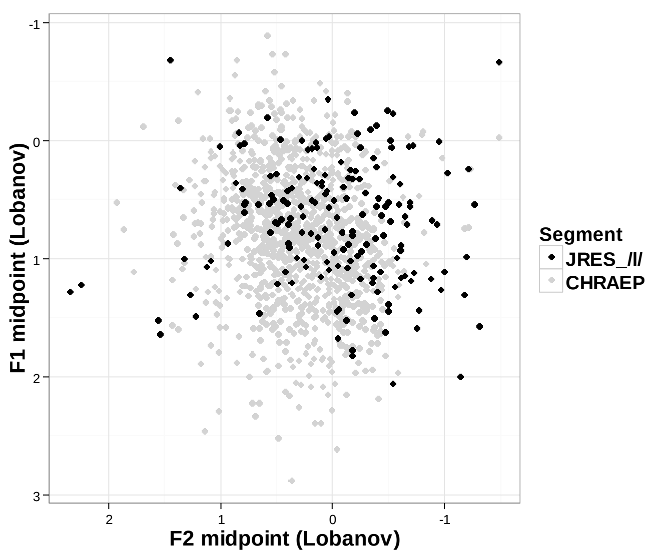


Table 4.4.2. Lmer model fit to normalized F1 midpoint values of JRES for all speakers, with phonological environment and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.29383	0.08070	3.641
phonological environment=Pre-lateral	0.49466	0.05625	8.794
speech rate	-0.03422	0.01939	-1.765

That pre-lateral environments have such a robust effect on the midpoint of JRES suggests that pre-lateral JRES exhibits a difference in terms of vowel quality from JRES in other phonological environments. Figure 4.4.4 demonstrates that these environments exhibit midpoint values that are indistinguishable from CHRAEP midpoints.[110] This indicates that pre-lateral JRES is consistently produced the same as CHRAEP, an observation that is corroborated by auditory analysis of pre-lateral JRES tokens.[111] These observations together suggest that JRES is contextually merged with CHRAEP before /l/ in Pidgin.

Figure 4.4.4. Scatterplot of normalized F1/F2 midpoint values of JRES before /l/ and all CHRAEP tokens.



[110] A scatterplot is used here instead of a density plot due to the difference in sample size between pre-lateral examples of JRES (n=174) and all CHRAEP tokens (n=1,153). Overlap is apparent using both plot types, but a scatterplot better represented the similarity of the two distributions.

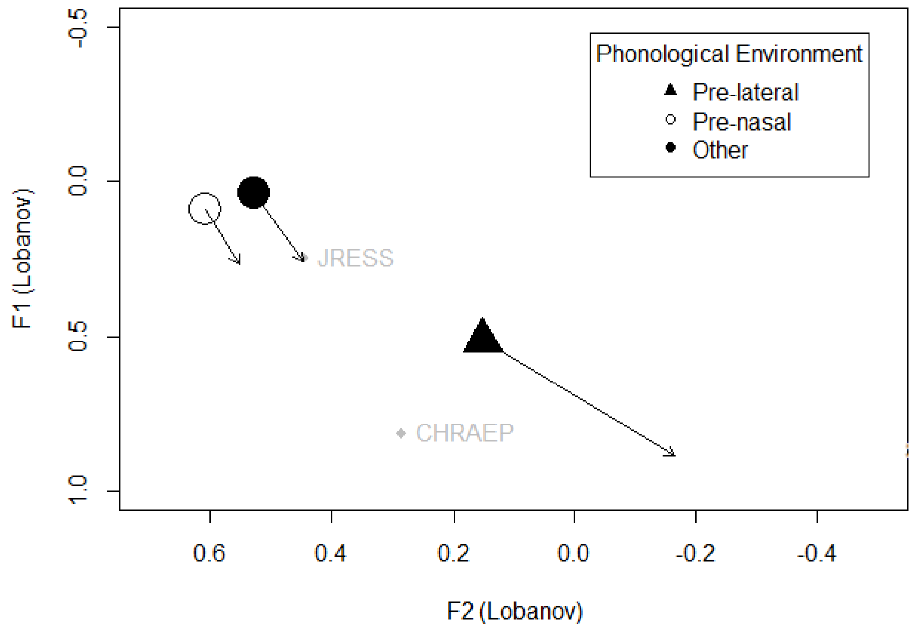
[111] For example, Keiko (old BC female) produces *waelfea* ‘welfare’ as [ˈwælfɛɐ], Victor (young BC male) produces *smael* ‘smell’ as [ˈsmæʊ], Palani (old IV male) produces *haelp* ‘help’ as [ˈhæɔp], and Mina (young IV female) produces *bael* ‘bell’ as [ˈbæl].

4.4.3. Trajectory of JRES

The results from the current data demonstrate that the differences exhibited by JRES in pre-lateral environments extend to the trajectory of the vowel. Figure 4.4.5 shows the trajectory from 30% to 70% through JRES in pre-lateral and pre-nasal positions, as compared with other phonological environments. The vowel's trajectory is plotted from the 30% mark to the 70% mark to reduce influence from surrounding phonological contexts, while retaining information about formant motion. Pre-nasal environments do not appear to motivate change in the trajectory of JRES, as the trajectory of pre-nasal JRES is largely identical with that of "other" phonological environments. Pre-lateral environments, on the other hand, motivate a noticeably longer trajectory in the vowel.[112] It is worthwhile noting that this trajectory is much longer than the trajectory of FES in any phonological environment (see §4.3.1). Also, JRES in all phonological environments has a backing offglide. This parallels findings from Drager et al. (2013), which show that Hawai'i English speakers who report an ability to speak Pidgin produce DRESS with a backing offglide, suggesting that Pidgin realizations of JRES have perhaps influenced DRESS in Hawai'i English (or, at the very least, that the languages have influenced each other in terms of the offglide produced in JRES and DRESS).

[112] The trajectory of pre-lateral CHRAEP and pre-lateral JRES are nearly identical; however, there are too few tokens of pre-lateral CHRAEP to reliably track its behavior. Despite this, I believe this provides further evidence that pre-lateral JRES is contextually merged with CHRAEP.

Figure 4.4.5. Trajectory of JRES from 30% to 70% of the duration of the vowel across phonological environment.



4.4.4. Summary of JRES findings

In sum, the midpoint and trajectory of JRES is influenced by phonological context. Pre-nasal positions motivate relatively fronter midpoints of JRES but do not alter vowel trajectory. Pre-lateral JRES is realized as lower and backer in the vowel space, and the vowel is merged with CHRAEP, converging on [æ]. Pre-lateral JRES also exhibits a longer trajectory than JRES in other phonological contexts. No differences arise in the behavior of JRES as a function of age group, gender, or PDM score.

4.5. CHRAEP

The existing literature describes CHRAEP in Pidgin as occupying a low-front position, lower and backer than JRES, but fronter than STAF and LAT. It is characterized by a relatively high F1 and F2. In English, TRAP is derived from Middle English short /ɑ/ (Labov et al. 2006: 13), and the vowel is involved in many changes across the English speaking world. TRAP is diphthongal, exhibiting a raised nucleus and a low offglide, before oral and nasal consonants in the American

North (New York, New England, the Inland North, and the Mid-Atlantic) (Labov 2001). In other parts of the United States, such as California (Kennedy & Grama 2012), Nevada (Fridland et al. 2015), Oregon (Becker et al. 2015), and Canada (Clarke et al. 1995), TRAP before oral consonants is realized as retracted, in line with the retraction (and sometimes lowering) that takes place in the short front vowels KIT and DRESS in these same dialects. In these dialects (with the exception of Canada), TRAP is realized as raised and diphthongized before nasal consonants (cf. Eckert 2008).[113] In New Zealand, TRAP is realized as relatively raised and lax, approximating [ɛ] (Watson et al. 2000), whereas in Australia, the vowel shows evidence that it is lowering and retracting in apparent time (Cox 1999). In many British dialects of English (and other Commonwealth English areas, such as Australia), the TRAP-BATH split is observed. This describes the phenomenon where Early Modern English /æ/ was lengthened in certain phonological environments (mostly before voiceless fricatives) and eventually merged in production with PALM or LOT (Wells 1982: 133-136). Today, these dialects produce different vowels in the words *cat* and *bath* (something similar to [æ] and [ɑ], respectively; cf. Wells 1982), whereas many North American dialects (excepting some Eastern New England varieties; see Labov et al. 2006: 172) would produce both words with /æ/. Given the contact Hawaiʻi has had with Commonwealth varieties of English over its history (see, e.g., Kent 1993), it is not unreasonable to expect that some speakers might exhibit the TRAP-BATH split in either Hawaiʻi English or Pidgin.[114] The following discussion addresses the behavior of CHRAEP using the data from the current study.

[113] This split-nasal system is typical of Anglo speakers in California English, but some ethnic groups (e.g., Chicano speakers) exhibit no such split system.

[114] This seems likely, given the pro-British sentiments of the people of Hawaiʻi (including the Hawaiian Royal Family) during the last half of the 19th century, who believed Britain to be a protector of the Islands, as trading influence and power shifted to U.S. designs and interests (Kent 1993: 18-19).

In Hawai‘i English, Drager et al. (2013) provide evidence that TRAP is retracted in the speech of young speakers (see table 2.1), relative to older speakers. Furthermore, TRAP is realized with a longer trajectory for young Hawai‘i English speakers who report an ability to speak Pidgin, whereas young non-Pidgin speakers exhibit a lower onset and more monophthongal quality in TRAP. There is also some evidence to suggest that the aforementioned TRAP-BATH split occurs for at least one older speaker of Hawai‘i English (Drager et al. 2012), who exhibits backer realizations of BATH in comparison to TRAP. In Pidgin, Sakoda and Siegel (2008: 222-224) have identified that CHRAEP and JRES in basilectal Pidgin are both realized as [æ̝]. Mesolectal varieties exhibit free variation, where CHRAEP realizations may be realized as [æ̝] or a lower [æ]. Contrary to its production in some older speakers of Hawai‘i English (Drager et al. 2013), CHRAEP is not realized as diphthongal in Pidgin (Sakoda, personal communication).

4.5.1. Phonological effect on F1 and F2 of CHRAEP

The results from the current data demonstrate that phonological environment has an impact on both formants of CHRAEP: F1 is affected by pre-nasal position and pre-voiceless fricative (pre-S), and F2 is affected by pre-nasal position.[115] For the purposes of the following discussion, pre-S tokens include CHRAEP before [f, θ, s, ʃ].[116] Figure 4.5.1 is a density plot of normalized midpoints in the F1 of CHRAEP in pre-S and pre-nasal position, as compared with all other phonological environments. Pre-S tokens of CHRAEP show a density peak and distribution that is shifted to the left (indicating lower realizations) in comparison to other phonological contexts. This suggests that CHRAEP before voiceless fricatives occupies a lower position in the vowel space, relative to other tokens of CHRAEP. By contrast, pre-nasal position exhibits a

[115] There is also evidence that F2 is affected by pre-lateral position, but there are too few tokens of pre-lateral CHRAEP to include in this discussion.
[116] These are, in fact, the only voiceless fricatives that /æ/ occurs before in English.

density peak and distribution that is shifted to the right (indicating higher realizations) in comparison to other phonological contexts. This suggests that pre-nasal tokens of CHRAEP occupy a higher position in the vowel space relative to other tokens of CHRAEP. It is worth noting that the raising of CHRAEP in pre-nasal environment observed here is much less pronounced than what is observed for TRAP in many dialects of English (e.g., the clear nasal split in California English; see Eckert 2008). Figure 4.5.2 shows an example of such a split in a single speaker of California English (from Eckert n.d.) as compared with Lena, a young IV speaker of Pidgin. Note that for the California English speaker, the midpoint of pre-nasal tokens of TRAP are much higher in the vowel space than pre-oral tokens of TRAP. By comparison, Lena, the young IV Pidgin speaker, exhibits a tight grouping of CHRAEP tokens, where the pre-nasal and pre-oral tokens occupy nearly identical positions in the vowel space. Despite this, the general grouping of pre-nasal CHRAEP tokens occupies a slightly higher and fronter area in the grouping of vowels in comparison to the grouping of pre-oral CHRAEP tokens. This corroborates the observation that pre-nasal position has a small effect on realizations of CHRAEP tokens.

Figure 4.5.1. Density plot of normalized midpoint in F1 of CHRAEP across phonological context; pre-S represents tokens of CHRAEP before voiceless fricatives.

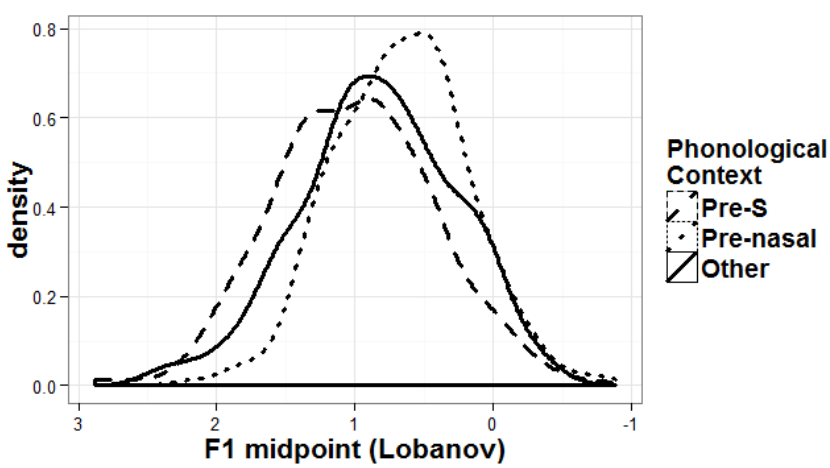
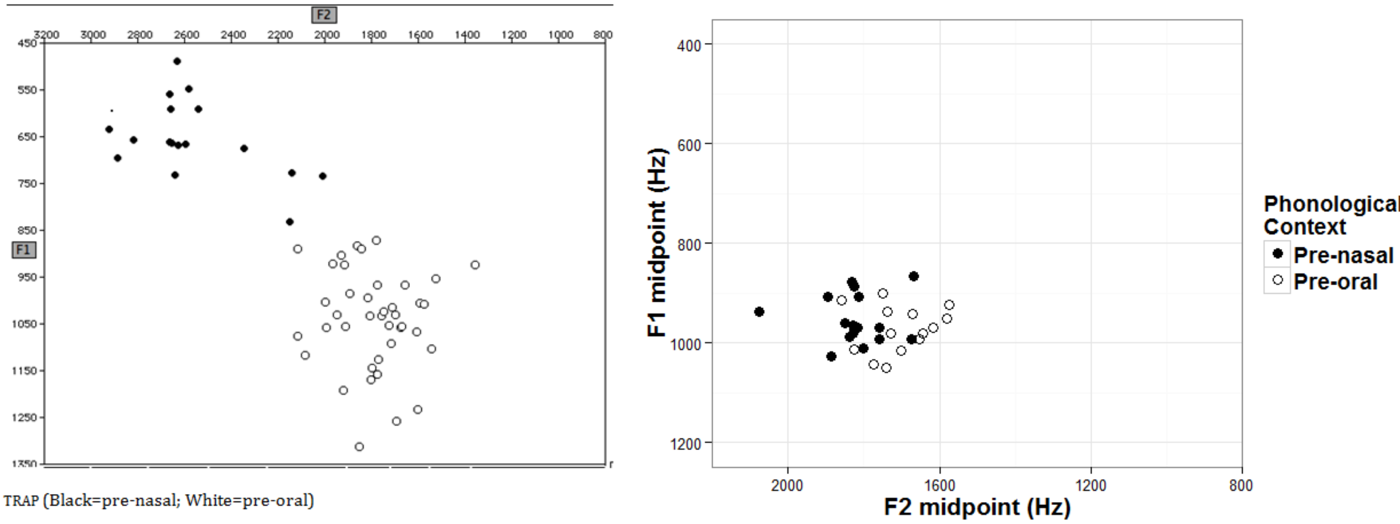
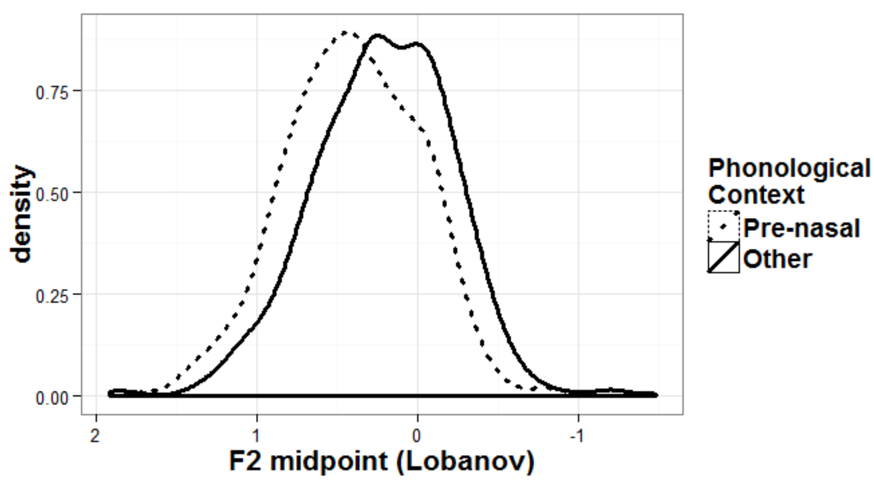


Figure 4.5.2. TRAP in pre-nasal and pre-oral environments for a single speaker of California English (left; adapted from Eckert n.d.) as compared with CHRAEP of Lena, a young IV speaker (b. 1988) in pre-nasal and pre-oral environments.



Phonological effects are also evident in the F2 dimension. Figure 4.5.3 is a density plot of normalized midpoints in F2 of CHRAEP in pre-nasal position compared to all other realizations of CHRAEP. Pre-S tokens are lumped together with "other" phonological contexts in this density plot, as no difference arises in F2 midpoint in pre-S tokens of CHRAEP. Pre-nasal environments motivate a density peak and distribution that are shifted to the left, including that this phonological environment motivates fronter realizations of CHRAEP.

Figure 4.5.3. Density plot of normalized midpoint in F2 of CHRAEP across phonological context.



Together, these observations demonstrate that pre-nasal tokens of CHRAEP are both higher and fronter in the vowel space relative to other CHRAEP tokens, and that CHRAEP before voiceless fricatives is lower (but not fronter) in the vowel space relative to other tokens. These observations are corroborated by linear mixed effects models discussed in §4.5.2.

That pre-nasal position motivates fronting and raising of CHRAEP is not uncharacteristic of low vowels cross-linguistically (see Beddor et al. 1986 for a discussion of acoustic motivations). Therefore, it is not particularly surprising that CHRAEP undergoes raising in pre-nasal positions, despite the fact that this raising is very subtle in Pidgin, and not similar to the raising and diphthongizing observed in many mainland American varieties (e.g., the California English speaker in figure 4.5.2 from Eckert n.d.).

That F1 of CHRAEP is lower (see figure 4.5.1) before voiceless fricatives is also not entirely surprising, given that at least some of the English dialects (likely Commonwealth varieties) spoken during the creolization of Pidgin exhibited the TRAP-BATH split. This dialect feature is the result of an incomplete (and somewhat inconsistent) Middle English allophonic rule, which lengthened /æ/ before tautosyllabic voiceless fricatives (Wells 1982: 204).[117] Eventually, [æ:] (as in the words *staff* or *ask*) was backed and merged with the PALM or LOT lexical sets. Thus, Commonwealth varieties today often produce the vowel in *bat* differently from the vowel in *bath*. Though most mainland United States English varieties no longer exhibit the TRAP-BATH split, there are some dialects which treat BATH words differently from TRAP words. Babbitt (1896) describes New York English, for example, as exhibiting fronted and raised BATH vowels, indicating that the TRAP-BATH split was evident in at least one region in North

[117] See examples in some Commonwealth varieties today where *bath* and *path* belong to the BATH lexical set, but *math* belongs to the TRAP lexical set.

America as early as the late 1800s.[118] That Pidgin speakers demonstrate a similar tendency to differentiate pre-S CHRAEP from other CHRAEP realizations suggests that this effect may simply be due to influence from the English spoken during the plantation days in 19-20th century Hawaiʻi. Given the fact that pre-S CHRAEP in the current Pidgin data is lower and backer (rather than higher and tenser) compared with other CHRAEP tokens, it seems likely that this effect can be traced to influence from British English. However, it is difficult to say for certain without further investigation whether the lowering effect of voiceless fricatives on CHRAEP in Pidgin can be linked to influence from British or American English.

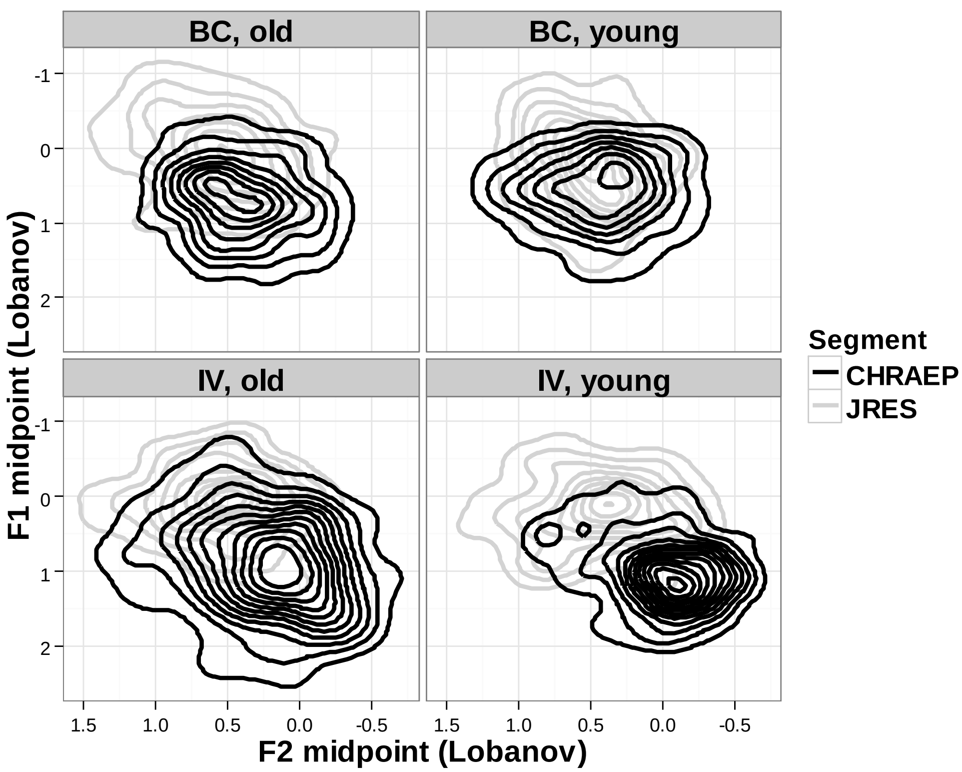
4.5.2. Change over age group in CHRAEP

The results from the current data demonstrate that the midpoint of CHRAEP changes as a function of age group in both F1 and F2. Figure 4.5.4 is a two-dimensional density plot of normalized midpoint values in F1 and F2 of CHRAEP separated by age group. JRES is included in this plot as a reference point (pre-lateral tokens of JRES are not included because pre-lateral JRES is merged with CHRAEP; see §4.4.2). The position of CHRAEP is relatively the same across age in BC speakers. The center of the distribution is located from approximately 0.25 to 0.75 in the F2 dimension, and between 0 and 1 in the F1 dimension. The distribution range of the two BC age groups is also quite consistent, as both age groups exhibit tokens restricted to an area between -0.5 and 2 in F1, and 1.25 and -0.5 in F2. CHRAEP and JRES are also relatively overlapped (though not to the extent of SHCHRIT and STIK), though JRES is situated higher in the vowel space than CHRAEP. However, IV speakers exhibit noticeably different distribution sizes and centers in comparison to BC speakers. Old IV speakers exhibit a very wide distribution from -1 to 2.5 in

[118] New York is not the only dialect today that shows differences in TRAP tensing. The vowel system of Philadelphia exhibits a system in which trap raises before [m, n, f, θ, s], as well as before [d] only in the words *mad*, *bad* and *glad* (Labov et al. 2006: 171).

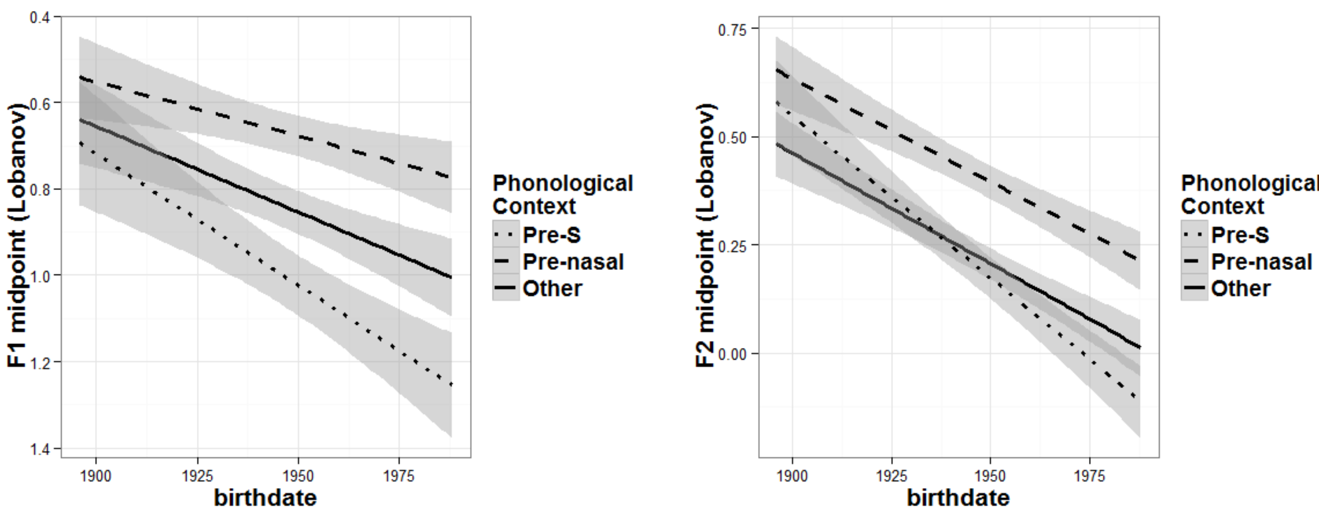
the F1 dimension, and 1.5 to -1.0 in the F2 dimensions. Furthermore, the distribution center of CHRAEP is lower and backer than it is in BC speakers, situated on 0.25 in the F2 dimension and 1 in the F1 dimension. Young IV speakers exhibit the lowest and backest realizations of CHRAEP of all speakers, with a distribution center situated in back of 0.0 in F2 and below 1 in F1. While the size of the distribution is noticeably smaller than that of old IV speakers, the tightly grouped concentric shapes in the low back area of the vowel space suggest that a token of CHRAEP is more likely to be relatively lower and more retracted in comparison to all other age groups. These findings suggest that CHRAEP has changed over real time from a relatively mid front position to a backer, more retracted position.

Figure 4.5.4. 2-d density plot of normalized midpoints of CHRAEP (black) and JRES (gray), separated by vowel identity and age group.



Looking at CHRAEP across phonological context over time reveals more about the lowering and retracting that CHRAEP exhibits over time. Figure 4.5.5 is a line graph representing the mean normalized midpoint of F1 and F2 of CHRAEP plotted against birthdate. Each plot isolates the phonological contexts discussed in §4.5.1: pre-S and pre-nasal contexts. In F1, pre-S context motivates the most drastic lowering relative to other phonological contexts, given the steeper slope exhibited by pre-S positions. By comparison, the lowering exhibited by pre-nasal position is relatively conservative, indicating that pre-nasal position diminishes the lowering associated with age group discussed above. In F2, pre-nasal position appears to have the same impact on the midpoint of F2, as pre-nasal contexts motivate higher realizations of CHRAEP. As suggested by §4.5.1, no change takes place over time between pre-S contexts relative to "other" phonological contexts.[119] All in all, pre-nasal positions motivate more conservative productions of Pidgin CHRAEP, especially in comparison to pre-S realizations.

Figure 4.5.5. Line graph of mean normalized midpoint of F1 (left) and F2 (right) of CHRAEP across phonological context plotted against birthdate; for F1, values lower on the y-axis indicate a lower realization; for F2, values lower on the y-axis indicate a backer realization.



These findings are corroborated by separate linear mixed-effects models fit to normalized F1 and F2 midpoints of CHRAEP, with age group, phonological context, and speech rate as

[119] There is a cross-over evident here, where pre-S CHRAEP appears to be associated with more retracted realizations for the youngest speakers; however, this finding does not appear to indicate a robust difference between the two phonological contexts, as there is noticeable overlap in the gray areas indicating standard error.

predictors. Table 4.5.1 shows the model fit to F1. There is a significant main effect of pre-S context, indicating that CHRAEP before voiceless fricatives exhibits higher F1 (~ lower realizations) relative to other phonological contexts. There is also a significant main effect of pre-nasal position, indicating that CHRAEP before nasal consonants exhibits lower F1 (~ higher realizations) relative to other phonological contexts. Finally, there is a main effect of old IV and young IV speakers on normalized F1 midpoint of CHRAEP, signifying that these two age groups exhibit larger F1 values (~ lower realizations) relative to old BC speakers. While the model suggests that young IV speakers produce slightly lower realizations of CHRAEP, old IV speakers and young IV speakers do not significantly differ from one another. Gender does not significantly impact the value of F1 in CHRAEP.

Table 4.5.1. Lmer model fit to normalized F1 midpoint values of CHRAEP for all speakers, with phonological environment, age group, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.82006	0.10515	7.799
phonological environment=Pre-S	0.14822	0.04769	3.108
phonological environment=Pre-nasal	-0.19209	0.03818	-5.032
age=young BC	-0.10779	0.11147	-0.967
age=old IV	0.24250	0.11228	2.160
age=young IV	0.30770	0.11233	2.739
speech rate	-0.02084	0.01933	-1.078

Table 4.5.2 shows the model fit to F2. There is a significant main effect of pre-nasal contexts, indicating that CHRAEP before nasals exhibits higher values of F2 at the midpoint (~ fronter realizations) relative to other phonological contexts. Pre-S realizations of CHRAEP were included with “other” phonological contexts in this model, as pre-S tokens of CHRAEP did not differ from “other” phonological contexts in terms of F2. There is also a main effect of young IV speakers, signifying that this age group exhibits lower F2 values (~ backer realizations) relative to old BC speakers. There is also a nearly-significant effect of old IV speakers, suggesting that this age group also exhibits lower F2 values relative to old BC speakers; however, the effect size

is noticeably smaller than what is observed for young IV speakers. Gender does not significantly impact the value of F2 in CHRAEP.

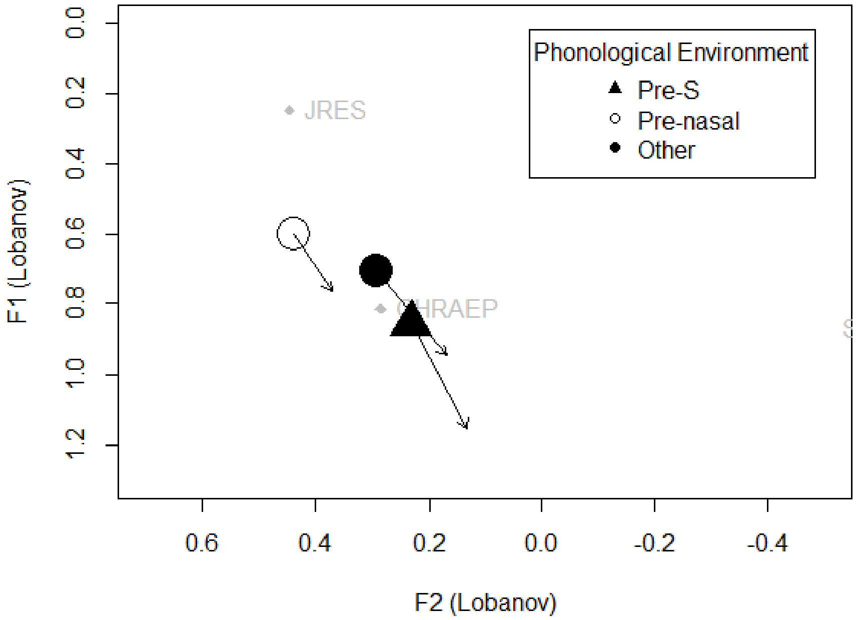
Table 4.5.2. Lmer model fit to normalized F2 midpoint values of CHRAEP for all speakers, with phonological environment, age group, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.317139	0.088184	3.596
phonological environment=Pre-nasal	0.227977	0.028040	8.130
age=young BC	0.022589	0.105207	0.215
age=old IV	-0.179714	0.105722	-1.700
age=young IV	-0.396392	0.105764	-3.748
speech rate	0.005872	0.013360	0.440

4.5.3. Trajectory of CHRAEP

Though phonological context motivates a different nucleus, there is little evidence in this current study to suggest that CHRAEP behaves differently over its trajectory as a function of phonological context. Figure 4.5.6 shows the trajectory of CHRAEP in pre-nasal and pre-S environments as compared with other phonological contexts. The vowel's trajectory is plotted from the 30% mark to the 70% mark to reduce influence from surrounding phonological contexts, while retaining formant motion. Two observations are key here: first, the direction and length of the formant trajectory in each phonological context is roughly equivalent. Though pre-S contexts exhibit a slightly longer trajectory, this does not differ greatly from the trajectories of "other" phonological contexts or pre-nasal contexts. Second, in no environment is CHRAEP particularly diphthongal (though the vowel exhibits a longer trajectory than in STIK). In comparison to some English dialects which exhibit a very diphthongal TRAP in some phonological environments (e.g., California or New York), Pidgin does not appear to exhibit diphthongal CHRAEP in any phonological context. While the nuclei of "true" diphthongs (see §7) cross vowel boundaries, the nucleus and offglide of CHRAEP are located in roughly the same area of the vowel space.

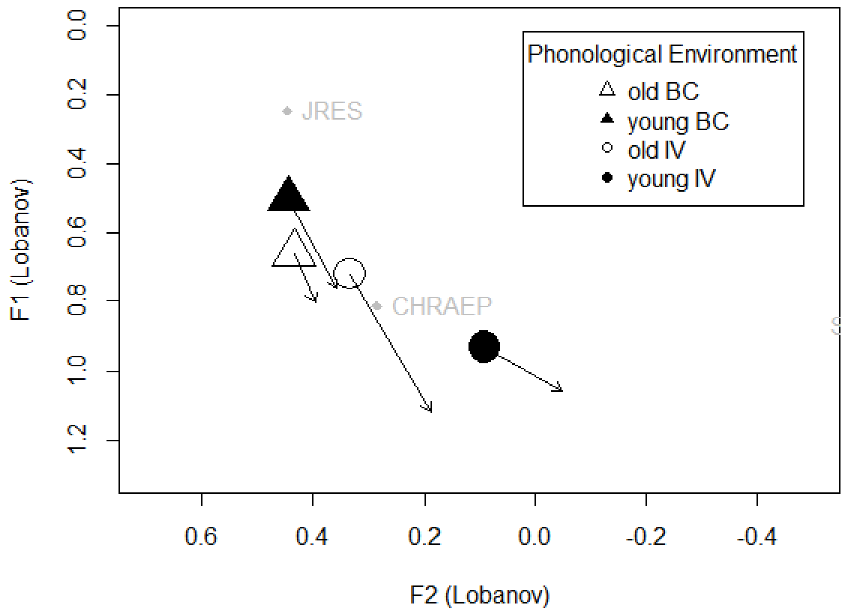
Figure 4.5.6. Trajectory of CHRAEP from 30% to 70% of the duration of the vowel across phonological environment.



The trajectory of CHRAEP appears to change somewhat over age group. Figure 4.5.7 shows the trajectory of CHRAEP across age group. Both old and young BC speakers exhibit very short trajectory lengths for CHRAEP, suggesting that relatively older speakers produce relatively monophthongal realizations of CHRAEP. There is a longer trajectory associated with the CHRAEP of old IV speakers relative to BC speakers. However, this longer trajectory is not exhibited by young IV speakers; instead, young IV speakers exhibit a very similar trajectory length to that of BC speakers.[120] Therefore, this does not look like a change in progress in which CHRAEP is becoming more diphthongal. Importantly, the trajectory of CHRAEP is not long as that exhibited by "true" diphthongs (see figure 4.3.1 and §7).

[120] Though similar in length to the trajectory of BC speakers, the trajectory of CHRAEP in young IV speakers is mostly in F2. This is likely due to the fact that CHRAEP is realized as lowest and backest in this age group as compared with any other age group. Also, the longer trajectory in the CHRAEP of IV speakers may be in anticipation of the lower midpoints of CHRAEP that young IV speakers show.

Figure 4.5.7. Trajectory of CHRAEP from 30% to 70% of the duration of the vowel across age group.



4.5.4. Summary of CHRAEP findings

In sum, realizations of CHRAEP are affected by phonological context and age group. Pre-nasal realizations of CHRAEP are higher and fronter in the vowel space over age group, and CHRAEP before voiceless fricatives is realized as lower in the vowel space than CHRAEP in all other phonological contexts. Neither pre-nasal nor pre-S contexts motivate radically different trajectories of CHRAEP. The vowel also lowers and retracts over age group. Old IV speakers exhibit significantly lower realizations of CHRAEP relative to BC speakers, and young IV speakers exhibit significantly lower and more retracted realizations of CHRAEP relative to BC speakers. This suggests that the position of CHRAEP has changed over real time and occupies a lower, more retracted position in the youngest speakers of Pidgin. Neither gender nor PDM score significantly affects the position of CHRAEP.

4.6. Discussion of front vowel findings

Given these results, a few conclusions can be drawn regarding the behavior of the front vowels in Pidgin. Relative to older speakers, younger speakers exhibit fronter realizations of SHCHRIT and lower realizations of STIK. There is also strong evidence to suggest that the two vowel classes have become less similar in spectral space, as STIK and SHCHRIT are the least overlapping in young IV speakers. Furthermore, there is evidence to suggest that the front vowels have become more similar to Hawai‘i English vowels over age group. Sakoda and Siegel (2008: 222) claim that SHCHRIT may exhibit a tenser realization for some speakers due to contact with English, meaning that there is room for the vowel to tense (or, become more peripheral). This observation that is consistent with the relatively fronter midpoint exhibited by SHCHRIT in IV speakers. CHRAEP has also lowered and retracted away from JRES over age group, increasing the distinction between the two vowels. However, CHRAEP and JRES are much less overlapping in BC speakers than SHCHRIT and STIK, contrary to claims in the existing literature that the two vowels are the same phoneme (e.g., Bickerton & Odo 1976). The retraction of CHRAEP also parallels the retraction of TRAP in Hawai‘i English (Drager et al. 2013), as well as the TRAP retraction that takes place in at least some phonological environments across the English speaking world (cf. Clarke et al. 1995; Labov et al. 2006; Kennedy & Grama 2012). Each of these changes is reminiscent of an English phonological system, and it is very likely that the changes in the front vowels that have taken place in Pidgin over time are a result of continued and sustained contact with English.

Despite these similarities, Pidgin vowels also behave in a way that is incongruent with English influence. The position of the vowel FES is notably higher than it often is in the speech of North American English speakers (cf. Labov et al. 2006), and as a result, the midpoints of

SHCHRIT, FES, and STIK are quite similar to each other.[121] Furthermore, the neutralization of a distinction between JRES and CHRAEP before /l/ is unattested in Hawai‘i English speakers.[122] Though this feature is attested in New Zealand English (Bauer & Warren 2004) and Australian English (Cox & Palethorpe 2003), it is unlikely that this contextual merger is due to influence from either of these varieties due to there being very little contact between them. There is also evidence that heavier use of Pidgin morpho-syntactic features correlates with less English-like realizations of SHCHRIT, STIK, and FES. For IV speakers with higher PDM scores, both SHCHRIT and FES are realized as lower in the vowel space, and STIK is realized as fronter in the vowel space. This means that SHCHRIT and STIK are more similar for speakers with higher PDM scores. The findings for PDM score suggest that speakers are able to stylistically exploit differences in the pronunciations of SHCHRIT, STIK, and FES as they use more morpho-syntactic markers of Pidgin. In these cases, the relevant variables appear to be, for some speakers, increasing the similarity between STIK and SHCHRIT, and lowering FES.

Further insights into the Pidgin vowel system can be made from observing how SHCHRIT and STIK interact. There is evidence to suggest that SHCHRIT and STIK exhibit considerable overlap in relatively older speakers, which corroborates findings from previous research (e.g., Bickerton & Odo 1976; Sakoda & Siegel 2008). However, there is evidence from the current study to suggest that SHCHRIT and STIK have moved away from each other over time in Pidgin. IV speakers (especially young IV speakers) are more likely to exhibit less spectrally overlapped distributions of the two vowels in comparison to BC speakers. This reduction of spectral overlap is due to the fronting that SHCHRIT exhibits and the lowering that STIK exhibits as a function of

[121] This is especially true when comparing this vowel set to the high back vowels; JOK occupies a space that is notably lower than either SHUTS or FUT.

[122] It is noteworthy that JRES does not exhibit principled motion over age group or gender, given that shifts involving DRESS are so common across the English speaking world (e.g., California, New Zealand, the Southern US). It is noteworthy that DRESS in Hawai‘i English does not exhibit any principled motion over age group (cf. Drager et al. 2013), potentially indicating that /ɛ/ is simply relatively stable in Hawai‘i.

age group. That SHCHRIT fronts also corroborates Sakoda and Siegel's (2008: 222) claim that SHCHRIT is laxer than it is in English, as the SHCHRIT of older Pidgin speakers occupies a backer (and what therefore might be construed to be laxer) position. However, STIK and SHCHRIT exhibit differences in all age groups in vowel duration and trajectory. STIK is significantly shorter than SHCHRIT for all age groups, even those older groups which exhibit higher levels of spectral overlap between the two vowels. Furthermore, STIK exhibits a fronting offglide (depending on phonological context), while SHCHRIT exhibits a consistent backing offglide (as in figure 4.1.6). These two differences suggest that while STIK and SHCHRIT exhibit significant spectral overlap in older speakers, there are at least two ways in which speakers might discriminate STIK and SHCHRIT phonemically. First, it is possible that older speakers attend to the length distinction between the two vowels. This would suggest the heretofore unattested possibility that Pidgin (at least those speakers which show overlap between SHCHRIT and STIK) exhibits phonemic vowel length. Second, it is possible that speakers attend to the trajectory cues which distinguish STIK from SHCHRIT. This would indicate that despite having roughly equivalent midpoints, older Pidgin speakers exhibit phonemic awareness of offglide targets. Further investigation is necessary to determine whether either cue (vowel length or trajectory) is more salient in the discrimination of Pidgin high front vowels in perception.

The way in which realizations of STIK and SHCHRIT interact with PDM score calls attention to another important point regarding the high front vowels. As use of morpho-syntactic markers of Pidgin increases, SHCHRIT lowers and STIK fronts most evidently for IV speakers. This effectively reduces the distance between the midpoints of the two vowels, especially given that SHCHRIT has fronted and STIK has lowered in the youngest age group. This suggests that there is a connection for young Pidgin speakers between the spectral proximity of the STIK and SHCHRIT and the degree to which they are speaking Pidgin. Furthermore, it opens the possibility that a speaker may use spectral overlap between STIK and SHCHRIT as a stylistic variable to index “Pidgin-ness”, or at the very least, to indicate that Pidgin is being spoken. It is of course impossible in the context of this study to isolate the specific meanings associated with overlapped SHCHRIT-STIK tokens. However, the fact that high PDM scores appear to offset changes (to some extent) that have taken place over time in SHCHRIT and STIK, suggests a strong connection in production between the observed similarity of these two vowels and speaking Pidgin.

That there is a connection between PDM score and SHCHRIT-STIK overlap is also consistent with findings from Drager et al.’s (2013) investigation of short front vowels in Hawai‘i English. Drager et al. (2013) identify a tendency in Hawai‘i English for KIT to be realized as higher in the vowel space for female speakers who report an ability to speak Pidgin. Though the effect Drager et al. report is in F1 (as opposed to F2, as it is in this study), it appears that younger Pidgin speakers with a high PDM score and Hawai‘i English speakers who report an ability to speak Pidgin exhibit changes to /ɪ/ that brings it closer to /i/.[123] Interestingly, Pidgin STIK is the only front vowel to report a gender effect, where females produce lower realizations of STIK. It is therefore possible STIK in Pidgin and KIT in Hawai‘i English are becoming more similar. Further study of balanced speaker sets is needed to address this question.

The behavior of FES in the vowel system is somewhat tied to the behavior of SHCHRIT. FES exhibits a fronter nucleus in young IV speakers, paralleling the fronter midpoints of SHCHRIT exhibited by old and young IV speakers. There are three ways to explain the fronting of FES, though evidence points to the first explanation being the most likely. First, the fronting of FES

[123] It should be noted that Drager et al. (2013) do not report findings from FLEECE, so it is quantitatively unclear how close raised KIT is to FLEECE for these speakers. Also, this portion of Drager et al.’s study is limited to females.

can be seen as occurring in parallel with the fronting of SHCHRIT. Both vowels can be characterized as phonologically front, tense, and non-low, and so movement in parallel is quite likely. FES is also not as front as SHCHRIT, suggesting that if the motion of SHCHRIT and FES are connected, FES lags behind SHCHRIT.[124] The lagging behind of FES with respect to SHCHRIT is reminiscent of the fronting pattern exhibited by the back tense vowels in English, GOOSE and GOAT, which also shows the relatively lower vowel of the high back pair (i.e., GOAT) lagging behind the relatively higher vowel (i.e., GOOSE). Further evidence for this position can be found in the parallel behavior of SHCHRIT and STIK as a function of PDM score. Both vowels exhibit lower midpoint values as PDM score increases, potentially to preserve phonemic contrast. Second, FES fronting may occur as the result of structural pressure to open up phonological space for the lowering of STIK in the youngest age group. This explanation would open up the question of whether STIK or FES initiated the motion. From the current data, it is not clear which vowel began shifting first, as both some lowering of STIK and fronting of FES are evident in old IV speakers. This is, therefore, not a question that can be addressed further using this data. The third possibility is that FES fronting is an independent phenomenon. However, given that FES appears to move in conjunction with the other non-low front vowels, this explanation seems unlikely.

Finally, it is worthwhile to note that CHRAEP behaves somewhat differently in Pidgin than it does in Hawai‘i English. While the lowering and retracting of CHRAEP in Pidgin parallels the behavior of TRAP in Hawai‘i English speakers, each vowel behaves differently with respect to its trajectory. Most notably, CHRAEP is not particularly diphthongal in Pidgin. This contrasts with findings from Drager et al. (2013), who find that TRAP is diphthongal for Hawai‘i English speakers that report an ability to speak Pidgin. Furthermore, the current study finds that older speakers of Pidgin produce relatively monophthongal realizations of CHRAEP; however, older

[124] It is also possible that FES might not ever be as front as SHCHRIT because of the shape of the vowel periphery.

speakers of Hawaiʻi English produce diphthongal realizations of TRAP (Drager et al. 2013: 45). The older interviewees in Drager et al. were born between 1931 and 1957 (between 55 and 80 years old at the time of recording), placing them in the same category as young BC and old IV speakers in the current study. While young BC speakers do not exhibit any diphthongal behavior in CHRAEP, old IV speakers exhibit the most diphthongal realizations of CHRAEP out of all the age groups. Because of this disparate behavior between Pidgin CHRAEP and Hawaiʻi English TRAP, it is possible that while these vowels do not vary according to PDM score, they may still have socio-indexical meaning for Pidgin speakers (and Hawaiʻi English speakers, alike).

CHAPTER 5

HIGH BACK VOWELS SHUTS, FUT, & JOK

This chapter addresses the behavior of the high back vowels, SHUTS, JOK and FUT in Pidgin.[125] In phonological descriptions, SHUTS and FUT occupy a high back position and JOK occupies a mid-back position (Bickerton & Odo 1976; Sakoda & Siegel 2008). SHUTS and FUT are described comprising a single lexical set in basilectal Pidgin that is realized phonetically as [u]; in mesolectal Pidgin, these two vowels are separate lexical classes, converging on [u] and [ʊ], respectively (Sakoda and Siegel 2008: 222-224). JOK is described as monophthongal preceding [m] and word-finally; JOK is reported as phonologically the same in both basilectal and mesolectal Pidgin. In total, this study analyzes data from 731 tokens of SHUTS, 380 tokens of FUT, and 978 tokens of JOK. Each vowel will be discussed individually with attention paid to the behavior of each high back vowel relative to other high back vowels. At the end of the chapter, a discussion of the findings places each vowel in context.

5.1. SHUTS

The existing literature describes SHUTS in Pidgin as occupying a high back position in the vowel space. In English, GOOSE is derived from Middle English /o:/, a vowel which raised to /u/ as a result of the Great Vowel Shift. Perhaps the most widely dispersed pattern across the Englishes of the world is the fronting of the nucleus of GOOSE (see, e.g., Ash 1996; Hall-Lew 2004; Labov et al. 2006; Durian 2012). In fact, the fronting of GOOSE is so widespread that it is difficult to isolate any specific regional counterexample. In North America alone, GOOSE fronting

[125] Though JOK (and GOAT, in Hawaiʻi English) is not generally considered a phonologically high back vowel, I discuss this group of vowels as a system. By calling this group "high back", I serve to distinguish these vowels from the low back vowels LAT, TAWK, and STAF (see §6).

is observed in “90% of the…continent” (Labov 2008: 27). Historically, GOOSE fronting is motivated by a combination of factors. First, there is ample available “space” in the vowel system for GOOSE to move into because English lacks a high central vowel. Second, the lexical set that GOOSE currently describes was historically two different classes: a front lexical set FEW (or, SHOES), where the vowel nucleus was preceded by a glide (e.g., *few*, *beauty*, *dew*, *newt*, *juice*, *suit*), and a back class GOOSE (or, BOOT), which was not preceded by any glide (e.g., *food*, *boot*, *do*, *too*, *goose*, *school*).[126] Ash (1996) and Labov (2008) contend that because these two classes were so uneven in size (that is, FEW had far fewer words associated with it), the two classes shifted towards each other in an attempt to “correct” for systemic asymmetry. Other explanations of GOOSE fronting suggest that fronting may also be motivated by compensation for coarticulation, as fronted /u/ frequently follows consonants with high F2 locus (Harrington 2007; Harrington et al. 2008). Evidence for this can be found across English dialects, as the most fronted variants of GOOSE are often those following coronal consonants (Labov et al. 2006).[127] Fronting of GOOSE is also generally inhibited before /l/ (with the exception of speakers in the American South), so much so that pre-lateral GOOSE is often considered a separate category (e.g., Labov et al. 2006; Hall-Lew 2009).

In Pidgin, this study finds that the front-back opposition for SHUTS parallels in large part its distribution in American English. SHUTS with a pre-vocalic glide (i.e., FYU) is observed in words like *byutiful* ‘beautiful’, *kanfyuz* ‘confuse’, *kyut* ‘cute’, *fyu* ‘few’, *myukas* ‘mucus’, and *vyu* ‘view’. Many Commonwealth English dialects, such as New Zealand English (Bauer & Warren 2004) and Standard Southern British (Harrington et al. 2008), may exhibit a post-apical

[126] In Labovian terms, the front member of this series /iw/ is opposed with the back member /uw/.

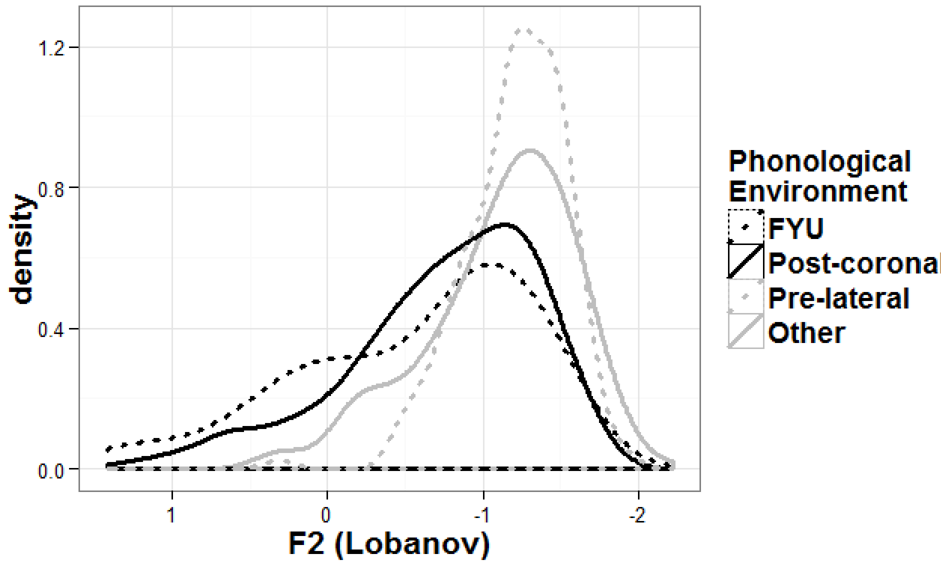
[127] The exception to this is the American South, which shows a slightly fronter GOOSE in word-final environments; however, fronted GOOSE is characteristic of the South (Thomas 2001: 33; Koops 2010). There is also evidence to suggest that GOOSE fronting in the South is quantitatively different from GOOSE fronting elsewhere in America (see, e.g., Koops 2010).

glide in words like *duty, news,* and *tune*. Pidgin speakers considered in this study produce a post-apical glide in one instance of the word *apochyuniDi* 'opportunity', but in general this glide is only realized following /n/ in the words *nyu* 'new', *nyuz* 'news', *nyuzpepa* 'newspaper', *nyu* 'knew', *rinyu* 'renew', and *aevenyu* 'avenue'. The following results demonstrate that fronted SHUTS is also a feature of Pidgin, and in fact, all changes involving SHUTS are found in F2. No changes arise in F1 as a function of age group, gender, phonological context, or PDM score.

5.1.1. Fronting of SHUTS

The results from the current data demonstrate that the midpoint of F2 of SHUTS exhibits variation across age group and two phonological contexts: post-coronal position, and following the apical glide /j/ (constituting what the current study calls the FYU lexical set). Figure 5.1.1 shows a density plot of normalized F2 midpoint values for all examples of SHUTS separated by phonological environment. Three environments are graphed against all other phonological environments in this figure: post-coronal, post-apical glide (i.e., the FYU lexical set), and pre-lateral SHUTS. Pre-lateral SHUTS tokens are separated in this density plot as pre-lateral position is often observed to motivate a backer /u/ nucleus in English varieties (see, e.g., Labov et al. 2006). The density peaks for SHUTS in both post-apical glide and post-coronal contexts overlap considerably, and they form a class separate from and in front of SHUTS in other phonological contexts. Pre-lateral SHUTS, however, shares a nearly identical density peak and distribution with SHUTS in "other" phonological contexts, signifying that the F2 midpoint of SHUTS is not greatly impacted by pre-lateral environments. By comparison, pre-lateral environments in English exhibit a much backer midpoint, and this environment is often treated as a separate category of GOOSE realizations (e.g., Hall-Lew 2004; Labov et al. 2006). Labov et al. (2006: 150) in particular notes that GOOSE shows a clear split where pre-lateral GOOSE is backer than all other examples of GOOSE.[128] While pre-lateral environments motivate backing of GOOSE in English, pre-lateral environments appear to have little effect on Pidgin SHUTS.

Figure 5.1.1. Density plot of post-coronal and FYU (or post-apical glide) environments (black) vs. pre-lateral and "other" environments (gray) on normalized F2 midpoints of SHUTS.



These phonological effects are corroborated by a linear mixed-effects model fit to normalized midpoint values of F2, with phonological context and speech rate as predictors (table 5.1.1). There is a significant main effect of FYU (post-apical glide) and post-coronal context, signifying that these two environments exhibit relatively fronter normalized F2 midpoint of SHUTS. The model shows that realizations of FYU are far fronter than realizations of post-coronal SHUTS, despite the fact that both environments motivate a fronted midpoint. However, the frontest FYU tokens are found in BC speakers, where realizations of FYU are far more common (108 tokens of FYU in BC speakers vs. 27 in IV speakers). As a result, FYU is not included in the group of post-coronal SHUTS in this analysis, as the contexts are not evenly balanced across age groups and they motivate different targets of the vowel /u/. As suggested by figure 5.1.1, pre-

[128] See figure 12.1 in Labov et al. (2006: 150); this figure is not reproduced here for copyright reasons.

lateral environments do not motivate a different midpoint value for SHUTS. It is worthwhile to note that these phonological contexts were treated as a single data column to avoid collinearity among realizations that were both post-coronal and pre-lateral. Words that fit both labels (e.g., *julai* ‘July’) patterned more closely with pre-lateral realizations (and SHUTS that fell under the category of “other”), but these tokens were concentrated in the frontest part of the distribution of pre-lateral tokens. Liquid onsets (i.e., /r, l/) before SHUTS were categorized as “other”, following Labov et al. (2006: 151). Words with /r/ in their onset (e.g., *kruz* ‘cruise’, *chru* ‘true’, *bru* ‘brew’, *ruf* ‘roof’) tended to pattern more closely with “other” phonological environments, but were concentrated in the frontest part of the distribution of “other” tokens. Words with onset /l/ did not show this same fronting, but instead appeared to be focused towards the center of the “other” group. Because post-coronal tokens of SHUTS behave markedly differently from SHUTS in other phonological environments, post-coronal SHUTS is discussed in the remaining analysis as a separate category from SHUTS in all other phonological contexts.

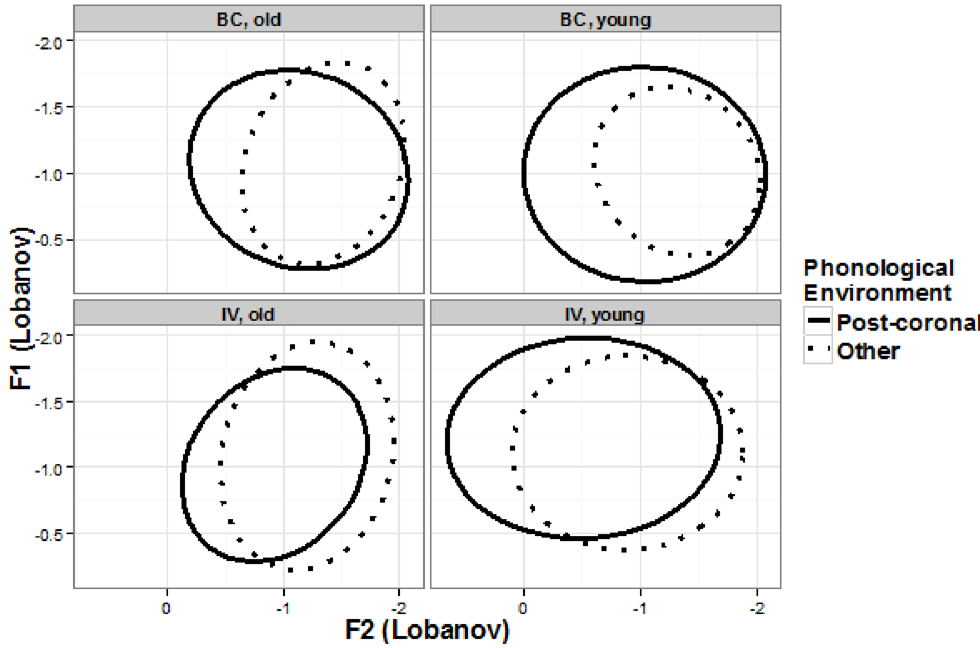
Table 5.1.1. Lmer model fit to normalized F2 midpoint values of SHUTS for all speakers, with phonological context and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.242347	0.094968	-13.082
phonological context=FYU	0.685005	0.078927	8.679
phonological context=Post-coronal	0.340755	0.055401	6.151
phonological context=Pre-lateral	-0.001755	0.074521	-0.024
speech rate	0.030469	0.021234	1.435

The position of SHUTS in the vowel space is not only determined by phonological environment, but also age group. Figure 5.1.2 is a vowel plot of the normalized midpoint values of SHUTS across age group, with ellipses representing two phonological contexts: post-coronal and SHUTS in all other phonological environments.[129] In this discussion, pre-lateral SHUTS are included in the "other" category, as pre-lateral SHUTS does not behave differently from "other" phonological contexts. Also, tokens of FYU are excluded from analysis because they do not appear evenly across all age groups (see discussion above). Both old and young BC speakers, exhibit no obvious effect of phonological environment on realizations of SHUTS. Post-coronal SHUTS occupies a slightly fronter position in the vowel space of both BC age groups with respect to "other" phonological environments. Furthermore, the distribution of post-coronal SHUTS is spread over a wider area than the distribution of SHUTS in "other" phonological environments. Old IV speakers do not appear to change the degree of frontness of post-coronal SHUTS in relation to speakers in the BC corpus. However, the distribution of post-coronal SHUTS appears to have shrunk in size and is concentrated to the front of the distribution of SHUTS in "other" phonological environments. However, the most notable difference in this plot is that young IV speakers exhibit fronter realizations of SHUTS in both post-coronal and "other" phonological environments relative to the other age groups. While the frontest portion of the distribution of post-coronal SHUTS is at or to the right of 0 in the F2 dimension for BC and old IV speakers, the frontest portion of the distribution of post-coronal SHUTS for young IV speakers is well to the left of 0 in the F2 dimension. As with other age groups, post-coronal SHUTS is in front of SHUTS in other phonological contexts. These observations together indicate a change in apparent time for IV speakers. The youngest speakers produce fronter realizations of SHUTS overall, and the fronting of SHUTS over time is led by post-coronal environments.

[129] This plot is not a density plot, as the density plot generated for these data proved more convoluted and less readable than the plot in figure 5.1.2.

Figure 5.1.2. Ellipses representing 95% confidence interval of the distribution of normalized midpoint F1 and F2 values of SHUTS in post-coronal (solid) and "other" (dotted) phonological environments across age group (for how ellipses are calculated, see §3.4).



A linear mixed-effects model was fit to normalized midpoint F2 values of SHUTS (FYU tokens excluded), with phonological context, age group and speech rate as predictors (table 5.1.2). There is a significant main effect of post-coronal position on realizations of SHUTS, indicating that the position of the vowel is fronter in post-coronal position relative to "other" phonological environments. There is also a significant main effect of young IV speakers, suggesting that young IV speakers produce fronter realizations relative to any other age group. There is a nearly significant effect of old IV speakers, signifying that old IV speakers produce slightly fronter realizations of SHUTS relative to old BC speakers. This effect is likely due to the fact that post-coronal SHUTS appears to shrink in size and be more concentrated in the frontest portion of the vowel distribution; the frontest part of the distribution of post-coronal SHUTS in old IV speakers does not deviate from that of BC speakers. The position of SHUTS in F2 is not conditioned by gender, so this factor is not included in the model.

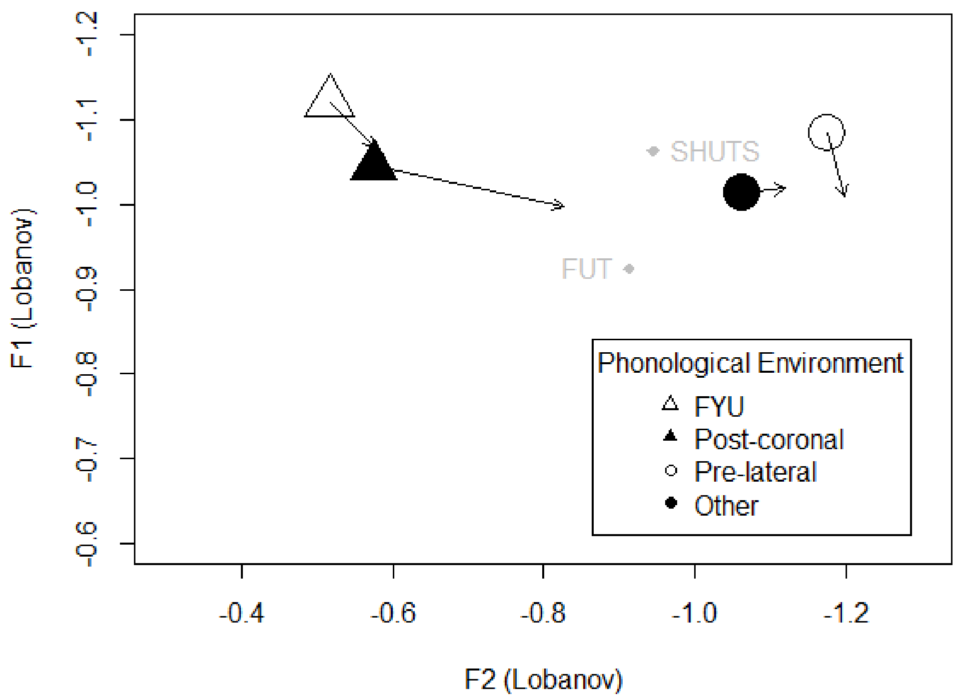
Table 5.1.2. Lmer model fit to normalized F2 midpoint values of SHUTS for all speakers (excluding FYU tokens), with phonological context, age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.328494	0.097807	-13.583
phonological context=Post-coronal	0.344798	0.047472	7.263
age=young BC	0.058659	0.093312	0.629
age=old IV	0.148280	0.095108	1.559
age=young IV	0.457090	0.094961	4.813
speech rate	0.008343	0.021136	0.395

5.1.2. Trajectory of SHUTS

The results from the current data demonstrate that SHUTS exhibits a markedly different formant trajectory for post-coronal environments and in FYU tokens as compared to pre-lateral and “other” environments. Figure 5.1.3 is a plot of the mean normalized formant contour from the first measurement of the vowel at 30% to the last measurement of the vowel at 70%. These points were selected to minimize the effect of surrounding phonological contexts on the vowel, while still observing formant motion. In post-coronal positions, SHUTS exhibits a front nucleus with a relatively back offglide. By contrast, FYU exhibits relatively little motion over its trajectory, signifying that the vowel does not move nearly as much over its duration as post-coronal tokens of SHUTS. Pre-lateral SHUTS is characterized by very little contour motion, as the nucleus and offglide are in relatively the same position. Also, pre-lateral SHUTS exhibits virtually no motion in the F2 dimension, while all other environments exhibit motion predominantly in the F2 dimension. SHUTS in “other” phonological contexts is also characterized by very little contour motion, though the nucleus for these contexts is slightly front (though not significantly so, based on the discussion in §5.1) of pre-lateral SHUTS. This plot suggests that SHUTS is less diphthongal in pre-lateral and “other” phonological environments in comparison to post-coronal environments. Furthermore, while FYU has a fronter midpoint than other phonological environments, it does not exhibit much movement over its trajectory, suggesting that it is relatively monophthongal. Finally, it appears that the use of midpoint values for SHUTS used in the above discussion (§5.1.1) underestimates the effect that preceding coronals have on realizations of the vowel.

Figure 5.1.3. Trajectory of SHUTS from 30% to 70% through the vowel across phonological context.



5.1.3. Summary of SHUTS findings

In sum, realizations of SHUTS are conditioned by phonological context and age group. SHUTS exhibits significantly higher F2 (~fronter realizations) in post-coronal environments, and following an apical glide (i.e., the FYU set). Pre-lateral realizations of SHUTS do not pattern differently from SHUTS in non-post-coronal environments. Post-coronal SHUTS and FYU tokens also exhibit a noticeably more diphthongal trajectory in F1/F2 space in comparison with pre-lateral environments and SHUTS in all other phonological environments. Young IV speakers exhibit a fronter midpoint of SHUTS realizations in comparison to any other age group, indicating a change in apparent time. This fronting occurs in both post-coronal and non-post-coronal environments, but post-coronal SHUTS appears to lead the fronting in young IV speakers. SHUTS does not exhibit variation as a function of gender or PDM score.

5.2. FUT

The existing literature observes that FUT in Pidgin is located in a high back position in the vowel space, similar to SHUTS. In English, FUT evolved historically from the split of Middle English short /u/ into the FOOT and STRUT lexical sets (Wells 1982: 197). Generally speaking, short /u/ underwent a vowel quality change, becoming /ʊ/, and then subsequently unrounded to /ʌ/ forming the STRUT lexical set (see §6.3). This process was inhibited in the presence of labial consonants (e.g., /p, w, f/), albeit imperfectly, so that today in most English dialects, *put* and *putt* are minimal pairs (Wells 1982: 197-198). As a result, the contemporary English lexical set FOOT applies to a relatively small set of words (primarily where the vowel is in labial environments, such as *put*, *foot*, *woman*). However, this split dates back to the 17th century (Wells 1982: 196), well before European contact with Hawaiʻi. Thus FOOT was a fully formed lexical set by the time English speakers reached Hawaiʻi. In comparison to either SHUTS (n=731) or JOK (n=978), Pidgin FUT (n=380) represents a small lexical class, and the phonological contexts it occurs in is relatively limited. Furthermore, English FOOT is not traditionally included in the set of back upgliding vowels, as FOOT is generally phonologically short and lax with respect to GOOSE and GOAT. FOOT also does not exhibit the degree of fronting in post-coronal position that is characteristic of GOOSE and, for some dialects of English, GOAT. In existing descriptions of Pidgin, FUT and SHUTS are variably described as a single phoneme (Bickerton & Odo 1976; Sakoda & Siegel 2008). Sakoda and Siegel (2008) observe that in basilectal Pidgin, FUT and

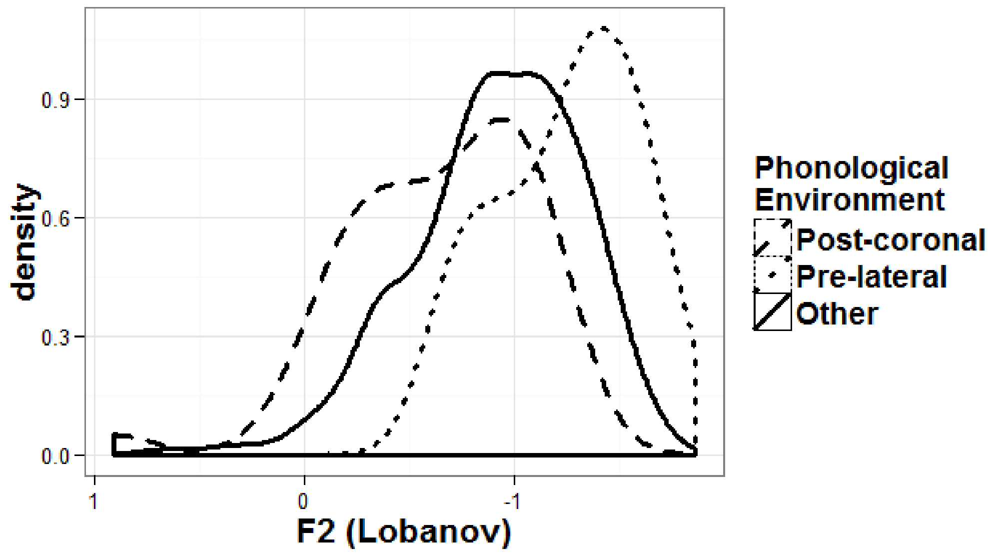
SHUTS are both realized as [u]; mesolectal speakers are likely to differentiate the two lexical sets, so that SHUTS is realized as [u] as FUT is realized as [ʊ]. The following discussion addresses the behavior of Pidgin FUT using the data from the current study, paying special attention to FUT in relation to SHUTS, because there is evidence that these two vowels have shifted away from each other in F1/F2 space.

5.2.1. Effect of phonological environment on F2 of FUT

Before discussing the movement of FUT in relation to SHUTS evidenced by the current data, a note must be made about the effect that phonological environments have on the F2 of FUT. As discussed in §5.2, the FUT lexical class in Pidgin includes a relatively small number of words, and the vowel is often found in labial environments. Because of this, there are relatively few phonological environments that occur frequently enough to be considered across the range of speakers. In the current data, only labial-adjacent (n=140), post-coronal (n=43), and pre-lateral (n=37) environments were frequent enough and evenly distributed across age groups to be tested across the range of speakers. Of these phonological environments, only post-coronal and pre-lateral had an effect on the midpoint realizations of FUT. As such, labial-adjacent environments are not separated in the following analysis. Figure 5.2.1 is a density plot of normalized midpoint F2 values of FUT in post-coronal, pre-lateral and "other" phonological environments. FUT in pre-lateral environments has a noticeably backer nucleus with respect to other phonological environments. Post-coronal contexts motivate subtle fronting, though this is not as marked as in SHUTS (see §5.1). Crucially, the relationship in figure 5.2.1 is evident in each age group, but because some age groups have relatively few examples (e.g., of the 78 examples of FUT in young BC speakers exhibit only five are in pre-lateral environments), the behavior of all speakers is analyzed together. A linear mixed-effects model fit to normalized midpoints of the

F2 of FUT, with phonological environment, age group, and speech rate as predictors corroborates the phonological effects discussed here. These models are discussed and presented in table 5.2.2 in the following section, §5.2.2.

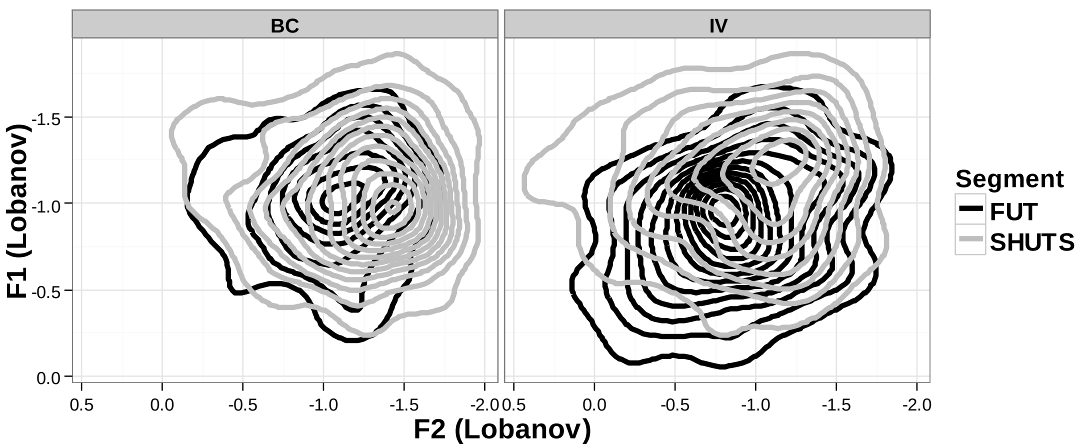
Figure 5.2.1. Density plot of normalized F2 midpoint values for all examples of FUT in post-coronal (dashed), pre-lateral (dotted) and "other" (solid) phonological environments.



5.2.2. Change in FUT over time: Split from SHUTS

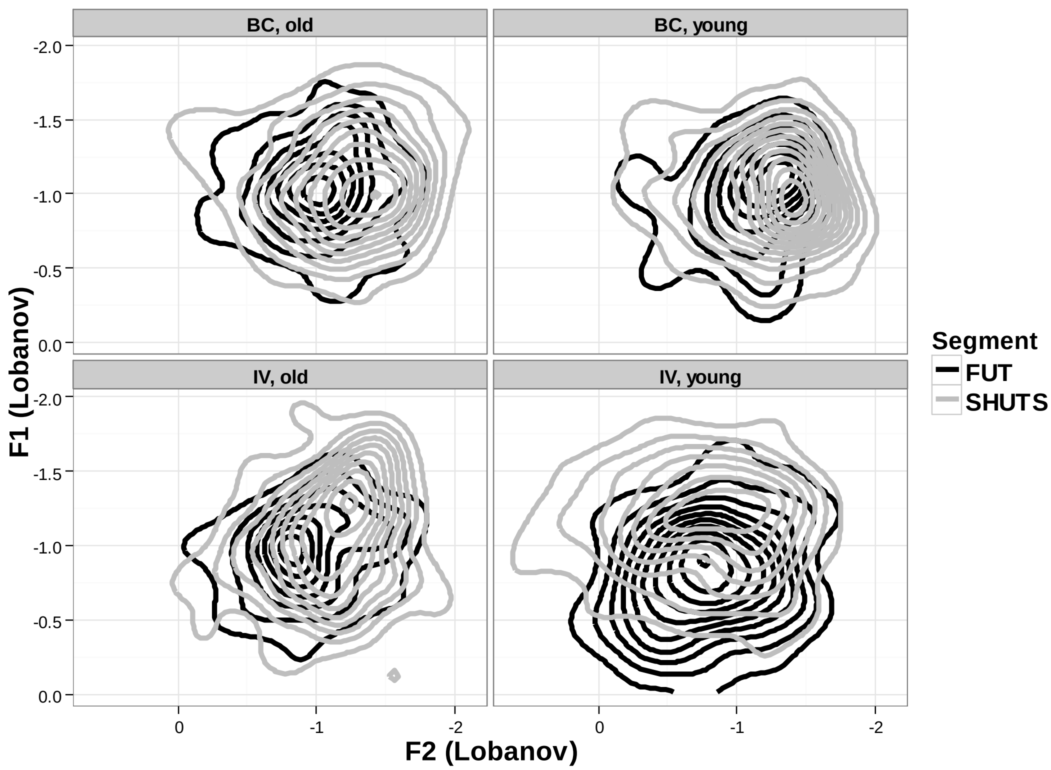
The results from the current data demonstrate that FUT changes its position in the vowel space over time. Figure 5.2.2 is a density plot of the normalized midpoints of FUT in comparison with SHUTS across corpora (FYU excluded, see §5.1.1). BC speakers exhibit quite overlapped distributions of FUT and SHUTS. Virtually the entire distribution of FUT is located within the space occupied by SHUTS, suggesting that BC speakers are likely to produce FUT and SHUTS in roughly the same F1/F2 area in the vowel space. Furthermore, the two vowel classes have close, but not identical, density centers. The density center of FUT is localized to the right of -1 in the F2 dimension and -1 in the F1 dimension, while the density center for SHUTS is slightly backer around -1.4 in the F2 dimension. By contrast, IV speakers exhibit a FUT that is relatively lower and fronter than that of BC speakers. The density center of FUT in IV speakers is largely to the left of -1 in F2, and dips below -1 in F1. The density center of SHUTS, by comparison, is located in a fronter (see §5.1.1) and higher (though not significantly higher) position than what is observed for BC speakers. The distributions of FUT and SHUTS appear to be roughly the same size (paralleling what is observed in BC speakers), despite the fact that both distributions have increased in size relative to BC speakers. These observations suggest a change in real time, where FUT and SHUTS have moved away from each other in F1/F2 space.

Figure 5.2.2. 2-d density plot of normalized values of FUT (black) and SHUTS (gray) separated by vowel identity and corpus.



This change over time appears to be further conditioned by age group within corpus. Figure 5.2.3 illustrates this difference by comparing the normalized midpoint values of FUT and SHUTS (FYU excluded) for all speakers across age group. In this density plot, it is apparent that FUT and SHUTS for BC speakers change very little with respect to each other. Both the size and position of the distributions of FUT and SHUTS are nearly identical, leading to considerable overlap between the two vowel classes. IV speakers, however, show what appears to be a change in apparent time. The density center for FUT in old IV speakers is centered in front of -1 in the F2 dimension and approximately on -1 in the F1 dimension; this is a position that is both fronter and lower than either age group in the BC corpus. Young IV speakers exhibit a slightly lower density center for FUT in comparison to old IV speakers, and the size of the distribution of FUT is noticeably larger, indicating that the distribution has also fronted with respect to old IV speakers. These observations suggest that the change in real time between BC and IV speakers is also taking place in apparent time for IV speakers. No changes in apparent time are evident in the BC speakers. Given these findings, it is evident that FUT and SHUTS have become less similar to each other in F1/F2 space over age group, potentially constituting the beginnings of a phonemic split that is most pronounced in the youngest speakers.

Figure 5.2.3. 2-d density plot of normalized values of FUT (black) and SHUTS (gray) separated by vowel identity and age group.



The movement in spectral space is corroborated by separate linear mixed effects models fit to normalized midpoint values of F2 (table 5.2.1) and F1 (table 5.2.2), with age group and speech rate as predictors. The model fit to F2 also has phonological context as a predictor to verify observations of the effects of phonological environment discussed in §5.2.1. In table 5.2.1, there is a significant main effect of young IV speakers, indicating that this group produces significantly fronter realizations of FUT with respect to all other age groups. There is also a significant main effect of post-coronal and pre-lateral phonological environments, corroborating the findings that the midpoint of FUT is fronter and backer, respectively, in these environments (see discussion in §5.2.1).[130] As with the models fit to F2 of SHUTS, these phonological contexts were treated as a single data column to avoid collinearity among realizations that were both post-coronal and pre-lateral. Additionally, liquid onsets /r, l/ were categorized as "other" rather than post-coronal, following Labov et al. (2006: 151). In the model fit to F1 (table 5.2.2), there is a nearly significant ($t = 1.887$) main effect of young IV speakers, indicating that FUT is lower in the youngest group of speakers.[131] Additionally, the intercept of old IV speakers is roughly half that of the intercept of young IV speakers, indicating that old IV speakers lower (though non-significantly so) FUT with respect to old BC speakers to an extent. The position of FUT in F1 and F2 is not conditioned by gender, so this factor is not included in the model.

Table 5.2.1. Lmer model fit to normalized F2 midpoint values of FUT for all speakers, with phonological environment, age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.17231	0.11488	-10.205
phonological context=Post-coronal	0.33079	0.08657	3.821
phonological context=Pre-lateral	-0.33258	0.08342	-3.987
age=young BC	-0.02107	0.10800	-0.195
age=old IV	0.08870	0.10741	0.826
age=young IV	0.27366	0.02396	2.559
speech rate	0.03130	0.02396	1.306

[130] Note that despite the robust effect size, the reported effects of post-coronal and pre-lateral phonological environments are to be taken with some caution, given the relatively small number of tokens (see §5.2.1).
[131] There is a small but significant effect of speech rate on realizations of F1 of FUT, suggesting that speakers lower realizations of FUT as speech rate increases. However, this effect is in the expected directed (see, e.g., Gay 1978), as increased speech rate often involves formant undershoot.

Table 5.2.2. Lmer model fit to normalized F1 midpoint values of FUT for all speakers, with age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.19110	0.10175	-11.706
age=young BC	0.06765	0.10119	0.669
age=old IV	0.09494	0.10073	0.943
age=young IV	0.18917	0.10024	1.887
speech rate	0.04621	0.02098	2.203

As a further measure of the similarity between FUT and SHUTS, each speaker's FUT and SHUTS was compared using Pillai scores derived from a MANOVA to quantify the degree of overlap between the two vowel classes as a single value. Figure 5.2.4 is a graph of the Pillai scores plotted against birthdate with separate lines fit to BC and IV speakers. Smaller Pillai scores indicate a greater degree of overlap between vowel classes. The plot in figure 5.3.4 demonstrates that birthdate affects Pillai score in different ways for each corpus. For BC speakers, speakers generally exhibit low Pillai scores, with three notable exceptions: Kaimana (old BC female), Kawika (old BC male), and Eddie (young BC male). It is unclear what features sets these three speakers apart from the rest of the BC speakers, but these speakers exhibit clearly distinct FUT and SHUTS realizations.[132] However, the rest of the BC speakers exhibit consistently low Pillai scores. In contrast, IV speakers show a trend where young IV speakers are more likely to exhibit higher Pillai scores in comparison to old IV speakers.[133] In line with observations taken from figure 5.2.3 and tables 5.2.1 and 5.2.2, the pattern in figure 5.3.4 underscores that it is young IV speakers who behave most differently from the rest of the age groups.

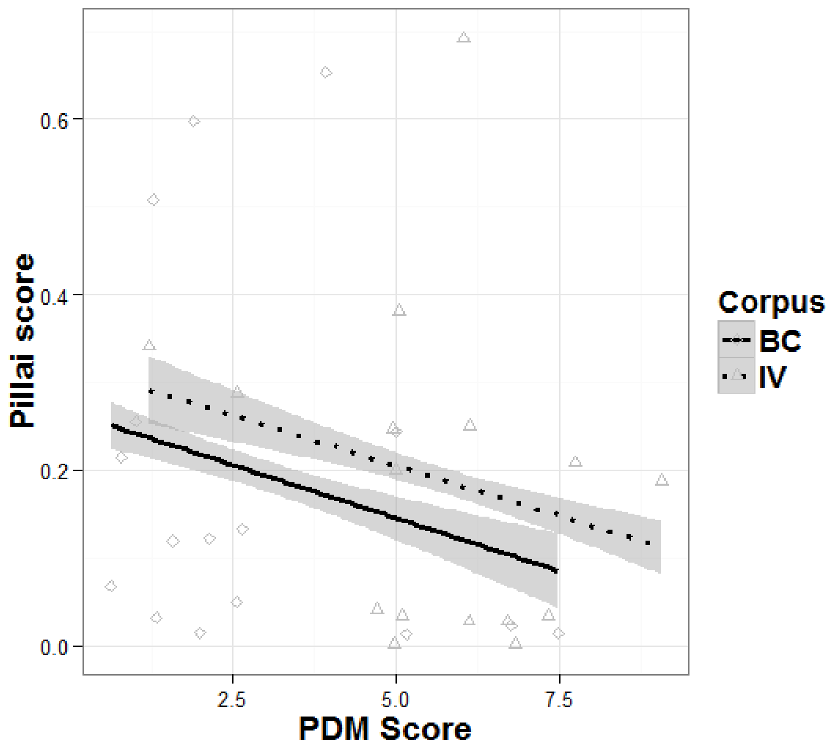
[132] It is puzzling to identify a single similarity among these three speakers that might explain their radically different Pillai scores. Eddie and Kaimana are both from O‘ahu, but Kawika is from Kaua‘i. All three identify as Hawaiian or part Hawaiian, but they are not the only BC speakers who are Hawaiian (Malia, Leilani, and Kimo also identify as Hawaiian or part Hawaiian). Additionally, all BC speakers are listed as completing roughly equivalent levels of formal education, and while Kawika and Eddie both work in blue collar jobs, they are not the only BC speakers that fit this description. Finally, there is nothing that clearly delineates their interviews as different from other BC speakers.

[133] Lena, a young IV female, exhibits the highest Pillai score and also is the youngest of the young IV speakers.

Figure 5.2.4. Pillai scores of FUT-SHUTS plotted against birthdate with separate best-fit lines for BC and IV speakers.

PDM score appears to play a more prominent role in the overlap exhibited between FUT and SHUTS in BC and IV speakers. Figure 5.2.5 graphs the FUT-SHUTS Pillai scores output by the MANOVA plotted against PDM score, with separate best-fit lines graphed for BC speakers and IV speakers. For each corpus, there is an inverse correlation between PDM score and Pillai score; that is, higher PDM scores are correlated with relatively lower Pillai scores. Putting this finding in context with the findings for the effect of age on Pillai score within corpus, a relatively high PDM score alone increases the likelihood that FUT and SHUTS will be overlapping for both BC and IV speakers.

Figure 5.2.5. Pillai scores of FUT-SHUTS plotted against PDM score for BC (solid) and IV (dotted) speakers.



Separate linear fixed effects models were fit to speaker Pillai scores within corpus, with PDM score and speech rate as predictors to corroborate these findings. Table 5.2.3 shows the results from the model fit to BC speakers. There is a significant main effect of PDM score on Pillai score, indicating that FUT and SHUTS become relatively more overlapped as PDM score increases. While the effect size is quite large, the change in the estimate is quite small, suggesting that this is a subtle effect. Table 5.2.4 shows the results from the model fit to IV speakers. Again, there is a significant effect of PDM score, indicating that as PDM score increases, FUT and SHUTS are likely to be more overlapping. Similar to the effect of PDM score in BC speakers, PDM score has a small estimate, demonstrating that the effect of PDM score is relatively subtle. For both IV and BC speakers, PDM score is negatively correlated with FUT-

SHUTS Pillai scores (see figure 5.2.5), indicating that relatively higher PDM scores tend to lessen the distinction between the two high back vowels.

Table 5.2.3 Linear fixed-effects model fit to speaker Pillai score of FUT-SHUTS for BC speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.25890	0.03815	6.786
PDM score	-0.02262	0.00454	-4.986
speech rate	0.000018	0.01091	0.002

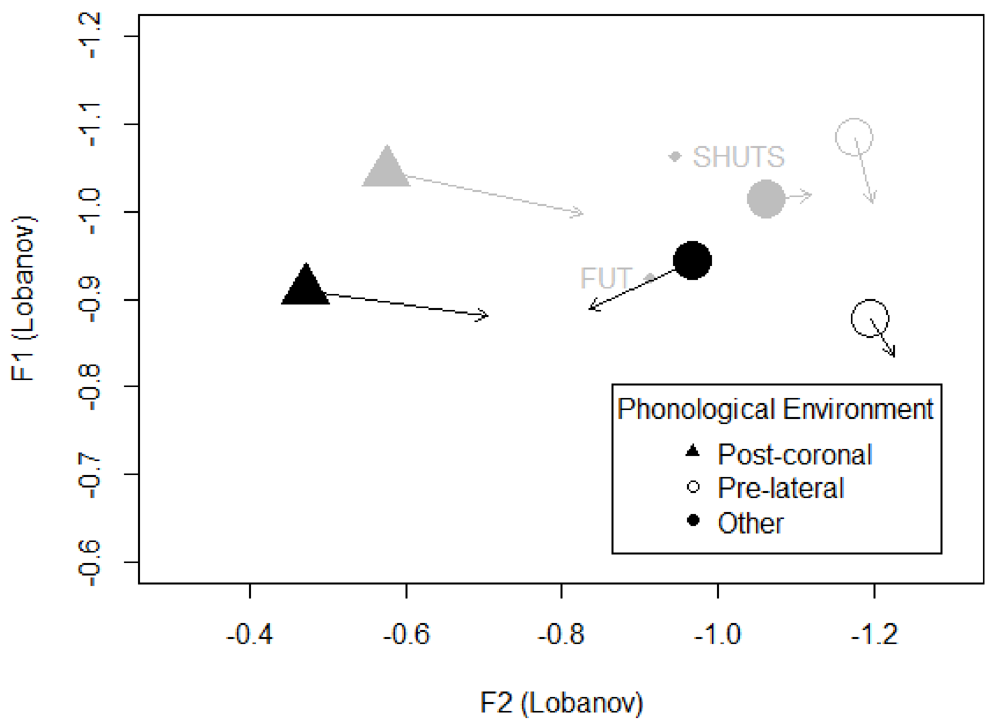
Table 5.2.4 Linear fixed-effects model fit to speaker Pillai score of FUT-SHUTS for IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.279356	0.046441	6.015
PDM score	-0.023148	0.004278	-5.411
speech rate	0.010951	0.009796	1.118

5.2.3. Trajectory of FUT

The results from the current data demonstrate that FUT exhibits a different formant trajectory for post-coronal environments and pre-lateral environments as compared with “other” environments. Figure 5.2.6 is a plot of the mean normalized formant contour from the first measurement of the vowel at 30% to the last measurement of the vowel at 70%. These points were selected to minimize the effect of surrounding phonological contexts on the vowel, while still observing formant motion. In post-coronal positions, FUT exhibits a front nucleus with a relatively back offglide. FUT in “other” phonological environments exhibits a relatively backer nucleus, with much the same offglide target in spectral space as post-coronal FUT. This indicates that FUT in non-post-coronal and non-pre-lateral environments exhibits a degree of centralization over its trajectory. Pre-lateral FUT is characterized by very little contour motion, as the nucleus and offglide are in relatively the same position, though the nucleus is noticeably backer than either post-coronal or “other” phonological environments. This plot suggests that FUT is less diphthongal in pre-lateral environments in comparison to post-coronal or "other" environments. Furthermore, the plot demonstrates that the trajectories of post-coronal and pre-lateral FUT closely parallel the trajectories of post-coronal and pre-lateral SHUTS. Only FUT in "other" phonological contexts differs from SHUTS in "other" phonological contexts, as FUT demonstrates an inglide as opposed to a backing offglide. This inglide parallels the inglide exhibited by STIK as well (see §4.2.4).

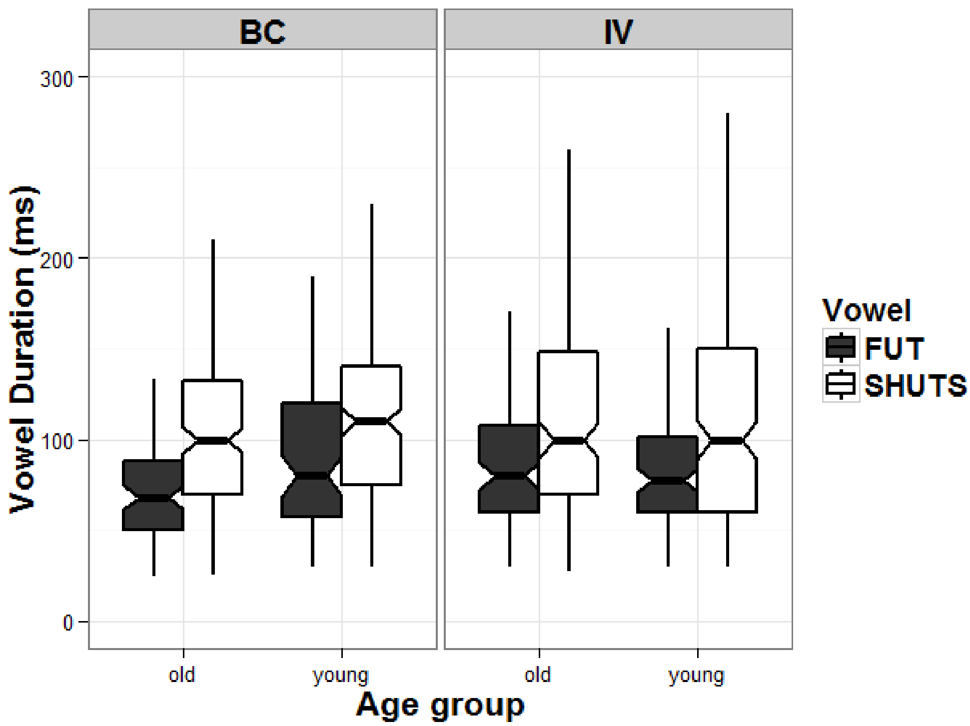
Figure 5.2.6. Trajectory of FUT (black) compared with SHUTS (gray) from 30% to 70% through the vowel across phonological environment.



5.2.4. Role of duration in distinguishing FUT and SHUTS

As discussed in §2.5 and §3.5.2, it is reasonable to expect that even if lexical sets exhibit spectral overlap, there is still a possibility for vowels to exhibit temporal differences. The results from the current data demonstrate that vowel duration is an important factor to consider when characterizing the spectral overlap exhibited by SHUTS and FUT. Figure 5.2.7 shows boxplots representing vowel duration for FUT and SHUTS over age group. Though FUT exhibits a shorter duration relative to younger age groups, median vowel duration does not change drastically in SHUTS over time. Furthermore, FUT is consistently shorter in duration. This change is noteworthy, given the significant spectral overlap FUT and SHUTS exhibit, especially in BC speakers. However, these duration data suggest that in both groups of BC speakers and old IV speakers, FUT is held temporally distinct from SHUTS.

Figure 5.2.7. Vowel durations (ms) of FUT and SHUTS plotted against age group (outliers removed).



To corroborate these findings, a linear mixed effect model was fit to vowel duration (ms) of all instances of FUT and SHUTS, with segment type and speech rate as predictors (table 5.2.5).[134] Speech rate was included as a predictor to control for vowel duration, as vowel

[134] Whether the vowel was found before a voiced consonant was also included as a factor in the original model, but this factor did not return significance. This is noteworthy, as the voicing of coda consonants has been shown to influence the duration of the preceding vowel (House 1961; Delattre 1962; Chen 1970; Klatt 1976). Furthermore, the voicing of coda consonants is a significant predictor for the low back vowels (see §6.4) and high front vowels

duration and speech rate have been shown to be linked (see §3.5.2). Table 5.2.5 shows a significant main effect of segment type and speech rate on vowel duration, as well as a moderate non-significant effect for young IV speakers. The model demonstrates that FUT (~123 ms) is significantly shorter than SHUTS (~143 ms). Additionally, the model corroborates that speech rate has a predictable effect on vowel duration, where higher rates of speech produce significantly shorter vowels. Age group does not significantly affect the duration of FUT or SHUTS.

Table 5.2.5. Lmer model fit to vowel duration (ms) of FUT and SHUTS for all speakers, with segment type and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	143.364	8.586	16.698
Segment=FUT	-19.566	5.538	-3.533
speech rate	-8.591	2.156	-3.984

5.2.5. Summary of FUT findings

In sum, the behavior of FUT varies as a function of phonological environment, age group and PDM score. The midpoint of FUT is fronter in post-coronal environments with respect to all other phonological environments, and this environment also exhibits backing over the vowel's F1/F2 contour. Pre-lateral environments motivate a backer midpoint relative to all other phonological environments, and this environment appears to inhibit the F1/F2 contour motion of FUT. Phonological environments that are neither post-coronal nor pre-lateral exhibit a centralized offglide, with a relatively backer nucleus. FUT also changes its position in the vowel space as a function of age group. Young IV speakers exhibit lower and fronter realizations of FUT than any other age group. This lowering and fronting is somewhat evident in old IV speakers, but differences in the normalized midpoint values of F1 and F2 of FUT do not reach significance for

---

SHCHRIT and STIK (see §4.2.5). This may be somewhat tied to the fact that FUT exhibits a relatively short duration relative to other vowels; however, this is outside the scope of this study and bears further investigation.

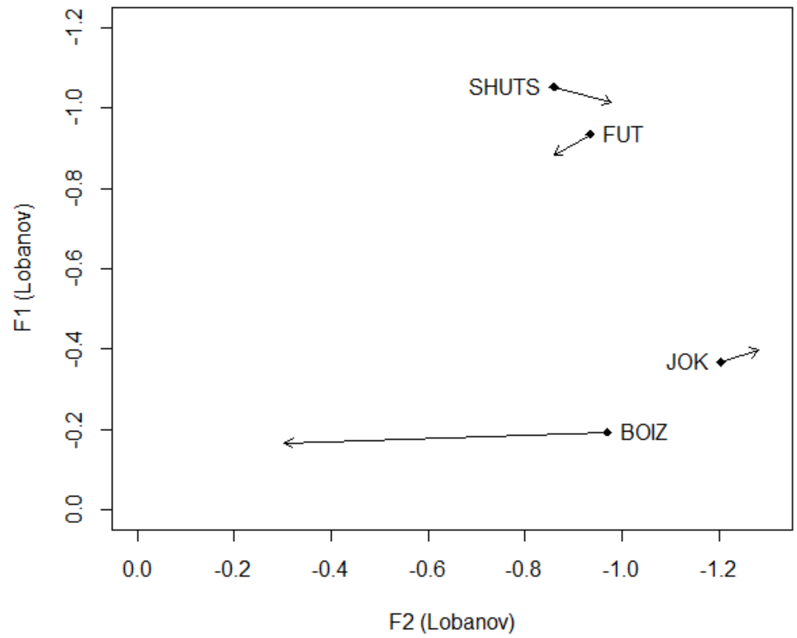
this age group. PDM score does not appear to have an effect on the midpoint of F1 or F2, but it does slightly decrease the FUT-SHUTS Pillai score, indicating that to some extent, PDM plays a role in increasing the similarity between FUT and SHUTS. Together, this suggests that FUT exhibits less overlap in spectral space over time, but that this reduction of overlap is inhibited to some degree by a high PDM score. However, vowel duration data, suggests that FUT and SHUTS are kept temporally distinct from each other in all age groups. Therefore, while FUT and SHUTS exhibit noticeable spectral overlap, especially in older speakers and speakers with a high PDM score, FUT is consistently shorter than SHUTS in all age groups. Gender does not significantly affect the position of FUT.

5.3. JOK

The existing literature describes JOK in Pidgin as occupying a tense mid back position in the vowel space. The current study demonstrates that JOK exhibits an F1 higher than that of SHUTS or FUT, and an F2 lower than that of SHUTS or FUT. In English, GOAT is derived from Middle English /o:/ and /ow/ (Labov et al. 2006: 14). In many American and British English varieties, GOAT is described as diphthongal (see, e.g., Wells 1982; Labov et al. 2006), though some more conservative dialects exhibit relatively monophthongal realizations of GOAT, such as the North Central region of the mainland US (Gordon 2004: 346), Hawai‘i English (Drager et al. 2012; Kirtley et al. forthcoming), as well as Scottish English (Stuart-Smith 2008: 50), rural varieties of Irish English (Hickey 2004: 72), and northern varieties of Welsh English (Penhallurick 2008: 112-113). In many American English varieties, GOAT is also fronting over time, especially in post-coronal positions; however this fronting lags behind the more extreme fronting exhibited by GOOSE (Labov 2001: 478-479). In Pidgin, JOK is described as monophthongal preceding [m] and word-finally (Sakoda & Siegel 2008: 223).

Before moving on, a brief point must be made regarding the trajectory of JOK. While JOK has been described as diphthongal in some phonological descriptions, this study finds that the vowel exhibits very little motion over its trajectory. Figure 5.3.1 is a plot of the mean normalized formant contour from 30% to 70% for all tokens of JOK with respect to all other high back vowels, as well as BOIZ for comparison (see §7.3). The 30% and 70% points were selected in order to reduce influence from the surrounding phonological contexts, while retaining information about the formant motion over the vowel. From the plot, JOK exhibits slightly less motion over its duration in comparison with other high back vowel vowels. By comparison, the "true diphthong" (Labov et al. 2006: 11) BOIZ exhibits much more noticeable formant over its duration. In general, JOK appears quite monophthongal. The trajectory of JOK will be returned to in §5.3.3, but given its monophthongal behavior, the following discussion of JOK is based on midpoint values of the entire vowel, rather than midpoint values of the nucleus at 30% (like diphthongs see §7). It is worth mentioning that the results reported in this chapter do not change if the 30% point through JOK is chosen. The following discussion addresses the behavior of JOK using the data from the current study.

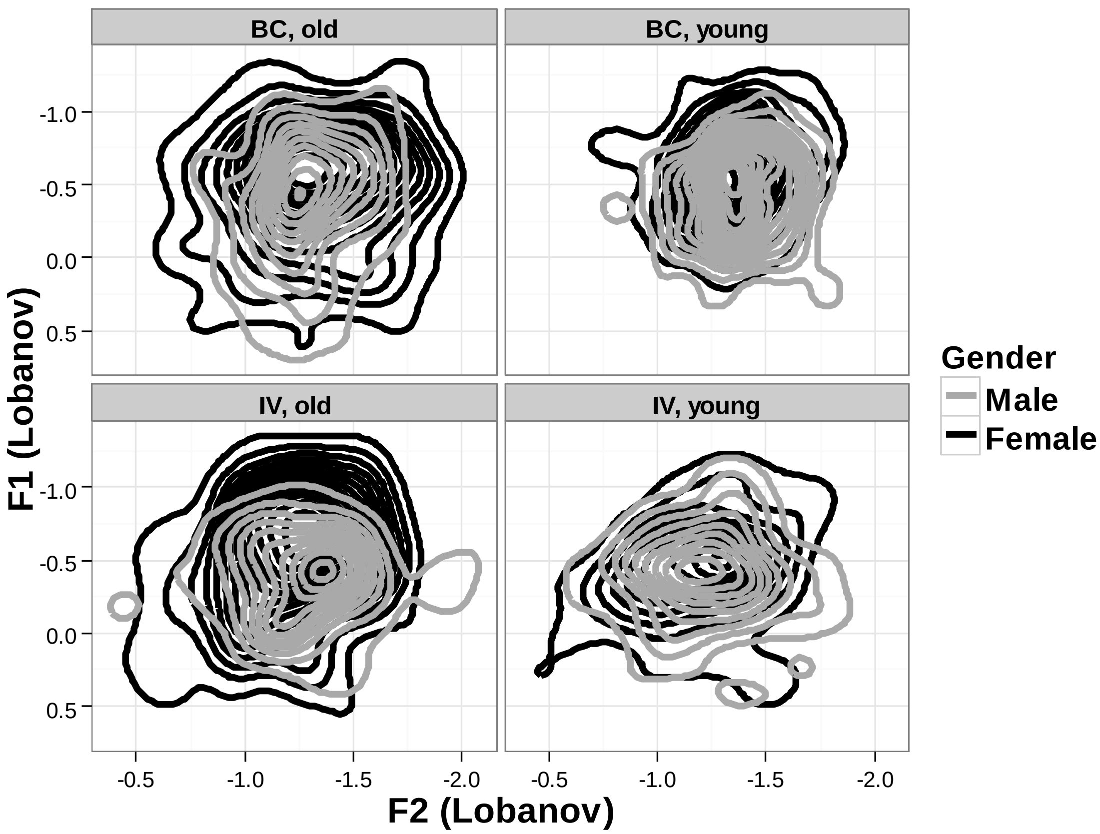
Figure 5.3.1. Trajectory of JOK and all other high back vowels and BOIZ (based on all realizations); nucleus represented by the measurement at 30% and offglide represented by measurements at 70% of the vowel's duration.



5.3.1. Stability of JOK in the vowel space

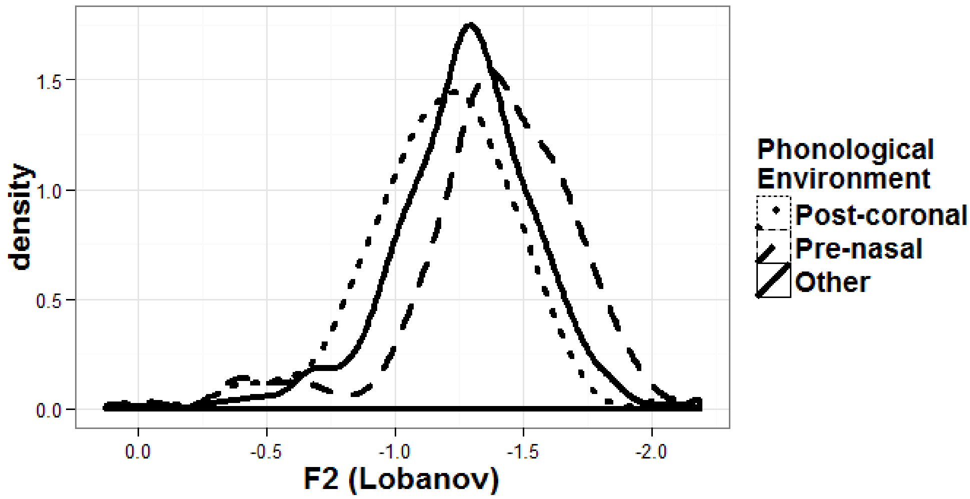
The present analysis shows that in comparison to SHUTS and FUT, JOK in Pidgin exhibits very little variation across age or gender. Figure 5.3.2 demonstrates this stability with two-dimensional density plots of the normalized midpoint of JOK over age group and gender. Though young BC speakers exhibit a somewhat tighter concentration of JOK realizations in comparison to the other age groups, the density center of JOK realizations for males and females in all age groups is centered between -1.0 and -1.5 in the F2 dimension and approximately on -0.5 in the F1 dimension. Furthermore, the genders exhibit strikingly similar distributions; only old BC and old IV males produce slightly more concentrated distributions of JOK than the females in that group.

Figure 5.3.2. 2-d density plot of normalized values of JOK separated by gender (males = gray, females = black) and age group.



Despite the lack of change over age group, JOK exhibits very slight differences in midpoint F1 and F2 values as a function of phonological environment. In F2, only pre-nasal and post-coronal environment motivate a difference in the position of JOK. Figure 5.3.3 is a density plot of normalized midpoints of F2 of JOK in post-coronal and pre-nasal, environments, as compared with other phonological environments. Immediately evident is that post-coronal JOK does not exhibit nearly the degree of fronting observed in both SHUTS and, to a lesser extent, FUT, as the distribution of post-coronal context and "other" are very overlapping. Pre-nasal position motivates the most clearly right-ward shifted distribution, indicating that these environments exhibit backer midpoint values relative to other phonological environments.

Figure 5.3.3. Density plot of normalized F2 midpoint values for all examples of JOK across phonological environments.



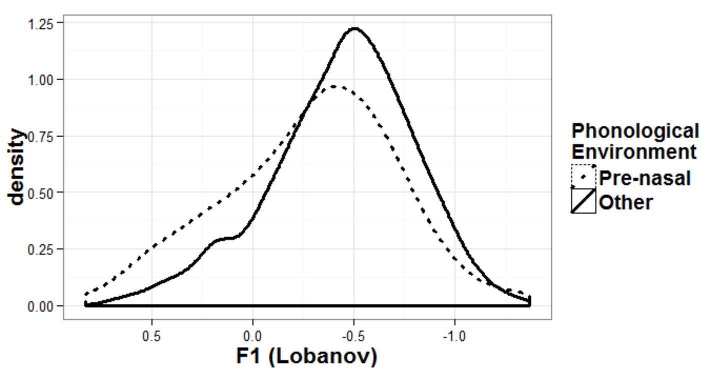
To corroborate these findings, a linear mixed-effects model was fit to normalized midpoint F2 values of JOK, with phonological context and speech rate as predictors (table 5.3.1). There is a significant main effect of pre-nasal position, indicating that pre-nasal JOK motivates significantly lower F2 values (~ backer realizations) in JOK. There is also a significant main effect of post-coronal context, indicating that these environments motivate significantly higher F2 (~ fronter realizations) in JOK. However, the intercept is much smaller than what is observed for SHUTS or FUT, indicating that the fronting motivated by post-coronal environments is relatively subtle. Gender and age group do not significantly affect the midpoint of F2 of JOK.

Table 5.3.1. Lmer model fit to normalized F2 midpoint values of JOK for all speakers, with phonological environment, gender and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.30323	0.05095	-25.577
phonological context=Post-coronal	0.07149	0.02460	2.906
phonological context=Pre-nasal	-0.10317	0.03119	-3.308
speech rate	0.01037	0.01234	0.841

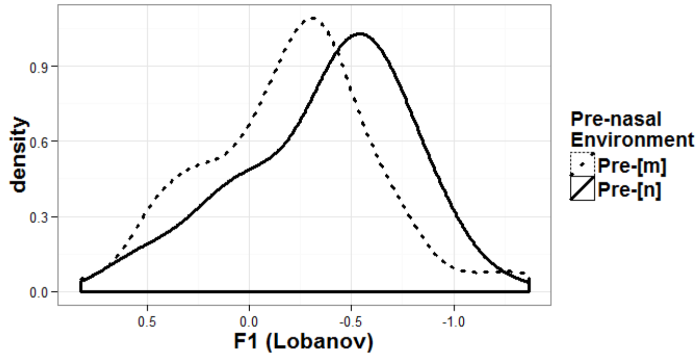
In F1, only pre-nasal contexts motivate different midpoint positions of JOK. Figure 5.3.4 is a density plot of normalized midpoints of F1 of JOK in pre-nasal contexts compared with other phonological environments. Pre-nasal JOK exhibits a subtly right-shifted density peak and distribution than "other" environments; however, the difference in height between these phonological contexts is extremely small. Upon closer inspection, the observed pre-nasal lowering appears to be restricted to JOK preceding [m]. Figure 5.3.5 is a density plot of pre-nasal JOK realizations separated by following phoneme identity.[135] Of note here is that JOK before [m] is lower than JOK before [n]. Comparing the density plots in figure 5.3.5 to figure 5.3.4, the density peak of JOK before [n] does not differ substantially from "other" phonological contexts, as the peak is centered roughly on -0.5 in F1. This finding demonstrates that tokens of JOK before [m] differ markedly from tokens of JOK in "other" phonological environments. Additionally, this finding suggests that the more monophthongal quality exhibited by JOK in before [m] reported by Sakoda and Siegel (2008: 223) is actually a lower vowel quality.

Figure 5.3.4. Density plot of normalized F1 midpoint values for all examples of JOK across phonological contexts.



[135] Note that no realizations were extracted from JOK before [ŋ], mirroring English phonotactics.

Figure 5.3.5. Density plot of normalized F1 midpoint values for JOK in pre-nasal environments.



To corroborate these findings, a linear mixed effects model was fit to normalized midpoint F1 values of JOK, with phonological context, gender, age group and speech rate as predictors (table 5.3.2). Gender and age group were included in the model, as they significantly improved the fit of the model (see discussion below). There is a significant main effect of pre-[m] position, indicating that this environment motivates significantly higher values of F1 (~ lower realizations) in JOK than other phonological environments. There is also a significant main effect of pre-[n] position, which indicates a similar lowering effect; however, the difference in the estimate between pre-[n] and pre-[m] suggests that the lowering effect pre-[n] has on JOK is small by comparison. There is also a significant main effect of young BC speakers, where this age group produces relatively higher realizations of JOK. Looking at the data in figure 5.3.1, it appears that this effect is largely a result of the much smaller area occupied by JOK in young BC speakers relative to old BC speakers, as the center tendencies of the distributions remain largely unchanged across age group. No other age groups exhibit significantly different F1 values. Finally, the model shows that males produce lower realizations of JOK than females, due likely in part to the more concentrated distributions of JOK that males exhibit in all age groups. Despite these age effects, no principled, unidirectional movement in the midpoint of the F1 of JOK takes place over time, which further underscores the stability JOK exhibits across age group.

Table 5.3.2. Lmer model fit to normalized F1 midpoint values of JOK for all speakers, with phonological environment, age group, gender, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.49299	0.06599	-7.471
phonological context=Pre-[m]	0.23256	0.06322	3.678
phonological context=Pre-[n]	0.09503	0.04710	2.018
age=young BC	-0.10991	0.05012	-2.193
age=old IV	-0.05130	0.05182	-0.990
age=young IV	-0.01037	0.05270	-0.197
gender=male	0.12371	0.03635	3.403
speech rate	0.01253	0.01614	0.776

5.3.2. Effect of PDM on JOK

The results from the current data demonstrate that PDM score plays a role in the realizations of JOK for BC speakers. Figure 5.3.6 shows the mean normalized F1 of JOK for BC and IV speakers plotted against PDM score. The plot shows that for BC speakers, realizations of JOK are more likely to be articulated relatively lower in the distribution of JOK vowels (~exhibit higher F1 values) if they exhibit higher PDM scores. IV speakers, on the other hand show no effect of PDM on the position of JOK in F1. Separate linear mixed-effects models were fit to normalized F1 midpoints of JOK for BC and IV speakers, with PDM score and speech rate as predictors. A significant main effect of PDM score was found in the model fit to F1 of JOK in BC speakers (table 5.3.3), indicating that a higher PDM score is correlated with relatively lower realizations of JOK. This effect is absent (t = -0.415) from the model fit to the normalized F1 midpoint of IV speakers. Only the model fit to F1 of JOK for BC speakers is shown, as this was the only model which returned a significant result. In the data, there is no clear relationship between the F2 of JOK and PDM score.

Figure 5.3.6. The effect of PDM score on F1 of JOK for BC (solid) and IV (dotted) speakers.

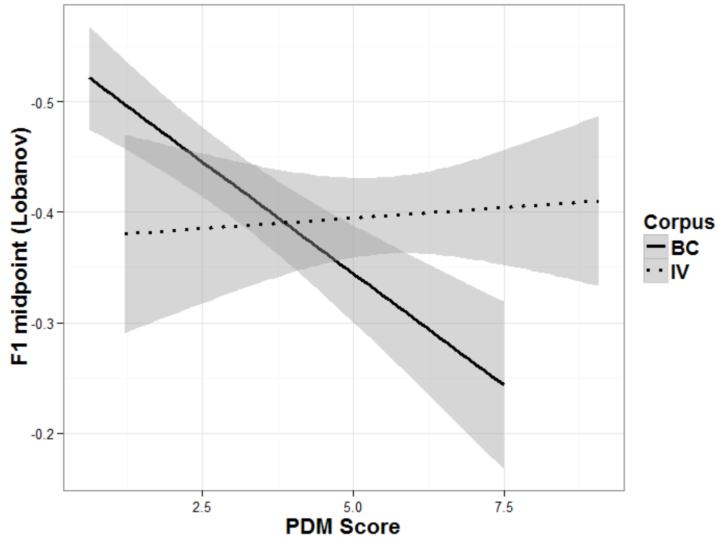


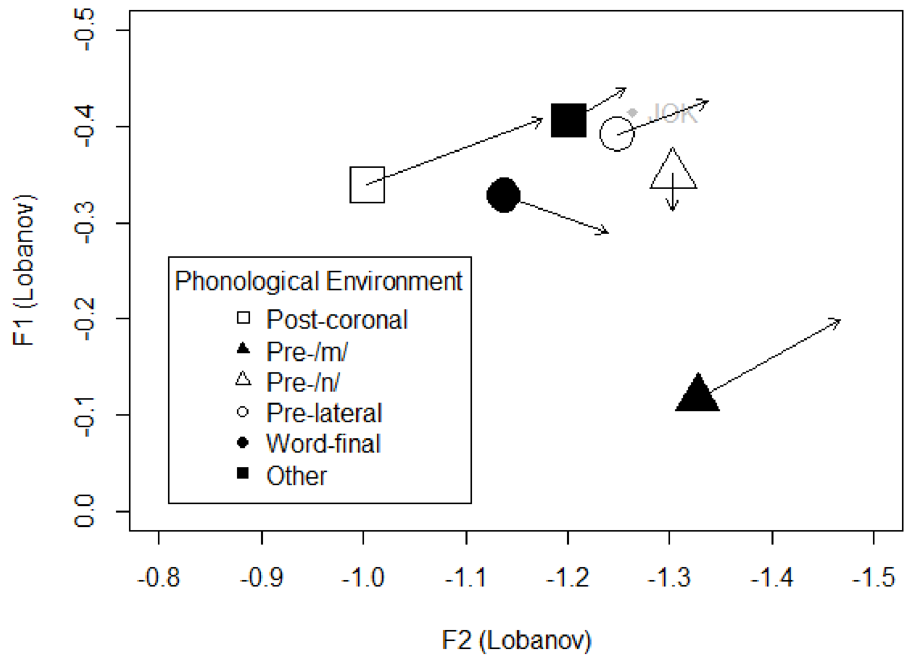
Table 5.3.3. Lmer model fit to normalized F1 midpoint values of JOK for BC speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.59606	0.08278	-7.200
PDM score	0.03742	0.01237	3.025
speech rate	0.02009	0.02121	0.947

5.3.3. Trajectory of JOK

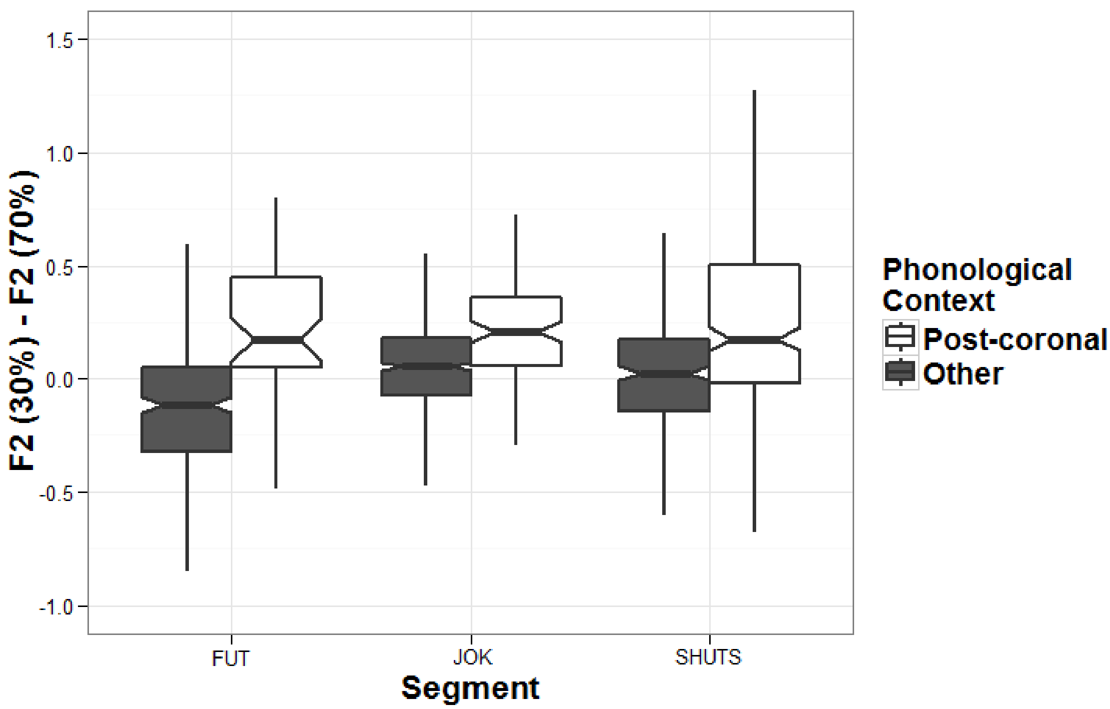
The results from the current data demonstrate that the formant trajectory for JOK varies with respect to phonological environment. Figure 5.3.7 is a plot of the median normalized formant contour from the first measurement of the vowel at 30% to the last measurement of the vowel at 70%. These points were selected to minimize the effect of surrounding phonological contexts on the vowel, while still observing formant motion. Post-coronal JOK exhibits a longer contour motion, mostly in F2, with a relatively fronter nucleus, though not strikingly so (see §5.3.1). However, contour motion is not nearly as long as it is in post-coronal SHUTS (see figure 5.1.4). Pre-lateral JOK exhibits less contour motion in comparison to post-coronal JOK, and the nucleus is, as discussed in §5.3.1, only slightly backer and lower than JOK in "other" phonological environments. JOK in "other" phonological environments exhibits little contour motion, suggesting that the vowel is quite monophthongal. An attempt was made to empirically corroborate the observation made by Sakoda and Siegel (2008: 223) that JOK before [m] and in word-final position is more monophthongal, relative to other phonological contexts. These environments were isolated, and they are also presented in figure 5.3.7. Word-final JOK exhibits trajectory motion similar to pre-lateral tokens, but with an offglide target that slightly lower in the vowel space. JOK before [m] also exhibits a very similar trajectory length to post-coronal JOK, only differing in that is it and backer lower in the vowel space than any other position. This graph also verifies that JOK before [n] appears to behave much differently than JOK before [m]. It occupies a relatively low position relative to "other" phonological contexts; however, its trajectory indicates that its offglide is in virtually the same position as its onset, suggesting the vowel is very monophthongal in this environment. Given these findings, it does not appear as if JOK before [m] and JOK in word-final position exhibit demonstrably shorter trajectories than JOK in any other context, contrary to Sakoda and Siegel's (2008) claim. Instead pre-[n] JOK is more monophthongal than JOK in any other phonological environment.

Figure 5.3.7. Trajectory of JOK from 30% to 70% through the vowel across phonological context.



Given these findings, it appears that JOK is generally a monophthongal vowel. However, all three high back vowels behave rather similarly in their trajectory in post-coronal environments. Figure 5.3.8 shows the distribution of trajectory distances in F2 from the 30% mark to the 70% mark for each high back vowel in post-coronal and non-post-coronal contexts. All three vowels exhibit a relationship where post-coronal trajectory length is longer than non-post-coronal trajectory length. FUT is the most obvious example of this, though the distribution of the “other” category in the figure is lower largely due to the inglide exhibited by the vowel (see §5.2.3). Furthermore, median trajectory length of JOK and SHUTS in “other” phonological contexts suggests that these vowels move very little over their durations. Motion along F2 appears to be particularly small in JOK, given that the vowel’s interquartile range is narrow in comparison to all other vowels. This appears to suggest that JOK is slightly more monophthongal in nature than SHUTS or FUT; however, the median difference between onset and offglide in F2 is strikingly consistent across vowel identity in post-coronal position.[136] The distance of the trajectory of all the high back vowels in post-coronal position is therefore roughly equal, despite the differences they exhibit in terms of midpoint F2.

Figure 5.3.8. Boxplots of trajectory distance of JOK in F2 (30% to 70%) of the high back vowels in post-coronal and non-post-coronal environments.



5.3.4. Summary of JOK findings

In sum, the position of JOK is affected by phonological context and PDM score, but does not change across gender (despite a significant finding in F2; see §5.3.1) or over time. Pre-nasal JOK is more likely to occupy a lower and backer position in the vowel space, relative to other realizations of JOK. The lowering effect of nasals on JOK is only evident before /m/. Post-coronal position motivates a fronter midpoint of JOK, though this effect is not nearly as robust as in

[136] This is corroborated by a linear mixed-effects model fit to the difference between F2 at 20% and F2 at 80% of vowels in post-coronal position, with vowel identity and speech rate as predictors. No significant differences arise in this model.

SHUTS or FUT. The trajectory length of JOK is also influenced by phonological context. Post-coronal position motivates a longer trajectory length in F2 in comparison to other phonological contexts. While Sakoda & Siegel (2008: 223) claim that JOK is most monophthongal before [m] and word finally, this study finds no evidence that the trajectory of JOK before [m] or word-finally is much different from any other phonological context (except JOK before [n]). Pre-[m] does, however, motivate a lowering of the midpoint of JOK, which may be the cause for the perception that it is more monophthongal in this context. Further research is needed to address this possibility. Word-final JOK is quite similar to its trajectory in "other" phonological environments, but it is associated with a slightly lower offglide target. It is possible that this change in trajectory motivates the perception of a more monophthongal vowel, but this too requires further study. Furthermore, the trajectory length of JOK in post-coronal position does not differ from the trajectory length of other high back vowels in the same phonological environment. PDM score also has an effect on the F1 midpoint of JOK, where speakers with high PDM scores in the BC corpus are more likely to produce JOK in a relatively lower position. The possible motivations behind this finding are discussed in §5.4. The vowel duration of JOK does not differ in any principled way across age, gender or phonological category.

5.4. Discussion of high back vowel findings

Given these results, a few conclusions can be drawn regarding the behavior of the high back vowels in Pidgin. First, there is ample evidence to suggest that FUT and SHUTS exhibit considerable spectral overlap in relatively older speakers, which corroborates findings from previous research that SHUTS and FUT are realized as similar (Bickerton & Odo 1976; Sakoda & Siegel 2008). However, the youngest group of speakers produces FUT in a position that is more clearly distinct from SHUTS than it is in older age groups. Therefore, there is evidence that SHUTS and FUT have undergone a split in spectral space over time, which is most evident in young IV speakers. There are, however, two caveats to this observation. First, FUT is temporally shorter than SHUTS for all age groups, including BC speakers, where the two vowels are nearly completely overlapped in F1/F2 space (compare findings between SHCHRIT and STIK). Second, while SHUTS in all phonological environments (with the exception of before [l]) exhibits a backing offglide, FUT exhibits an inglide in non-post-coronal and non-pre-lateral environments. In other words, FUT is distinct from SHUTS in terms of vowel duration, and FUT exhibits a different trajectory from SHUTS in certain phonological environments. That FUT differs from SHUTS in these two ways suggests even among older speakers of Pidgin, FUT is a distinct phonemic category (compare with SHCHRIT-STIK in §4.2). However, it is unclear to what extent duration or trajectory information is used by Pidgin speakers in assessing vowel identity. Data from perception experiments on speakers of Pidgin would certainly shed light on these issues, but such work falls outside the scope of this study.

It is also worth noting that the patterns exhibited by SHUTS and FUT in young IV speakers parallel vowel realizations of Hawai‘i English speakers. GOOSE is reported to be fronting in Hawai‘i English in apparent time in the speech of young females (Simpson et al. 2014; Kirtley et al. forthcoming). Furthermore, Hawai‘i English GOOSE is reported to have a backing offglide (Kirtley et al. forthcoming), similar to that of some mainland American English varieties (Koops 2010). Though SHUTS has not been described as diphthongal or having a backing offglide in the existing literature, Pidgin SHUTS appears to pattern closely with the reported trends in English. The fronting offglide associated with FUT in Pidgin is also observed in Hawai‘i English (Kirtley et al. forthcoming).[137] Both the fronting of SHUTS and increased difference between FUT and

[137] This point is to be taken with some caution, as the behavior of FOOT was not a primary focus of Kirtley et al.

SHUTS over time parallels a phonological system that is more similar to that of English. As such, these changes are likely the result of long-standing and sustained contact with English in Hawai‘i.

Though the fronting of SHUTS over time is likely due to English contact, it is interesting to note that while mainstream GOOSE fronting on the American mainland (cf. Koops 2010) is commonly led by females, no evidence of a gender disparity arises in the motion over time of any of the high back vowels for Pidgin speakers. This lack of a gender disparity is at the very least noteworthy in Pidgin, as it is so common in many varieties of English. In Hawai‘i English, it is clear that young female speakers exhibit fronted GOOSE and GOAT (Simpson et al. 2014); however, no analysis of male speech has been undertaken in the same way, thus making generalizations between Pidgin and Hawai‘i English vowel systems along these lines difficult. General observations about the lack of gender differences in Pidgin are discussed more completely in §8.

Despite the trajectory and temporal differences that arise between FUT and SHUTS, it is clear from the preceding analysis that spectral overlap of the two vowel categories has a connection in production with “Pidgin-ness”. There is a significant decrease in FUT-SHUTS Pillai scores as PDM score increases for both BC and IV speakers, suggesting that an increased use of Pidgin morpho-syntactic markers is associated with more spectrally overlapped FUT and SHUTS. Though IV speakers exhibit a FUT that is less similar to SHUTS than BC speakers, the similarity between these two vowels still appears to increase as PDM score increases, indicating that even for young speakers (who exhibit the highest overall PDM scores) this pattern holds. This same finding is equally true for SHCHRIT-STIK vowel pairs (see §4.2). These findings suggest that a speaker may use spectral overlap between FUT-SHUTS and STIK-SHCHRIT as stylistic variables to index “Pidgin-ness”, or at the very least, to indicate that Pidgin is being spoken (as opposed to English).[138] However, in order to answer more refined questions of when and under what circumstances stylistic variables are employed by Pidgin speakers, further research needs to be undertaken.

In comparison with other high back vowels, JOK exhibits remarkable stability over age group and phonological environment in terms of midpoint value. Only pre-nasal environments motivate significantly different midpoint values in the vowel. This stability is noteworthy, given the pattern of fronting that GOAT exhibits across the English-speaking world, especially in post-coronal position (see, e.g., Labov et al. 2006: 153-155). This fronting is also found in Hawai‘i, even as GOAT is described as being more monophthongal than elsewhere in the United States (Drager et al. 2012; Kirtley et al. forthcoming). Simpson et al. (2014) identify that GOAT fronting in post-coronal positions occurs in the speech of young Hawai‘i English speaking females. However, the same fronting does not appear to be characteristic of JOK for Pidgin speakers, despite the fronting over time that SHUTS exhibits. There are, I believe, two possibilities for why JOK remains so stable over time. First, Pidgin vowels may simply be realized similarly to English vowels, where SHUTS is somewhat fronted and JOK is relatively conservative in a mid-back position. In fact, a conservative GOAT vowel with relatively fronted or centralized GOOSE is found in the English of New England, the Inland North, and the North Central (Labov 2001: 479), and this pattern also appears to be characteristic of Hawai‘i English (Simpson et al. 2014).[139] That JOK in Pidgin exhibits no apparent fronting may simply be due to the fact that GOAT in Hawai‘i in general is not particularly fronted. Second, it may be that JOK carries some social meaning which

[138] Of course it is impossible in the context of this study to isolate the specific meanings associated with overlapped FUT-SHUTS tokens. “Pidgin-ness” may just be one aspect of the indexical field (cf. Eckert 2008) associated with this particular phonetic variable.

[139] A fronted GOOSE and a conservative GOAT also typifies the English spoken in many parts of Canada, though GOOSE in these varieties is often much more fronted (Labov 2001: 478).

prevents it from participating in the fronting that is taking place to some extent in Hawaiʻi English. Simpson (2013, 2014) and ongoing work by Hannah Rosenberg-Jones suggests that a backer and more monophthongal /o/ increases the perception that a speaker is local, relaxed, and went to public school.[140] It is therefore possible (and, in my view, likely) that a back JOK vowel in Pidgin might carry a similar meaning.

There remains a question as to why PDM score has a lowering effect on the F1 of JOK for BC speakers. It is not immediately clear why this may be, but it is possible that a lowered /o/ vowel in general in Hawaiʻi may index Localness. Simpson et al. (2014) find that young female speakers of Hawaiʻi English exhibit a change in apparent time, where younger speakers produce a lower GOAT vowel than older speakers. In their discussion about avenues for future research, Simpson et al. suggest that a backed /o/ vowel may have some connection with Localness.[141] That low JOK is correlated with high PDM scores in Pidgin in the current data suggests the possibility that the height of /o/ may also be tied in some way to Localness, as speaking Pidgin is often closely tied to Local identity (Kawamoto 1993; Roberts 2004). Furthermore, this lowering effect appears in both Pidgin speakers and Hawaiʻi English speakers (albeit in slightly different ways), suggesting that the lowering of /o/ in Hawaiʻi—whether in Pidgin or Hawaiʻi English—may be linked to Local identity. As with other observations regarding vowels and their connection to Local identity, this remains an open question worthy of future research.

[140] To my knowledge, there was nothing in the stimuli created by Rosenberg-Jones or Simpson which precluded the possibility that listeners believed they were listening to Pidgin instead of English (though ‘it was a good show’, the carrier sentence used in Rosenberg Jones’ stimuli was not particularly basilectal at the very least). It is in fact possible that a backed, monophthongal /o/ in general (regardless of knowledge of whether someone is speaking Pidgin) is highly correlated with these perceptions. This remains an open question.

[141] Simpson et al. (2014) also suggest that a lowered /o/ in Hawaiʻi English may have some impact on the low back vowels in Hawaiʻi English. It is unknown whether the lowered GOAT of young female Hawaiʻi English speakers is in a similar space as older speakers’ THOUGHT. In Pidgin, it appears that as PDM score increases, the distance in F1 between JOK and TAWK decreases for BC speakers more obviously than IV speakers (see §6.2.3), but the two vowel classes remain distinct.

CHAPTER 6

LOW BACK VOWELS LAT, TAWK, & STAF

This chapter addresses the behavior of the low back vowels LAT, TAWK, and STAF. Each of the low back vowels is characterized by a relatively high F1 and a low F2. In Sakoda and Siegel (2008), LAT and TAWK are described as rounded in the basilect and LAT is described as unrounded in the mesolect. STAF by contrast is always unrounded and either merged with LAT or distinct from both LAT and TAWK. TAWK is described as rounded and variably merged with LAT (see Sakoda & Siegel 2008: 224). In total, this study analyzes data from 854 tokens of LAT, 552 tokens of TAWK, and 798 tokens of STAF. Each vowel is discussed individually, with attention paid to the behavior of each low back vowel relative to other low back vowels. At the end of the chapter, a discussion of the findings places each vowel in context.

6.1. LAT

The existing literature describes LAT in Pidgin as LAT low and back in the vowel space. In English, LOT is derived from Middle English /ɔ/ (Labov et al. 2006). In Pidgin, LAT is described as being in one of three relationships with surrounding low back vowels: 1) it is realized the same as STAF and distinct from TAWK; 2) it is realized the same as TAWK and distinct from STAF; 3) it is realized as distinct from both TAWK and STAF (Bickerton & Odo 1976; Sakoda & Siegel 2008: 222-224). The current dataset shows that in Pidgin, words with initial /w/, which can appear in either the LOT or THOUGHT lexical set in English depending on the dialect and speaker (e.g., *watch*, *want*; see Labov et al. 2006: 168), tend to fall within the LAT lexical set in Pidgin. The following discussion addresses the behavior of LAT using the data from the current study.

6.1.1. Effects in F1 of LAT

The results from the current data demonstrate that LAT in Pidgin behaves differently depending on the language from which a lexical item is derived. Within the LAT lexical set, I include words that traditionally belong to the English lexical set PALM, which is largely reserved for foreign borrowings (e.g., *Bach, taj, mafia, lager*).[142] In Pidgin (and creoles more broadly), the argument for what constitutes a foreign borrowing is somewhat of a slippery slope, as it is possible to argue that none of the lexicon is genetically related to the creole in the same way that daughter languages are related to their mother languages. Instead of focusing on lexical classes reserved for borrowings, it makes more sense to analyze words derived from superstrate languages separately from words derived from substrate languages. That substrate words may behave differently from superstrate words in Pidgin is largely founded on findings that there are substrate influences in Pidgin in terms of the patterning of morpho-syntactic elements (see, e.g., Siegel 2000). Given this, it stands to reason that words derived from a substrate language (e.g., Hawaiian, Portuguese) might be treated differently in Pidgin than words derived from the superstrate language, English. In Pidgin, a large percentage of substrate words have come from Hawaiian, including general borrowings across semantic domains (e.g., *wahine* 'girl/woman', *ali'i* 'royalty/ruler', *makamaka* 'intimate friend',[143] *pokāne* 'night walker', *āweoweo* 'Priacanthus/Hawaiian bigeye'), place names (e.g., *Kapa'a*, *Mākaha*, *Kekaha*, *Halawa*), and proper names (e.g., *Akana*, *Hokulani*). The set of substrate words which fall under the LAT lexical set may also be expanded to include words from other substrate languages, including Japanese (e.g., *hibachi* 'small cooking stove', *menpachi* 'Holocentridae/squirrelfish'), Filipino languages

[142] A small number of lexical examples in the PALM set derive from Anglo-Saxon <al, a#, ah> spellings (e.g., *balm, calm, psalm, father*). It should also be noted that Wells also finds this class to be less coherent than other lexical sets (cf. Wells 2010).
[143] This is roughly the word's meaning in Hawaiian; in Pidgin the phrase *hai makamaka* 'high makamaka' generally indicates that a person is stuck up or stuffy.

(e.g., *achiote* ‘Bixa orellana/annatto’, *pancit* ‘noodles’, *kumadre* ‘female sponsor in baptism, confirmation or marriage of one’s child’), and Portuguese (e.g., *babuz* ‘buffoon/fool/idiot’,[144] *bacalhau* ‘dried and salted cod’).

In the current dataset, there are 214 substrate words out of the total 854 tokens of LAT, and the vast majority of substrate words (172, or, 80%) are of Hawaiian origin. Given that the vast majority of words in the substrate class come from Hawaiian, it is problematic to subset and compare the class of substrate words according to each individual languages of origin (e.g., Hawaiian vs. Portuguese words, where Portuguese words comprise a mere two examples). However, there is a large enough class of Hawaiian-derived words to test whether they behave differently than superstrate-derived LAT tokens.[145] In fact, there is reason to expect vocalic variation involving LAT that is conditioned by whether a word is derived from Hawaiian. In short-long pairs (i.e., /a/ vs. /a:/), Hawaiian also exhibits a quality difference. The longer vowel is realized as [ɑː] and the shorter is realized as [ɐ] (Schütz 1981; Pukui & Elbert 1986). All examples of Hawaiian-derived words in LAT for the current data were short. Analysis of the current LAT data suggests that Pidgin speakers treat Hawaiian words differently from other words. Hawaiian-derived words for young IV speakers are realized as slightly higher in the vowel space than other tokens of LAT. Figure 6.1.1 demonstrates this in density plots that compare English-derived words to Hawaiian-derived words (all other substrate words not included). The plots show that there is nearly complete overlap between the density peaks of LAT in Hawaiian-derived words and English-derived words produced by the three older groups of speakers. However, young IV speakers exhibit a bimodal distribution, where LAT in Hawaiian-

[144] This is the Pidgin spelling (see Appendix A for Odo Orthography) of the Portuguese word *bobo* ‘buffoon’. Sakoda and Siegel (2008: 220) spell this as *babooz.*

[145] Other lexical sets also included Hawaiian words (e.g., HAUS, PRAIS, SHCHRIT), but no other lexical set had a large enough sampling of Hawaiian words to reliably compare their behavior against English-derived words.

derived words is realized as higher than LAT in English-derived words. Of the 42 Hawaiian words that occur in the speech of young IV speakers, 30 of them (or 71%) are place names (e.g., *Kekaha*).[146] However, as figure 6.1.3 demonstrates, young IV speakers do not exhibit radically different density peaks for Hawaiian place names and other Hawaiian words (e.g., *aliʻi*).

That Hawaiian words exhibit a higher midpoint in LAT than English words is corroborated by a linear mixed-effects model fit to normalized midpoint F1 values of LAT in young IV speakers (excluding words from other languages) with gender, whether a word derives from Hawaiian, and speech rate as predictors (table 6.1.1). The model demonstrates a significant main effect of Hawaiian-derived words, signifying that LAT in Hawaiian-derived words is higher than it is in all other LAT tokens. While this difference is not necessarily large enough to suggest that LAT in words of Hawaiian origin constitute a distinct lexical set, it is evident that young IV speakers distinguish Hawaiian words from the general class of English-derived LAT words in production. There is also a main effect of gender, indicating that males produce lower realizations of LAT than females. This gender effect will be discussed further in §6.1.2.

[146] It might be expected that place names would differ in some way from other words, as place names often occupy an important role in the construction of linguistic landscapes (see Gorter 2006).

Figure 6.1.1. Density plot of normalized F1 midpoint of LAT words derived from Hawaiian vs. all other tokens of LAT across age groups.

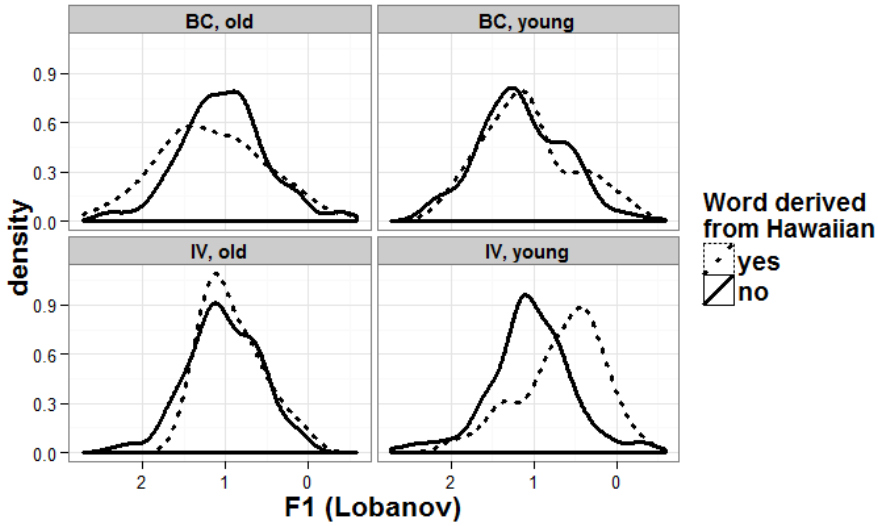


Figure 6.1.2. Density plot of normalized F1 midpoint of LAT place names derived from Hawaiian vs. all other Hawaiian-derived words.

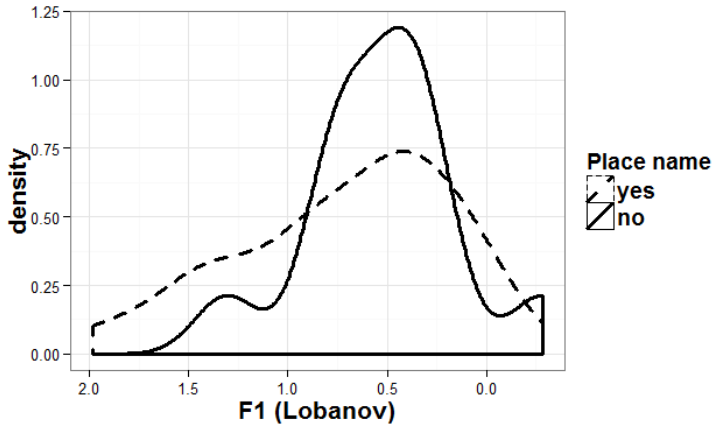


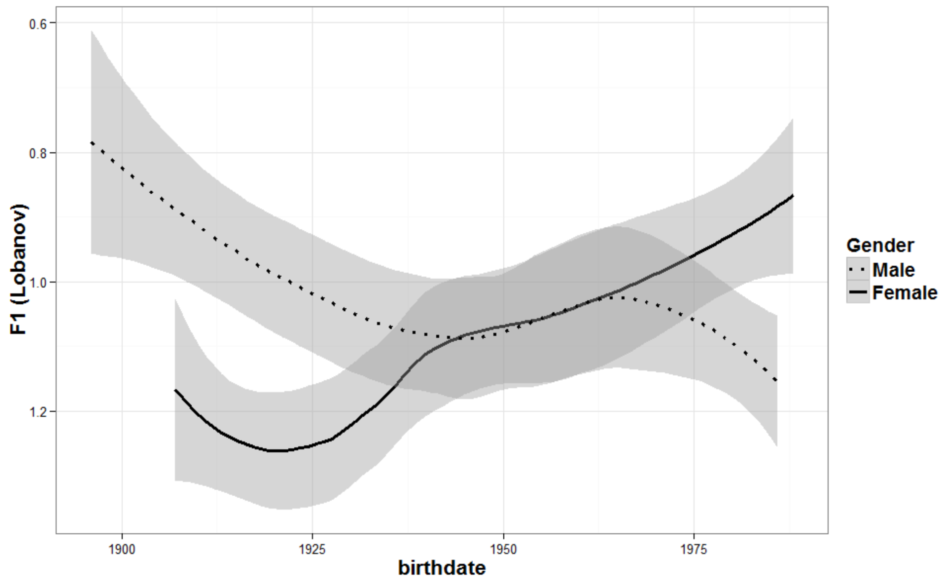
Table 6.1.1. Lmer model fit to normalized F1 midpoint values of LAT for young IV speakers, with Hawaiian word, gender and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.23056	0.22964	5.359
Hawaiian word=yes	-0.31153	0.09385	-3.319
gender=male	0.26505	0.10447	2.537
speech rate	-0.09098	0.05255	-1.731

6.1.2. Raising of LAT

The remainder of the analysis of the F1 of LAT is fit only to non-Hawaiian words, as findings in §6.1.1 demonstrate that Hawaiian-derived words impact the height of Pidgin LAT. The results from the current data demonstrate that LAT exhibits principled movement over real time but only for females. Figure 6.1.3 demonstrates this raising with birthdate plotted on the x-axis. The oldest females exhibit a lower LAT vowel, and LAT exhibits higher midpoints over each age group. For speakers born between 1930 and 1975, LAT exhibits the same height in female speakers as male speakers. By the youngest group of speakers (i.e., those born after 1975), female realizations of LAT are both higher than those of males and higher than any other age group. Males, on the other hand, exhibit a lowering pattern over time. This is especially the case in the youngest age group, such that the youngest males produce lower mean values of LAT than their female counterparts. The general pattern appears to be one where males produced higher LAT than females until about 1930, and those born between 1930 and 1975 raised LAT slightly, but males and females produced relatively equivalent LAT tokens in terms of F1. In the youngest group, however, males and females differ in their pronunciations, so that females exhibit a higher position of LAT and males exhibit a lower position of LAT. It is worthwhile to note that this pattern of LAT raising is evident whether or not words of Hawaiian origin are included in the sample (see §6.1.1).

Figure 6.1.3. Smoothed mean of normalized midpoint of F1 in LAT over time for males and females.



To verify the change in the height of LAT over time in females, a linear mixed-effects model was fit to normalized F1 of LAT of all female speakers, with birthdate, gender and speech rate as predictors (table 6.1.2). There is a significant effect of birthdate, indicating that males exhibit lower realizations of LAT as birthdate increases. There is also a significant effect of gender, indicating that females exhibit generally lower realizations of LAT compared with males. Finally, there is an interaction between between birthdate and gender, indicating that older females produce higher realizations of LAT than younger females. LAT exhibits no noticeable differences in the F1 dimension as a function of phonological context.

Table 6.1.2. Lmer model fit to normalized F1 midpoint values of LAT for female speakers (excluding Hawaiian word), with age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-5.396781	3.215597	-1.678
birthdate	0.003396	0.001656	2.051
gender=female	16.213719	4.618595	3.511
speech rate	-0.055005	0.024507	-2.244
birthdate * gender=female	-0.008286	0.002370	-3.496

6.1.3. Phonological effects on F2 of LAT

The results from the current data demonstrate that the midpoint of F2 of LAT is affected by two phonological environments: post-coronal position and pre-lateral position. Figure 6.1.4 shows the F2 of LAT across three phonological contexts: post-coronal position, pre-lateral position, and all other following environments. LAT in pre-lateral environments has a slightly backer nucleus with respect to other phonological contexts. Post-coronal contexts motivate slight fronting, though this is nowhere near as marked as in other back vowels (see, e.g., §5.1). A linear mixed-effects model fit to normalized midpoint of the F2 of LAT with phonological environment and speech rate as predictors corroborates these findings (table 6.1.3). There is a significant main effect in the negative direction (indicating backing) for pre-lateral contexts in relation to "other" phonological environments. There is also a significant main effect in the positive direction (indicating fronting) for post-coronal position in relation to "other" phonological environments. The position of LAT in F2 is not conditioned by gender or age.

Figure 6.1.4. Density plot of F2 midpoint values for all examples of LAT across phonological environment.

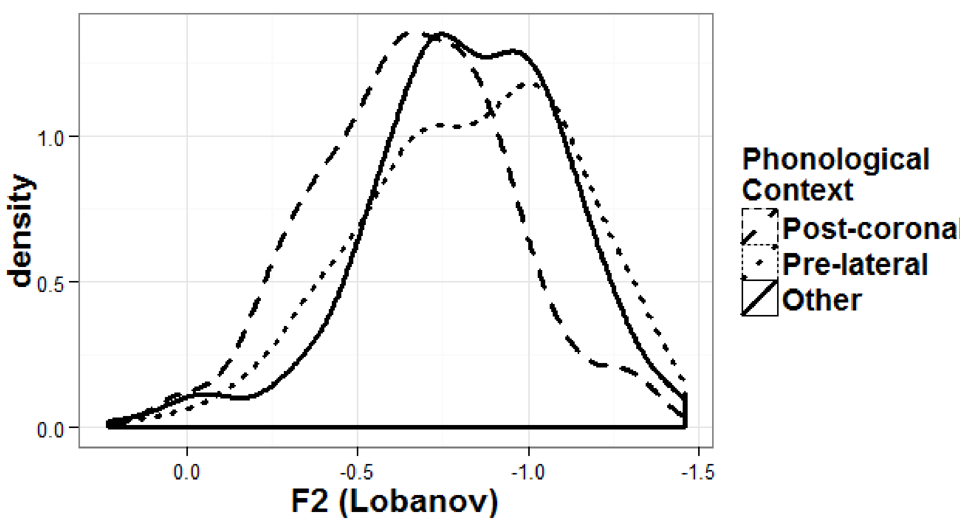


Table 6.1.3. Lmer model fit to normalized F2 midpoint values of LAT for all speakers, with phonological context and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.812823	0.052421	-15.506
phonological context=Post-coronal	0.125018	0.026321	4.750
phonological context=Pre-lateral	-0.096343	0.034325	-2.807
speech rate	0.004053	0.012199	0.332

6.1.4. Summary of LAT findings

In sum, the position of LAT is dependent on phonological context, age group, gender, and, for young IV speakers, whether a word is derived from Hawaiian. Pre-lateral phonological environments motivate lower F2 (~ backer realizations) in LAT, which is consistent with trends observed in the high back vowels (see §5). In terms of F1, there is evidence that females produce significantly higher realizations of LAT over time. Young IV females exhibit the highest variants, both overall and with respect to young IV males. Males, by contrast, appear to change very little over time, with the exception of a downward trend in the young IV group. Furthermore, young IV speakers make a unique distinction between Hawaiian words and all other words; words of Hawaiian origin are realized with a lower F1 (~ higher realizations) than all other words. Further discussion of these observations is found in §6.5. PDM score was not found to have an effect on the F1 or F2 of LAT. The trajectory of LAT was not found to differ in any principled way across age group, gender, phonological context, or with respect to PDM score.

6.2. TAWK

The existing literature describes TAWK in Pidgin as occupying a low back position in the vowel space, generally higher and backer than LAT or STAF. In American English, THOUGHT is variably merged with and converges on the space occupied by LOT (e.g., Labov et al. 2006 *inter alia*). Based on the data from the current study, TAWK in Pidgin includes words that also belong to the English lexical set CLOTH, a lexical set which is predictable based on following phonological context.[147] However, this set reliably maps on to TAWK in Pidgin. For the current data set, TAWK includes only two substrate words in these data: the proper name *Long* and the Japanese word *bon (dance)*. For many of the Pidgin speakers in the current data, the pronunciation of TAWK exhibits a noticeable offglide, though not to the extent of some East-coast American mainland dialects, such as New York and Philadelphia (Gordon 2004). The current study shows that TAWK changes its position over age group; however, pre-lateral TAWK behaves differently than TAWK in other phonological contexts. As a result, pre-lateral TAWK is discussed separately (§6.2.2) from TAWK in all other phonological environments (§6.2.1). The following discussion addresses the behavior of TAWK using the data from the current study.

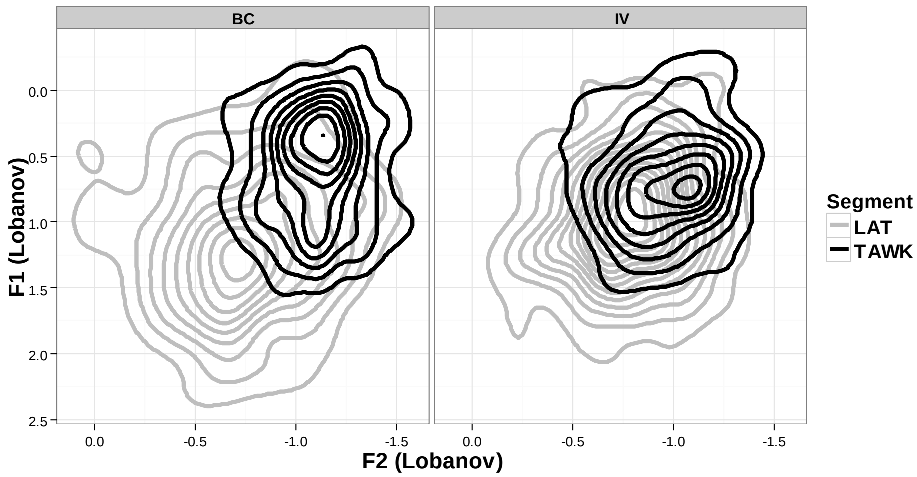
6.2.1. Change in TAWK over time: Movement towards LAT

The results from the current data demonstrate that TAWK exhibits principled movement with respect to the LAT lexical set. Figure 6.2.1 is a two-dimensional density plot of the normalized formant midpoint values for LAT and TAWK across corpus, separated by vowel identity. Immediately clear is that TAWK occupies a high and back position relative to LAT in both corpora, suggesting that for Pidgin speakers, TAWK forms a separate lexical class from LAT. However, there are noticeable differences between the two plots. TAWK for IV speakers occupies a fronter position relative to BC speakers. Realizations of TAWK for BC speakers are centered to the right of -1 in the F2 dimension and above 0.5 in the F1 dimension, while realizations of TAWK for IV speakers are centered on -1 in the F2 dimension, and below 0.5 in the F1

[147] CLOTH includes words where the vowel occurs before fricatives, and where that word patterns with THOUGHT in General American English (Wells 1982: 136). Generally speaking, a THOUGHT-CLOTH distinction is atypical of American English dialects.

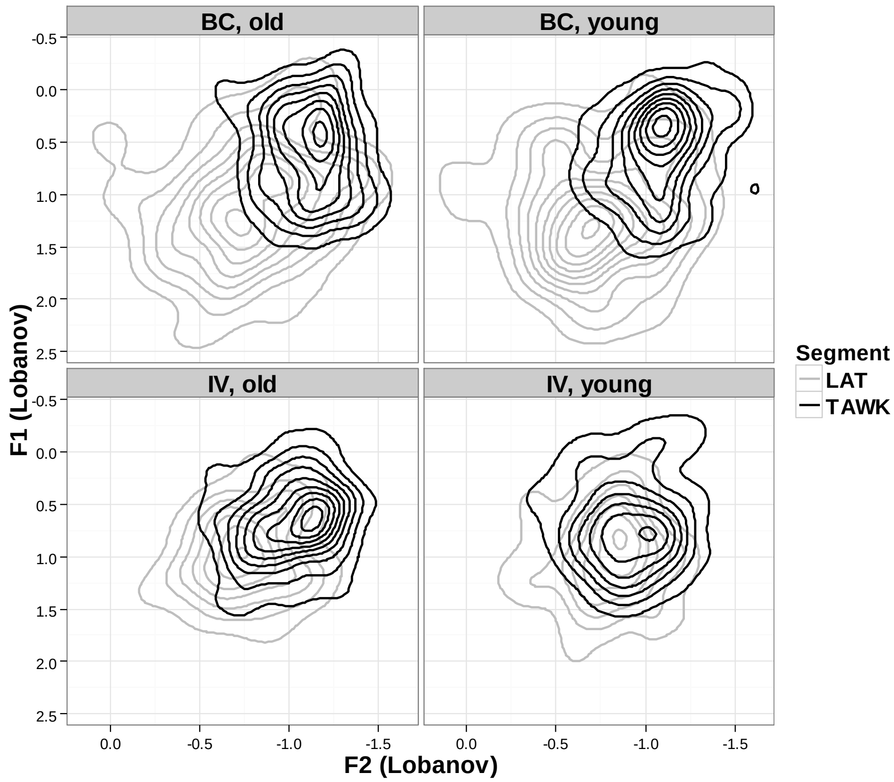
dimension. This difference between the two corpora suggests a change in real time, where TAWK has begun to front and lower into the space occupied by LAT.

Figure 6.2.1. 2-d density plot of normalized midpoints of LAT (gray) and TAWK (black), separated by vowel identity and corpus.



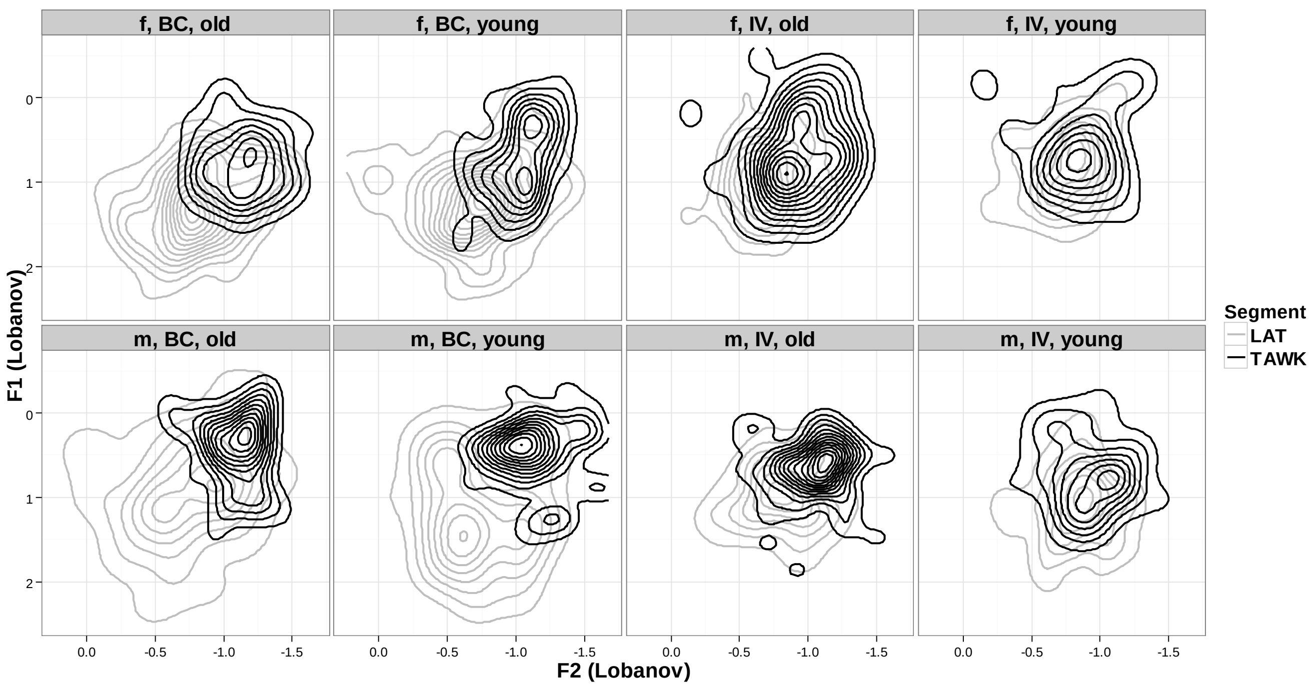
This change over time is also observable in apparent time when each corpus is divided into relatively younger and older speakers. Figure 6.2.2 is a two-dimensional density plot of the distribution of LAT and TAWK across corpus and relative age, excluding pre-lateral contexts, as this environment has an effect on the fronting of TAWK (see §6.2). TAWK does not obviously shift its position between old BC and young BC speakers (excluding a slightly fronter midpoint in young BC speakers that brings the center of the LAT distribution close to -1). However, old IV speakers show two major differences from BC speakers: first, the distribution of LAT in IV speakers is considerably less dispersed in space than in BC speakers; second, the distribution of TAWK has shifted to a fronter position in the vowel space in IV speakers. Furthermore, old IV speakers exhibit lower TAWK than young BC speakers; the center of the distribution of TAWK is below the 0.5 mark in F1 in old IV speakers. No obvious changes take place in F2. In young IV speakers, the center of the distribution of TAWK is considerably fronter relative to older age groups, indicated by movement across the -1 line in F2. Similar to old IV speakers, the distribution of LAT for young IV speakers also exhibits less dispersion in the vowel space.

Figure 6.2.2. 2-d density plot of normalized midpoints of LAT (gray) and TAWK (black), separated by vowel identity, corpus and age (excludes pre-lateral tokens).



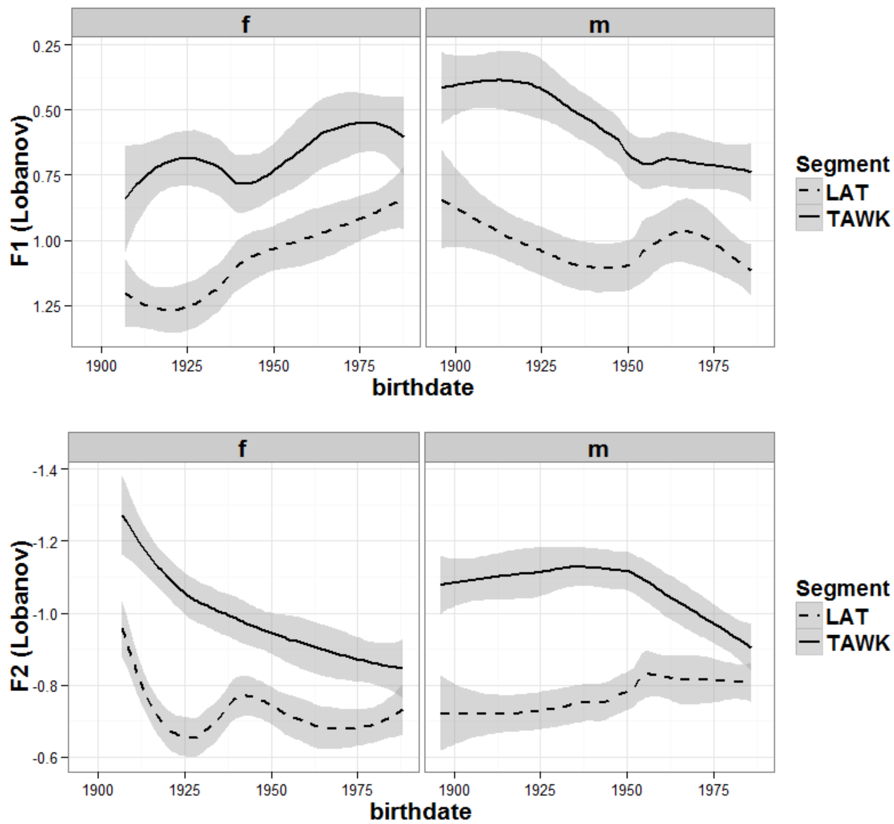
Change in the position of TAWK over time also varies across gender. Figure 6.2.3 shows this change in F2 for males and females across age groups, excluding pre-lateral environments. First, male distributions of LAT occupy more space than female distributions of LAT, and it appears that females exhibit more overlap between the two vowel categories. This is especially apparent in young BC speakers and old IV speakers. Whereas males exhibit a recognizable cluster of TAWK vowels separate from LAT, the distributions of TAWK and LAT in females are much more overlapped. Further, there is a noticeable trend where female realizations of TAWK are fronter relative to those of males. The center tendencies of the distribution of mean normalized F2 values in females is ahead of that of males for young BC, old IV and young IV speakers. Males, by contrast, move comparably little within each corpus, only exhibiting fronter distributions of TAWK across corpora.

Figure 6.2.3. 2-d density plot of normalized F1/F2 midpoint of TAWK (pre-lateral environments excluded) across age group for males and females.



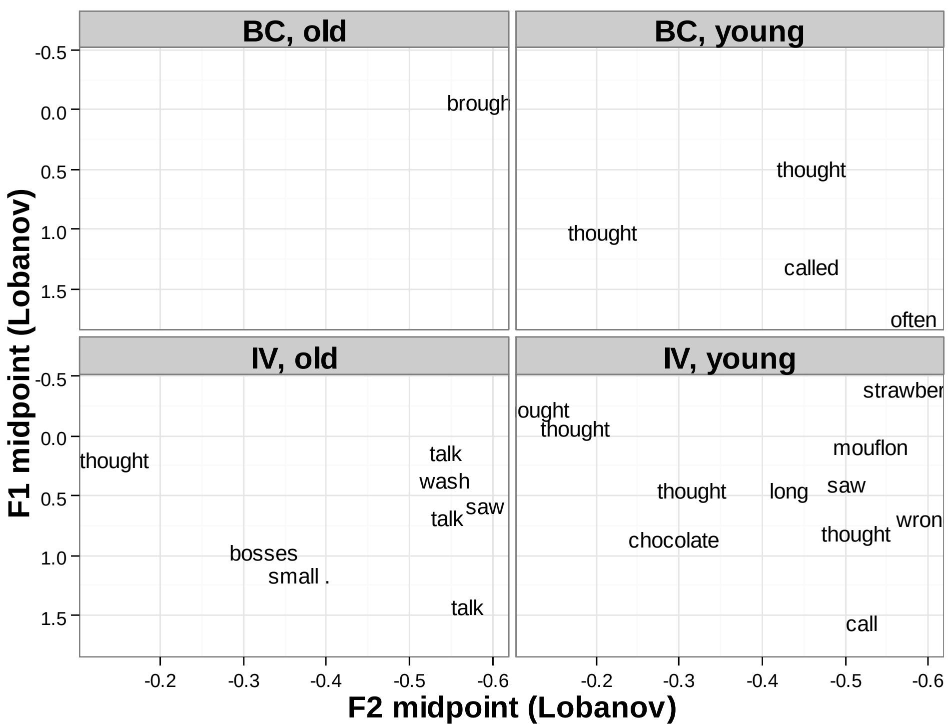
The tendency towards merger is particularly clear if the behavior of F1 and F2 is isolated for LAT and TAWK, separated by age and plotted against speaker birthdate (figure 6.2.4). In these graphs, lower F1 indicates a higher vowel, and lower F2 indicates a backer vowel. In F1, females exhibit a tendency towards raising TAWK over time; however, the most striking feature of the graph is the raising that takes place in LAT for females (see §6.2.1). In the youngest speakers, LAT exhibits its highest relative values, and the F1 of LAT and TAWK overlap. On the other hand, males show a slight tendency to lower TAWK and LAT over time, and both vowels appear to exhibit similar patterns over time. In F2, both males and females exhibit fronter realizations of TAWK with respect to LAT as a function of age. While this trend is more clearly evident in females, both genders exhibit similar trends towards fronting. This trend is most pronounced in the youngest speakers, as the youngest group of males and females show the greatest similarity between the F2 of LAT and TAWK.

Figure 6.2.4. Smoothed mean of normalized midpoint of F1 (top) and F2 (bottom) in LAT and TAWK (pre-lateral environments excluded) over time for males (right) and females (left).



The frontest realizations of TAWK appear to be primarily those in post-coronal environments. Figure 6.2.5 plots all tokens of TAWK which exceed -0.6 in the F2 dimension following normalization. These words represent the frontest tokens for all speakers. BC speakers exhibit relatively few tokens of TAWK in this window, and two of the five tokens are found in the word *thought*. By comparison, IV speakers produce considerably greater numbers of tokens past the -0.6 threshold, with all but four tokens in post-coronal environments (*bosses* and *wash* in the old IV speakers, and *mouflon* and *call* in young IV speakers).[148] When evaluated auditorily, the frontest vowels in these age groups appear to retain their rounded qualities. The notable exceptions to this are the instances of *thought* (Lani) and *bosses* (Kahea) in old IV speakers and *chocolate* (Myko),[149] *strawberry* (Mina), *mouflon* (Myko), and the two frontest instances of *thought* (Mina and Lena) in young IV speakers.[150] In these particular examples, the vowel in the lexeme in question is unrounded and is perceptually no different from LAT for each of these speakers. However, it is also important to note that for some words, pairs exist with both rounded and unrounded pronunciations. For example, Myko's pronunciation of *mouflon* in figure 6.2.5 is unrounded; however, Myko produces other instances of this word that are distinctly backer and rounder. This suggests that a shift towards unrounded LAT does not occur for all instances of the word.

Figure 6.2.5. Words with the frontest realizations of TAWK by age group.



148 TAWK occurs in the second syllable of *mouflon* ('wild sheep') (i.e., [mũˈflɔ̃n]).
149 For other Pidgin speakers, the first syllable of *chocolate* may also be pronounced with LAT.
150 As a reminder, all names are pseudonyms.

The observations regarding the fronting of TAWK as a function of age and gender are corroborated by a linear mixed-effects model fit to normalized F2 midpoints of TAWK realizations (excluding pre-lateral environments), with age group, gender and speech rate as predictors. Table 6.2.1 shows a significant main effect of age for old and young IV speakers, indicating that these two age groups produce fronter realizations of TAWK than old and young BC speakers. This effect is most noticeable in the young IV speakers. There is no effect of gender, but the results from the model corroborate that females produce very slightly (though not significantly) fronter realizations of TAWK than males (see figure 6.2.3). An identical model was fit to normalized F1 of TAWK, but no main effects surfaced, suggesting that speakers do not significantly alter the height of TAWK over age group.[151]

Table 6.2.1. Lmer model fit to normalized F2 midpoint values of TAWK (excludes pre-lateral realizations) for all speakers, with age group, gender and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.23698	0.07545	-16.395
age=young BC	0.04757	0.06046	0.787
age=old IV	0.12886	0.06116	2.107
age=young IV	0.19027	0.06257	3.041
gender=female	0.04443	0.04331	1.026
speech rate	0.02236	0.01600	1.398

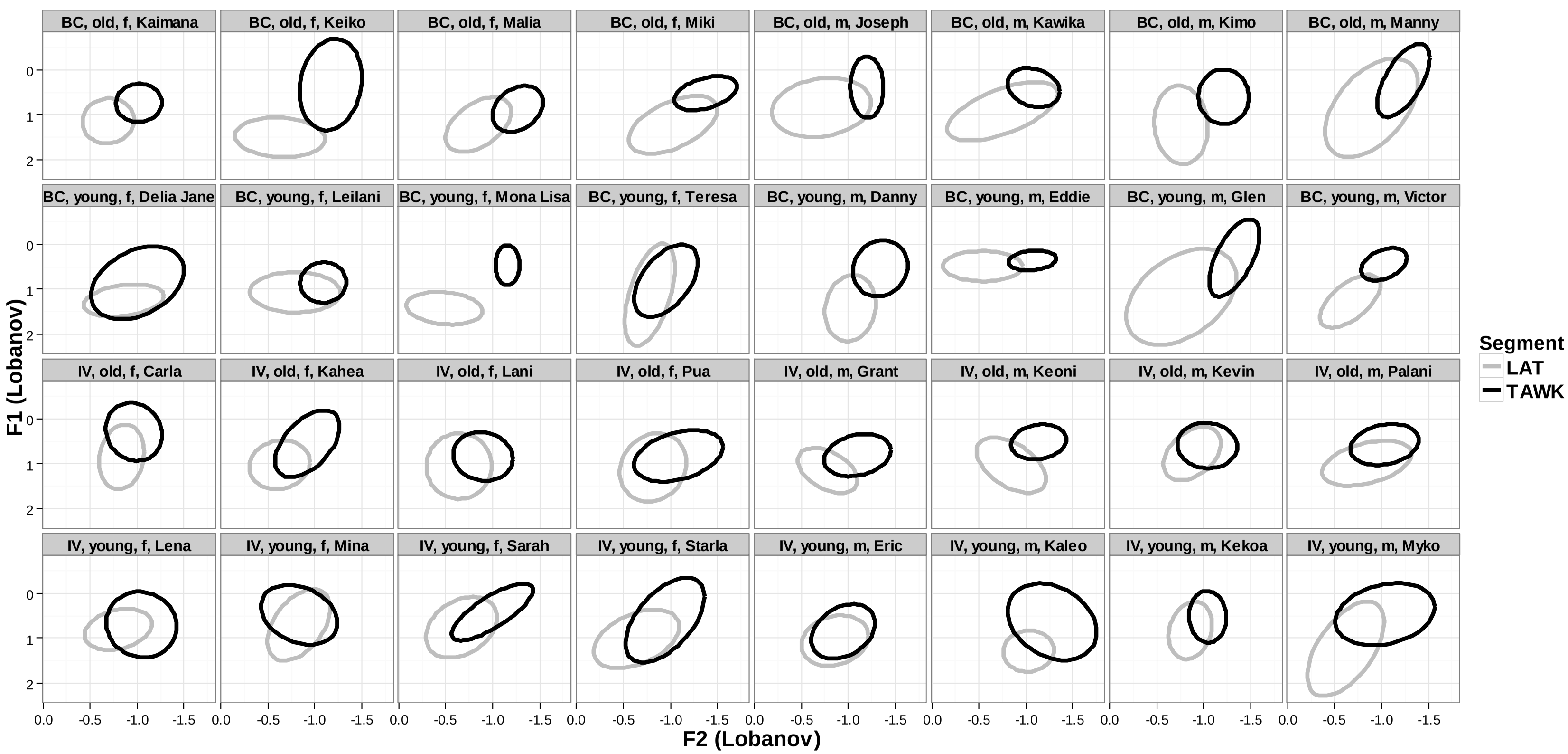
Even given these larger trends, speakers demonstrate individual variation with respect to how and whether they exhibit the merger between LAT and TAWK. Figure 6.2.6 depicts the distribution of LAT and TAWK with ellipses representing 95% confidence intervals for each speaker used in this study. From analyzing this plot, there are two distinct patterns that old BC speakers exhibit with respect to distribution size and orientation of LAT and TAWK. First, the vowel classes LAT and TAWK may exhibit similarly sized distributions, but occupy separate

[151] Old IV speakers (t = 1.022) and young IV speakers (t = 1.100) showed lower realizations, but the effect sizes suggested this difference was not significant.

places in the vowel space. This pattern is followed by the old BC speakers Kimo, Kaimana, Keiko and Malia. In the second kind of pattern, speakers may exhibit a TAWK distribution that is restricted to a much smaller region towards the back of the space occupied by LAT. This pattern is exemplified by old BC speakers Joseph, Kawika, Manny, and Miki. Even in cases where relatively high overlap is evident, such as with Manny, the position of the distributions is different enough to constitute separate vowel classes. Young BC speakers largely seem to follow these two patterns; however, two speakers, Delia Jane and Teresa, exhibit overlapping distributions of LAT and TAWK. Teresa's vowel distributions appear the most overlapped, as the orientation and size of LAT and TAWK appear to be roughly equal. Delia Jane, on the other hand, exhibits a broader distribution of TAWK realizations, which is not due to any obvious phonological or lexical effects. The LAT-TAWK overlap characterized by Delia Jane and Teresa may be described as a third type of pattern, one which is exemplified by a large degree of overlap and, often, a broadening of the range occupied by TAWK as opposed to a shrinking of the range occupied by LAT. Old IV speakers appear to extend these same patterns to their next logical steps, and speakers generally produce more overlap of LAT and TAWK than that exhibited by either of the BC speaker age groups. In fact only three speakers from the IV corpus, all of them male, Keoni, Grant, and Palani, show less than 50% overlap between both LAT and TAWK. For all other speakers, the size of the distribution of LAT and TAWK are quite similar, and the vowels' distributions are in closer proximity than what is observed in BC speakers. Young IV speakers show the greatest amount of similarity between LAT and TAWK distributions, and it is clear that not only are the two vowels similar in orientation, they are also similar in distribution. Five speakers, Lena, Mina, Sarah, Eric and Alika, exhibit almost complete overlap of the two vowel classes, indicating a nearly or completely merged LAT-TAWK. Only Kaleo, Myko and

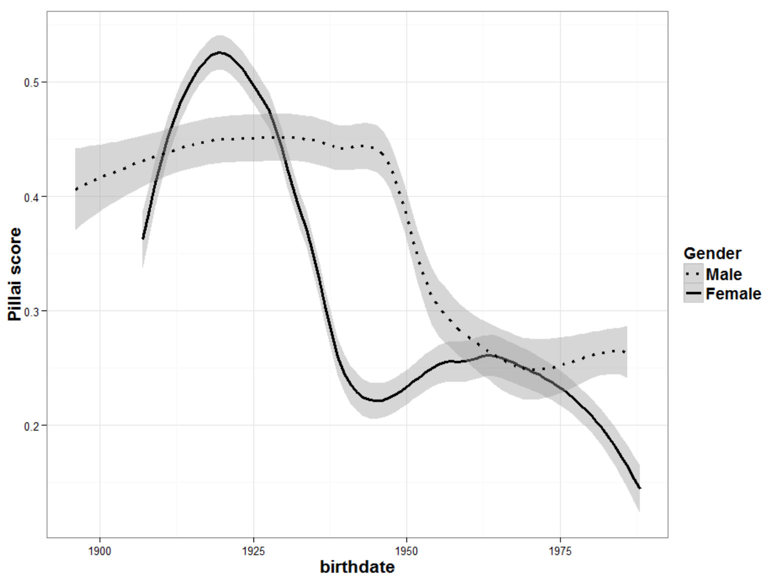
Starla exhibit seemingly distinct LAT and TAWK. Thus, while the overall population of young IV speakers does not show a complete merger between these two low back vowels, certain speakers appear to have already merged (or nearly merged) the two vowels.

Figure 6.2.6. Individual speaker plots for normalized midpoint F1 and F2 values of LAT (gray) and TAWK (black) organized by corpus, age and gender.



As a further measure of the similarity between LAT and TAWK, each speaker's LAT and TAWK were compared using Pillai scores derived from a MANOVA to quantify the degree of overlap between the two vowel classes as a single value. Figure 6.2.7 is a graph of the Pillai scores output by the MANOVA plotted against birthdate. Smaller Pillai scores indicate a greater tendency towards merger. From this graph, it is evident that both males and females exhibit less of a distinction between LAT and TAWK over time, a pattern which appears to be in line with the behavior of individuals in figure 6.2.6 as well. However, females begin to exhibit smaller Pillai scores earlier than males. Furthermore, while males exhibit little change in Pillai score from approximately 1960 to 1986, females continue to exhibit smaller Pillai scores. This suggests that females are merging (or, trending towards merging) LAT and TAWK more than males.[152]

Figure 6.2.7. Smoothed mean of Pillai scores of LAT-TAWK plotted against birthdate for males (dotted line) and females (solid line).



[152] Because it is a measurement based on production and not perception, the Pillai score cannot distinguish between a complete and near-merger (see §3.5.3 for a discussion of the limitations of Pillai scores).

These observations are corroborated by a linear fixed-effects model fit to Pillai score, with gender, age group and speech rate as predictors.[153] Table 6.2.2 shows a significant main effect of gender, and old and young IV speakers, indicating that females, as well as old and young IV speakers, produce smaller Pillai scores (or, more overlapped LAT and TAWK distributions).

Table 6.2.2. Linear fixed-effects model fit to speaker Pillai score of LAT-TAWK for all speakers, with age group, gender, and speech rate as predictors.

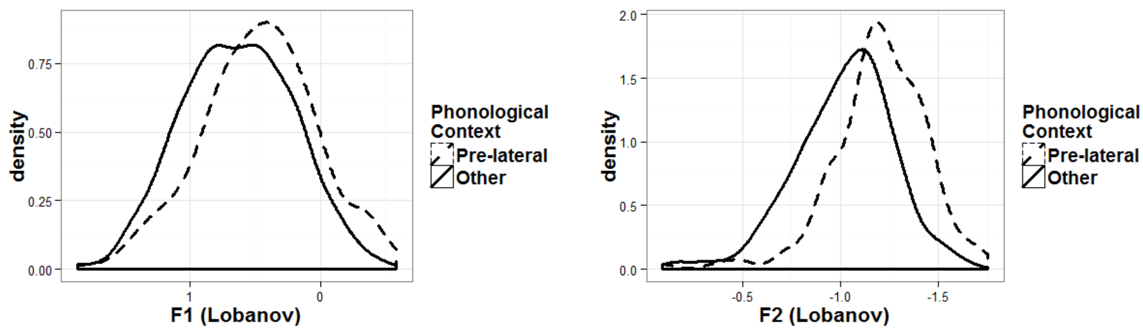
	Estimate	Std. Error	t value
(Intercept)	0.483805	0.021222	22.798
age=young BC	0.008868	0.011504	0.771
age=old IV	-0.126014	0.012078	-10.434
age=young IV	-0.186373	0.011829	-15.756
gender=female	-0.050879	0.008255	-6.163
speech rate	-0.012516	0.005523	-2.266

6.2.2. Effect of /l/ on TAWK

The results from the current data demonstrate that the only phonological environment to have a significant impact on the position of TAWK is when the vowel is in pre-lateral position (n=159). Figure 6.2.8 demonstrates this effect in both F1 and F2. TAWK occupies a distribution that is shifted to the right in both graphs, indicating that pre-lateral TAWK is both higher and backer than TAWK in other phonological environments. The effect in F1 is somewhat more subtle than the effect in F2.

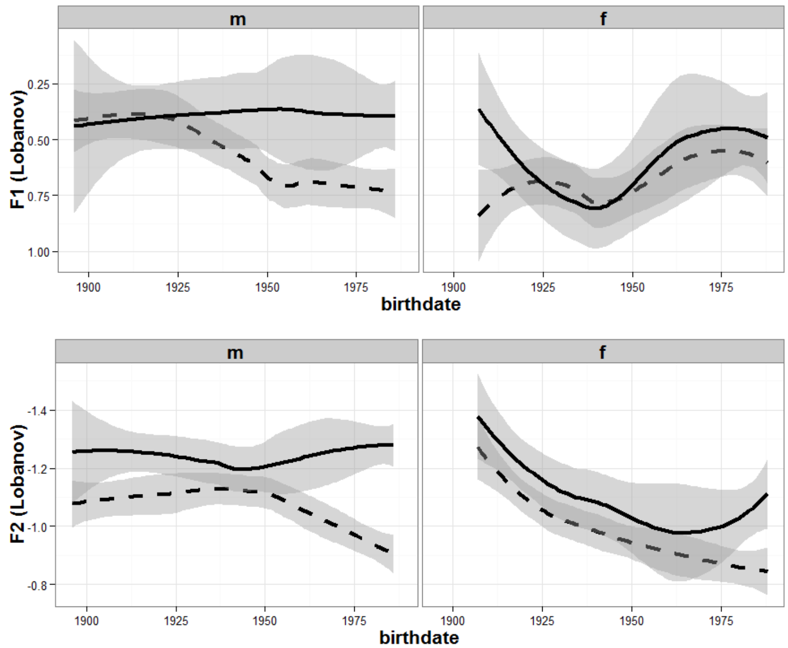
[153] Speech rate is a significant predictor in the model reported in table 6.2.2. This raises an interesting question. In a speech community where two vowels are variably merged (e.g., Pidgin speakers in Hawai‘i), it is certainly possible that speech rate (or, vowel duration more generally) might increase the likelihood for merger, given the tendency for vowel centralization (or, undershooting formant targets) in some languages (cf. Lindblom 1963; Gay 1968). However, I know of no work that corroborates this possibility. It is also quite possible that speech rate and tendency toward vowel merger are independent phenomena, meaning that including speech rate as a predictor in the model would serve no diagnostic purpose. The reported effect is also quite small, suggesting the possibility that a more rigorous statistical model would not return a significant effect of speech rate.

Figure 6.2.8. Density plot of F1 (left) and F2 (right) midpoint values for all examples of TAWK in pre-lateral position.



As reported in §6.2.1, pre-lateral environments motivate a higher, backer position in TAWK relative to other phonological environments. This environment can also be demonstrated to have an effect over time and across gender. Figure 6.2.9 separates pre-lateral TAWK realizations from all other TAWK realizations, and graphs formant movement for males and females in both phonological environments over birthdate. These plots demonstrate that pre-lateral environments have an effect on both the F1 and F2 of TAWK that manifests differently across males and females. The general pattern is that pre-lateral environments inhibit the fronting and lowering of TAWK, especially in younger speakers. However, pre-lateral environments inhibit motion in both formant dimensions in males, but only in F2 for the youngest females. Male F1/F2 values for TAWK in pre-lateral contexts remain constant over all age groups, even as F1 and F2 changes in the non-pre-lateral TAWK of relatively younger speakers. On the other hand, female pre-lateral TAWK appears largely to follow the fronting pattern that characterizes TAWK in general. However, the youngest group of females (i.e., young IV females) appears to reverse this pattern in F2; pre-lateral TAWK shows a slight upturn, signifying that the vowel may be backer in this age group. No change appears to take form in female pre-lateral TAWK in F1 over time, though it is worth noting that the trajectory of change in F1 for TAWK in females is quite a bit different than it is for males. Specifically, pre-lateral TAWK for females is lower for older females in comparison to older males.

Figure 6.2.9. Male (left) and female (right) smoothed mean F1 (top) and F2 (bottom) values over birthdate in TAWK with pre-lateral environments separated (solid line).



These effects of pre-lateral environments are corroborated by separate linear mixed-effects models fit to normalized F1 and F2 midpoint values of TAWK in pre-lateral environment, with age group, gender and speech rate as predictors. Table 6.2.3 shows a significant main effect of gender on the F1 of TAWK, indicating that females produce significantly lower TAWK in pre-lateral environments than males. Table 6.2.4 demonstrates a similar trend in F2, where females produce slightly fronter realizations of the vowel, though the difference is not significant (t=1.582). No significant changes take place over time in the F1 of pre-lateral TAWK.[154] Furthermore, unlike TAWK in all other phonological environments, pre-lateral TAWK does not change over age group in F2 (compare table 6.2.4 and table 6.2.1). Therefore, while TAWK fronts

[154] Though tangential, it is worth noting that speech rate also has a near-significant impact on the height of TAWK, but virtually no effect on the frontness of TAWK. This result suggests that as talkers increase their rate of speech, they also are more likely to raise pre-lateral TAWK. Though interesting, any further discussion of this result must be relegated to a more systematic study of speech rate and vowel position.

over time, pre-lateral environments inhibit this fronting, especially for males, who show a clearer split in both F1 and F2 between TAWK in pre-lateral environments and all other instances of TAWK.

Table 6.2.3. Lmer model fit to normalized F1 midpoint values of TAWK in pre-lateral environments for all speakers, with age group, gender and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.66493	0.18580	3.579
age=young BC	0.11884	0.10047	1.183
age=old IV	0.08062	0.12557	0.642
age=young IV	0.03915	0.09359	0.418
gender=female	0.17342	0.07375	2.351
speech rate	-0.08416	0.04729	-1.780

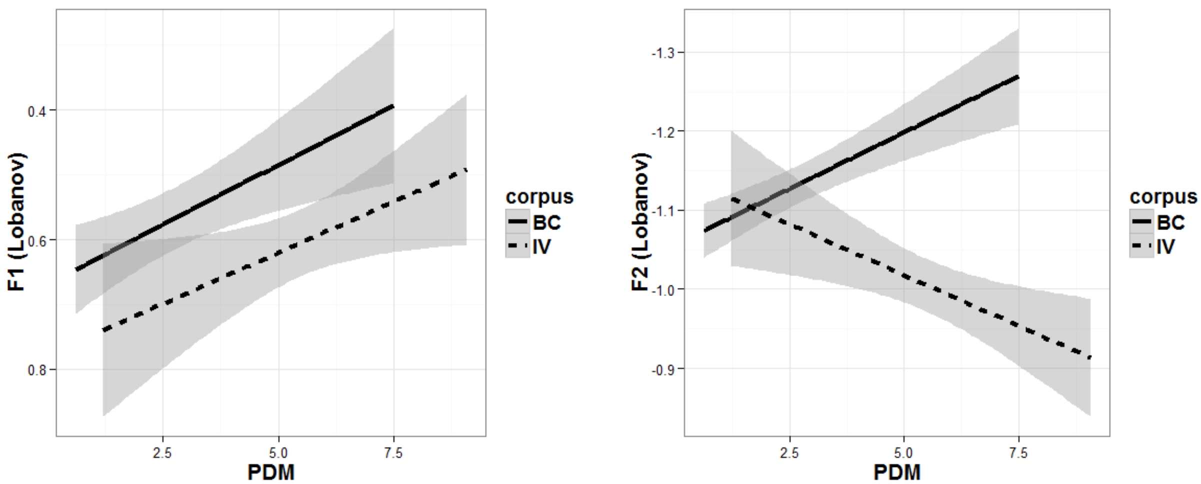
Table 6.2.4. Lmer model fit to normalized F2 midpoint values of TAWK in pre-lateral environments for all speakers, with age group, gender and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.33390	0.09934	-13.428
age=young BC	0.11909	0.06857	1.737
age=old IV	0.12280	0.08089	1.518
age=young IV	0.09136	0.06770	1.349
gender=female	0.08032	0.05076	1.582
speech rate	-0.00333	0.02227	-0.150

6.2.3. Effect of PDM on TAWK

The results from the current data demonstrate that PDM plays a role in the realizations of TAWK for both BC and IV speakers. Figure 6.2.10 shows the mean normalized F1 and F2 of TAWK for IV and BC speakers plotted against PDM score. The left plot shows that for both BC and IV speakers, realizations of TAWK are more likely to be articulated toward the higher portion of the distribution of TAWK vowels (~exhibit lower F1) if they exhibit higher PDM scores. The right plot shows that in F2, IV speakers do something different from BC speakers. For BC speakers, realizations of TAWK are more likely to be articulated toward the back portion of the distribution of TAWK vowels (~ exhibit lower F2). However for IV speakers, higher PDM scores appear to be associated with fronter realizations of TAWK (~higher values of F2). This suggests that IV speakers with high PDM scores maintain a higher TAWK vowel, and BC speakers with high PDM scores maintain a TAWK vowel that is both higher and backer.

Figure 6.2.10. The effect of PDM score on F1 (left) and F2 (right) of TAWK for BC (solid) and IV (dotted).



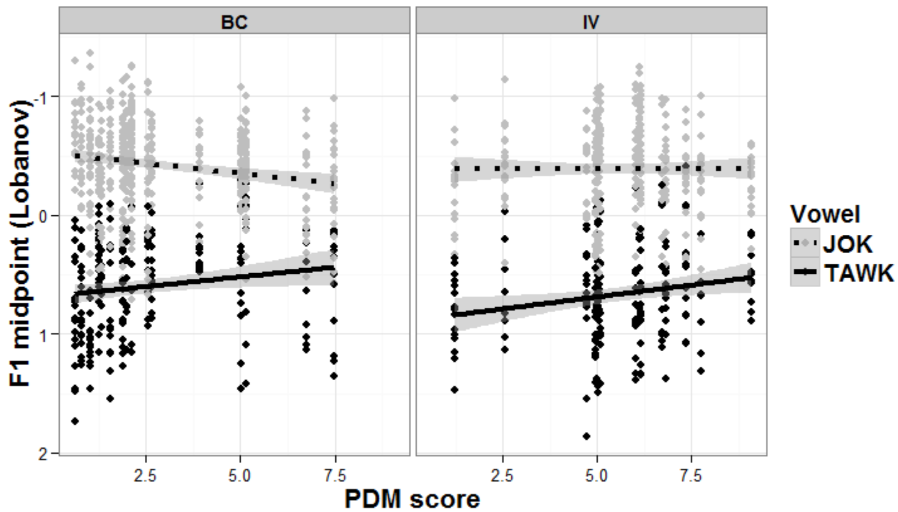
Separate linear mixed-effects models were fit to normalized F1 and F2 midpoints of TAWK for BC and IV speakers with PDM score and speech rate as predictors. A significant main effect of PDM score was found in the model fit to F1 of TAWK in IV speakers (table 6.2.5), indicating that a higher PDM score is correlated with relatively higher realizations of TAWK for IV speakers. This same finding is observed in the model fit to the midpoint of F1 of TAWK for BC speakers, though the effect size only approaches significance (t = -1.574), suggesting that PDM score has a less robust effect on the height of TAWK for BC speakers. The model fit to the midpoint of F2 of TAWK for BC speakers also only approaches significance (t = -1.566), suggesting that speakers with high PDM scores are only somewhat more likely to co-occur with relatively backer realizations of TAWK. On the other hand, the model fit to the midpoint of F2 of TAWK for IV speakers exhibits a small, non-significant positive effect (t = 1.230). Given the finding that TAWK is already fronter for relatively younger speakers (see §6.2.1), PDM does not appear to have a robust effect on the frontness of TAWK. Table 6.2.5 shows the results from the model fit to F1 of TAWK for IV speakers, as this is the only model in which PDM score reached clear significance.

Table 6.2.5. Lmer model fit to normalized F1 midpoint values of TAWK for IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.98907	0.17781	5.562
PDM score	-0.03474	0.01737	-2.000
speech rate	-0.04900	0.03734	-1.312

It should be noted that the raising exhibited by TAWK as a function of PDM score does not create a situation where TAWK is realized as completely overlapping with JOK, the next highest back vowel in the vowel space. Figure 6.2.11 shows the midpoint of TAWK and JOK for BC and IV speakers plotted against PDM score. As PDM score increases, the distance in F1 between TAWK and JOK decreases for BC speakers more obviously than for IV speakers. However, despite the raising that TAWK exhibits as a function of PDM score, JOK and TAWK remain noticeably distinct in the vowel space.

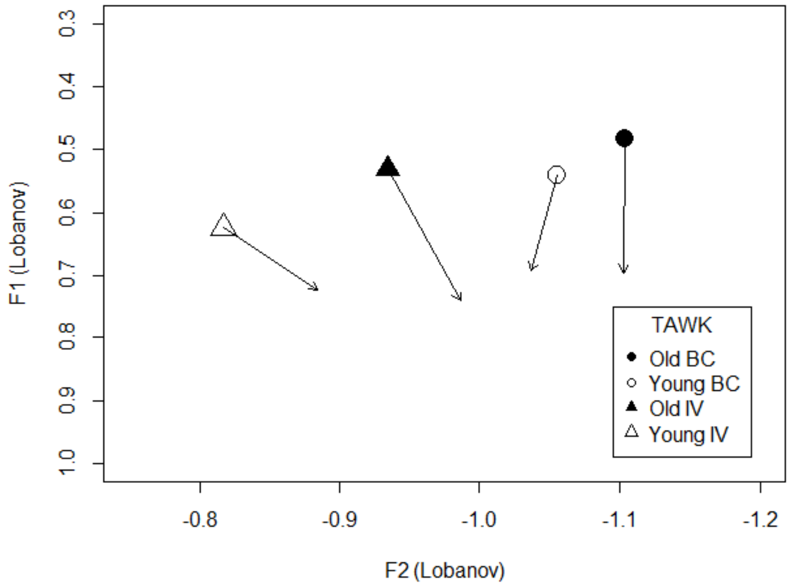
Figure 6.2.11. The effect of PDM score on F1 of BC (left) and IV (right) of TAWK (solid line) and JOK (dotted line), plotted with vowel midpoints for TAWK (gray) and JOK (black).



6.2.4. Trajectory of TAWK over time

The results from the current data demonstrate that the formant trajectory of TAWK is somewhat different for the youngest age group compared with all three of the other groups. Figure 6.2.12 is a plot of the mean normalized formant contour from the vowel at 30% to the vowel at 70%. These points were selected to minimize the effect of surrounding phonological context on the vowel, while still observing formant motion. Young IV speakers show a moderate divergence from the pattern exhibited by all other age groups. BC speakers and old IV speakers exhibit a somewhat large degree of contour motion in TAWK that is largely relegated to F1. However, young IV speakers show slightly less difference between the onset and offglide targets for TAWK, suggesting that the vowel is at least somewhat less diphthongal for this age group. The vast majority of the movement in the formant trajectory of TAWK in young IV speakers is also in F2, rather than the movement in F1 exhibited by the other age groups. Finally, it is worth noting that the changes in offglide quality across age group are not nearly as noticeable as the changes that have taken place in the position of the nucleus.

Figure. 6.2.12. Trajectory of TAWK over age group (excluding pre-lateral environments) from 30% to 70% through the vowel.



6.2.5. Summary of TAWK findings

In sum, realizations of TAWK are conditioned by gender, age, phonological context, and PDM score. Both males and females produce fronter TAWK over time. In females, this fronting occurs alongside a simultaneous raising of LAT (see also §6.1); females also exhibit more overlapped distributions for TAWK and LAT. Males demonstrate overlapped distributions of LAT and TAWK over time, though not to the extent females do. Furthermore, females exhibit an increase in overlap between these two vowels earlier than males. Pre-lateral positions serve to inhibit the fronting of TAWK over time, and pre-lateral TAWK is also relatively higher in the vowel space. This is especially apparent in males, who show virtually no movement over time in TAWK in this phonological environment. On the other hand, females do not exhibit different midpoints for TAWK in pre-lateral environment except for the youngest group of speakers (i.e., young IV speakers). Furthermore, having a high PDM score (i.e., exhibiting more morpho-syntactic markers of Pidgin) motivates significantly higher realizations of TAWK in IV speakers, as well as somewhat backer and higher realizations of TAWK in BC speakers. Finally, the trajectory of TAWK appears to be shortest in young IV speakers.

6.3. STAF

The existing literature describes STAF in Pidgin as occupying a low back to low central position in the vowel space. Sakoda and Siegel (2008) describe the lexical set as variably overlapping with LAT, but not overlapping with TAWK. In English, STRUT evolved historically from the split of Middle English short /u/ into the FOOT and STRUT lexical sets (see §5.2).[155] Unlike FOOT, the size of the lexical class STRUT was not significantly restricted due to the split, as STRUT was not affected heavily by surrounding phonological context. However, this split dates back to the 17th century (Wells 1982: 196), well before European contact with Hawai‘i. Thus, STRUT was a fully formed lexical set by the time English speakers reached Hawai‘i. The following discussion addresses the behavior of Pidgin STAF using the data from the current study.

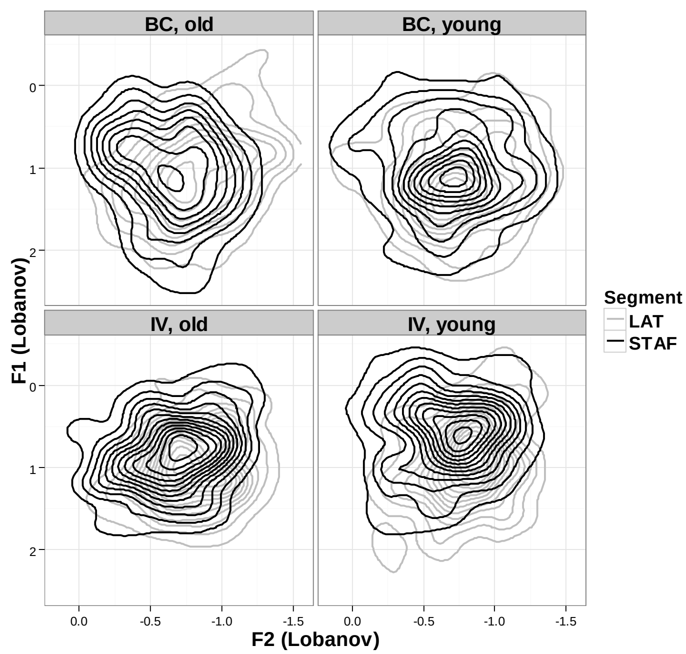
6.3.1. Raising of STAF away from LAT

The results from the current data demonstrate that STAF exhibits principled movement with respect to LAT. Figure 6.3.1 is a two-dimensional density plot of normalized midpoint values of STAF and LAT across age group. This plot does not control for phonological environment, as no phonological environments motivate consistent differences in the F1 of STAF.

[155] An important distinction must be made here between English and Pidgin. In English, the lexical set STRUT does not include lexemes in which the vowel is unstressed; these items belong to the English lexical set *commA* (e g., *sofa*, *visa*, *China*, *arise*). There is a historical reason for this; Middle English did not have a final vowel corresponding to Modern English [ə] (Wells 1982: 167). The vast majority of words that are realized with [ə] are therefore either borrowed, or, in the case of contemporary English, derived via phonological processes of reduction. In Pidgin, however, Sakoda and Siegel (2008: 229) argue that vowels in unstressed positions are not reduced to [ə] via synchronic phonological processes, but rather are full vowels (compare, e.g., English ‘alcohol [ˈælkəˌhɔl] with Pidgin ‘aelkahawl’ [ˌælkɑˈhɔl]). The interaction between vowels and syllable stress in this way had led to some claims that Pidgin is a syllable-timed language (cf. Da Pidgin Coup 1999). Therefore, it is likely that unstressed vowels in general behave differently in Pidgin than they do in English (that is, perhaps vowels in unstressed positions pattern more closely with vowels in stressed positions in Pidgin than they do in English). This is an area for future research, as this study only analyzes vowels in stressed positions.

From this plot, it is evident that old BC, young BC, and old IV speakers exhibit quite overlapped distributions of the two vowels. Very little changes in the distribution or position of the midpoint of STAF, except perhaps that BC speakers exhibit a more dispersed distribution of STAF with respect to old IV speakers, and STAF in old IV speakers appears slightly higher and potentially fronter than LAT. The most noticeable change occurs in young IV speakers, who exhibit slightly higher midpoints for STAF with respect to LAT. This suggests that for young IV speakers, STAF and LAT may be in the beginning stages of a phonemic split (but see §6.4).

Figure 6.3.1. 2-d density plot of normalized midpoints of STAF (black) and LAT (gray), separated by vowel identity, corpus and age.



The height of STAF appears to vary somewhat across gender. Figure 6.3.2 shows two-dimensional density plots of STAF and LAT broken down by age group and gender. STAF in young IV males is slightly (but visibly) higher in the vowel space than LAT; however, females exhibit more variability in their productions of STAF with respect to LAT, as they exhibit a wider distribution of STAF than that of LAT for old and young BC speakers. Despite this, the central tendencies of the two vowels in BC females are not radically different, suggesting that the two vowels occupy very similar areas. Old IV females produce similarly sized distributions of STAF and LAT. As with figure 6.3.1, young IV speakers produce higher distributions of STAF in comparison with LAT. Males seem to produce more of a height distinction between the two vowels, though this may partly be because young IV females also exhibit higher LAT (see §6.1.2). Figure 6.3.3 helps tease apart this gender difference slightly more, as it highlights movement over time solely in F1. While BC females (i.e., those born prior to 1930) exhibit a height difference between STAF and LAT, this is again likely due to the rather low LAT exhibited in the oldest group of females. For females born between 1930 and 1970, the height of STAF and LAT is not different. For the youngest speakers, STAF occupies a higher position in the vowel space than LAT, despite the fact that LAT also exhibits a higher midpoint (see §6.1.2). On the other hand, males show very little difference in the height of STAF and LAT until approximately 1955, where STAF occupies a higher position in the vowel space than LAT.

Figure 6.3.2. 2-d density plot of normalized midpoints of STAF (black) and LAT (gray), separated by vowel identity, gender, corpus and age.

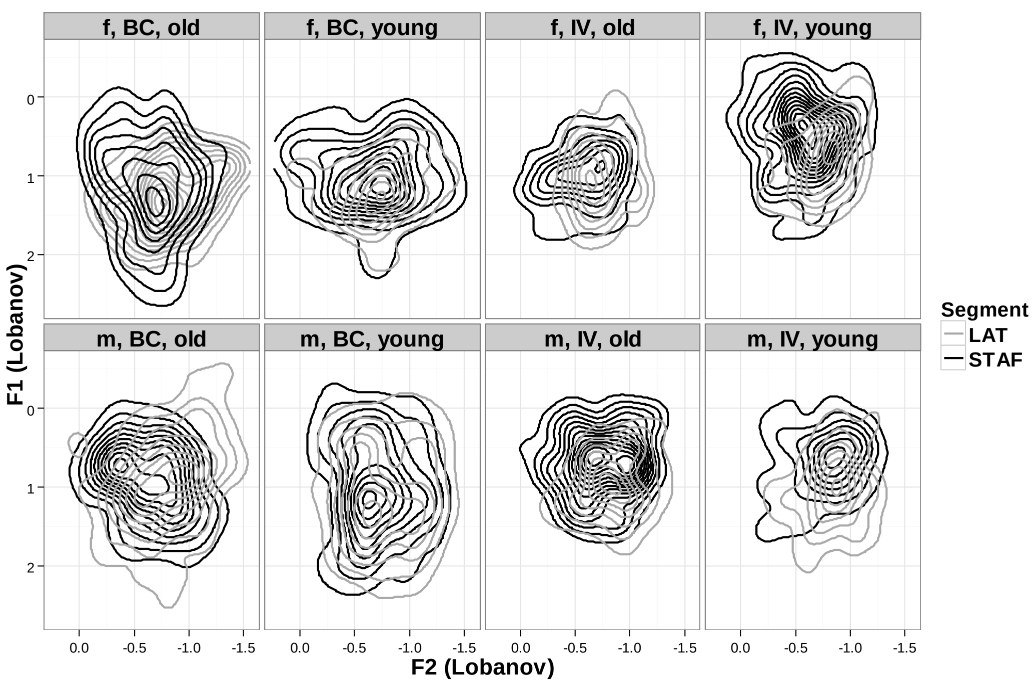
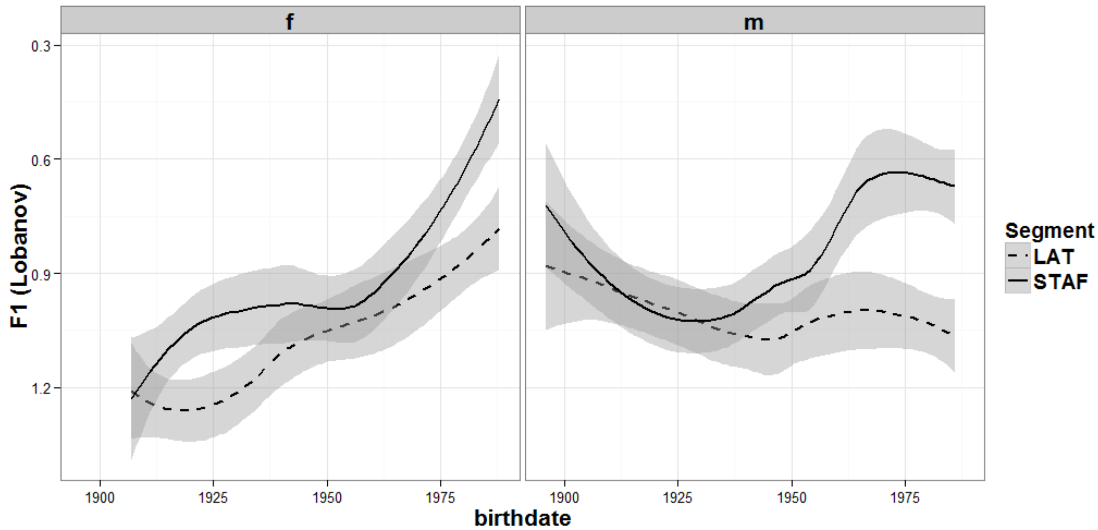


Figure 6.3.3. Change in F1 in STAF (all tokens) for males (right) and females (left) against birthdate.



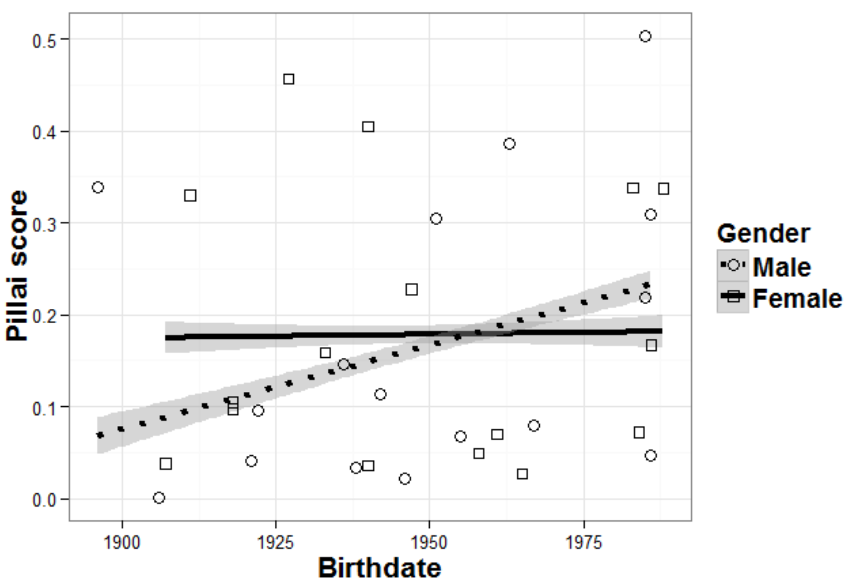
The change in the position of STAF over time is corroborated by a linear mixed-effects model fit to normalized midpoints of F1, with age group, gender and speech rate as predictors (table 6.3.1). There is a significant main effect of young IV speakers, indicating that young IV speakers produce higher STAF tokens than BC speakers and old IV speakers. There is also a nearly significant effect of old IV speakers, suggesting that the raising of STAF is inchoate in old IV speakers. Gender does not have a significant effect on the F1 of realizations of STAF, and does not improve the fit of the model; therefore, it is not included in the final model.

Table 6.3.1. Lmer model fit to normalized F1 midpoint values of STAF for all speakers, with age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.12707	0.11060	10.190
age=young BC	-0.05078	0.10807	-0.470
age=old IV	-0.17917	0.10901	-1.644
age=young IV	-0.43427	0.10925	-3.975
speech rate	-0.02735	0.02297	-1.191

There is also some quantitative evidence to suggest that LAT and STAF become less similar over age group. Figure 6.3.4 plots STAF-LAT Pillai scores derived from a MANOVA on the y-axis against birthdate on the x-axis with a best fit line for both males and females. The plot demonstrates that while males exhibit a clear pattern where STAF and LAT become more distinct over time, females exhibit no clear pattern of raising as a function of age. This disparity is likely another result of the fact that females raise the position of LAT over time. As such, while the Pillai score is able to discern the degree of overlap between LAT and STAF, it is not able to account for the raising that occurs in both vowels. However, there is a tendency for male speakers most obviously to increase Pillai score as a function of birthdate, indicating that STAF and LAT become more dissimilar from each other over time.

Figure 6.3.4. Pillai scores of STAF-LAT plotted against birthdate for males (dotted) and females (solid).



A linear fixed-effects regression model fit to Pillai scores, with age group, gender and speech rate as predictors corroborates this observation (table 6.3.2). There is a significant main effect of young BC, old IV, and young IV speakers, indicating that all of these age groups exhibit higher STAF-LAT Pillai scores, signifying less overlap between the two vowel distributions. This effect is much higher in young IV speakers, suggesting that this group exhibits the least overlapped STAF and LAT distributions of all age groups. There is also a nearly significant main effect of gender, signifying that females exhibit slightly higher Pillai scores than males. However, this effect size indicates that this gender effect is very small.

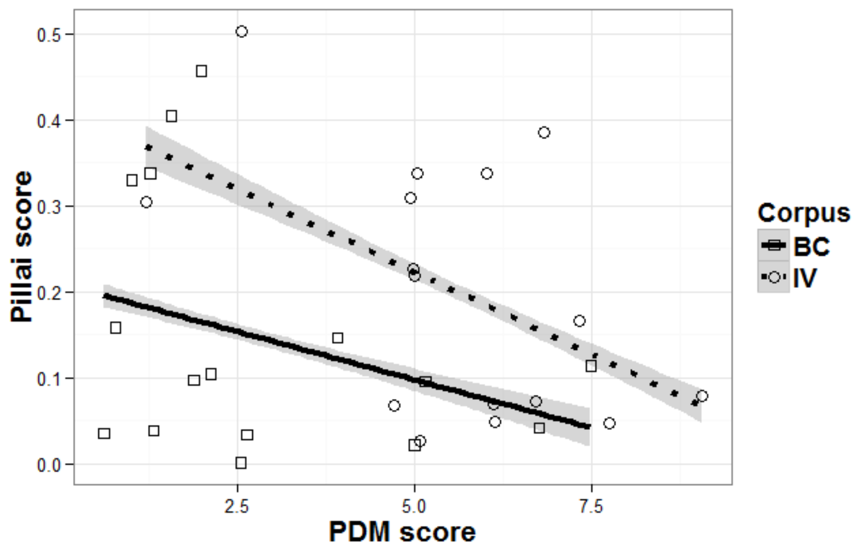
Table 6.3.2. Linear fixed-effects model fit to STAF-LAT Pillai scores for all speakers, with age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.147436	0.017581	8.386
age=young BC	0.039334	0.009639	4.081
age=old IV	0.032604	0.009921	3.286
age=young IV	0.121605	0.009897	12.287
gender=female	0.013596	0.006833	1.990
speech rate	-0.008105	0.004534	-1.788

6.3.2. Effect of PDM on STAF-LAT

The results from the current data demonstrate that one of the conditioning factors for overlap between STAF and LAT is PDM score, which affects the STAF-LAT Pillai scores for both BC and IV speakers. Figure 6.3.5 shows STAF-LAT Pillai scores plotted against PDM score for each corpus. Both BC and IV speakers demonstrate a tendency for higher PDM scores to correlate with lower Pillai scores, indicating less spectral overlap between STAF and LAT. Both best fit lines exhibits roughly equivalent slopes, suggesting that the effect of PDM is similar for both BC and IV speakers, despite the lower average Pillai score exhibited by BC speakers. This indicates that as PDM score increases for both BC and IV speakers, so does the likelihood that a speaker will exhibit more similar STAF and LAT vowels.

Figure 6.3.5. Pillai scores of STAF-LAT plotted against PDM score for BC speakers (solid) and IV speakers (solid).



These observations are corroborated by separate linear fixed-effects models fit to STAF-LAT Pillai scores for BC and IV speakers, with PDM score and speech rate as predictors. Table 6.3.3 shows the results from the model fit to BC speakers. There is a significant main effect of PDM score on STAF-LAT Pillai scores, indicating that as PDM score increases, the tendency to produce overlapped distributions of STAF and LAT also increases. The model fit to IV speakers (table 6.3.4) returns a similar significant main effect of PDM score, though the effect size is larger, indicating that the effect is more robust for this group.

Table 6.3.3. Linear fixed-effects model fit to STAF-LAT Pillai scores for BC speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.293564	0.021765	13.488
PDM score	-0.022215	0.002231	-9.956
speech rate	-0.024682	0.005958	-4.142

Table 6.3.4. Linear fixed-effects model fit to STAF-LAT Pillai scores for IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	0.369146	0.028180	13.100
PDM score	-0.038641	0.002520	-15.331
speech rate	0.011767	0.006036	1.949

6.3.3. Phonological effects on F2 of STAF

The results from the current data demonstrate that the midpoint of F2 (but not F1) of STAF is affected by two phonological environments: post-coronal position and pre-labial position. Figure 6.3.6 depicts STAF in post-coronal and pre-labial environments as compared with all other phonological environments. Post-coronal position motivates a slight degree of fronting of STAF, though this fronting is not as pronounced as what is observed for high back vowels (see §5), and pre-labial position motivates a clear backing pattern.[156] These phonological effects are corroborated by a linear mixed-effects model fit to normalized midpoint values of the F2 of STAF, with phonological context and speech rate as predictors (table 6.3.5). There is a significant main effect of post-coronal position as well as pre-labial position, indicating that these phonological environments motivate fronting and backing of STAF, respectively. Pre-labial contexts may motivate lower F2 values due the extension of the oral tract that occurs due to lip rounding (de Jong 1995: 69; Flemming 2013: 6). It is worthwhile to note that these phonological contexts were treated as a single data column to avoid collinearity among realizations that were both post-coronal and pre-labial. Words that fit both labels (e.g., *staf* 'stuff', *taf* 'tough', *tab* 'tub') patterned more closely with pre-labial realizations, but were concentrated in the frontest part of the distribution of pre-labial tokens. There were no effects of gender or age group the F2 of STAF.

[156] This backing pattern is also observed for pre-lateral environments (not pictured); however, as only 20 total tokens of STAF were measured in pre-lateral environments, it is unclear whether the backing observed in the data is generalizable to other words and speakers.

Figure 6.3.6. Density plot of phonological environment on normalized F2 midpoint of STAF.

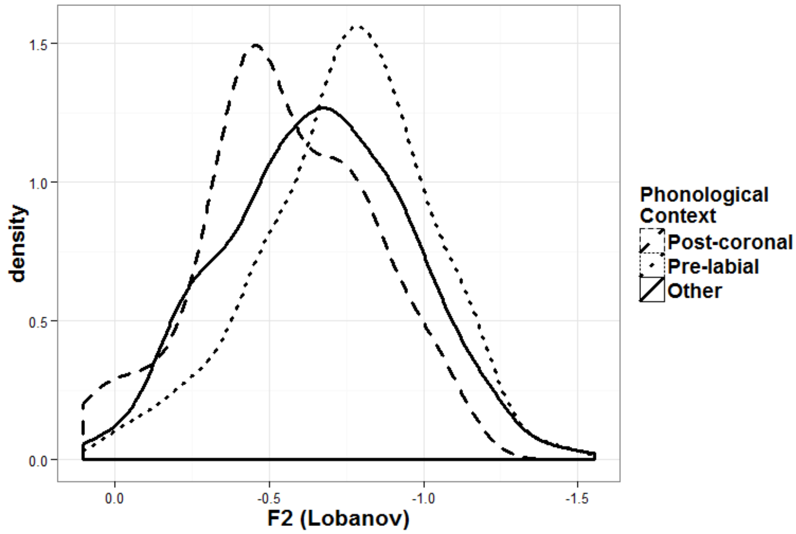


Table 6.3.5. Lmer model fit to normalized F2 midpoint values of STAF for all speakers, with phonological context and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.695701	0.054908	-12.670
phonological context=Post-coronal	0.104905	0.039515	2.655
phonological context=Pre-labial	-0.089987	0.033768	-2.665
speech rate	0.007858	0.012676	0.620

6.3.4. Summary of STAF findings

In sum, variation in STAF is conditioned by age group and phonological context. STAF raises over time; the first indication that STAF is higher than LAT is in old IV speakers, with young IV speakers showing an even greater difference between STAF and LAT. While males and females appear to raise in slightly different ways with respect to LAT (females raise STAF alongside but beyond LAT, while males appear to exhibit relatively lower LAT in the youngest age group), both males and females exhibit higher STAF in the youngest age group than in any of the other age groups. Furthermore, while phonological environment does not impact the height of STAF, pre-labial and post-coronal STAF motivate backer and fronter STAF realizations, respectively. The position of STAF is also affected by PDM score; speakers in both corpora with higher PDM scores exhibit smaller Pillai scores, signifying more overlapped distributions of LAT and STAF. The trajectory of STAF does not change in any principled way across age group, gender, phonological context, or with respect to PDM score.

6.4. Durations of the low back vowels

The results from the current data demonstrate that vowel duration is an important factor to consider when characterizing the behavior of the low back vowels. As discussed in §2.5 and §3.5.2, it is reasonable to expect that even if lexical sets exhibit spectral overlap, there is still a possibility for vowels to exhibit temporal differences. Figure 6.4.1 shows boxplots representing the range of durations across low back vowel type (LAT, TAWK, and STAF) before voiceless and voiced consonants. The figure demonstrates that while the inherent duration of each vowel category differs, low back vowels in Pidgin have shorter durations before voiceless consonants than before voiced consonants. This is consistent with findings in English that the voicing of phonological environment influences the duration of the preceding vowel (House 1961; Delattre 1962; Chen 1970; Klatt 1976). Furthermore, there seems to be a consistent hierarchy of vowel duration to vowel identity, where TAWK is longer than LAT, which is in turn longer than STAF. It is also worth noting that TAWK exhibits the widest inter-quartile range of vowel duration values, though this is perhaps due to TAWK having the fewest number of tokens in the category of low back vowels available for analysis.

Figure 6.4.1. Vowel durations (ms) of low back vowels before voiced consonants (outliers removed).

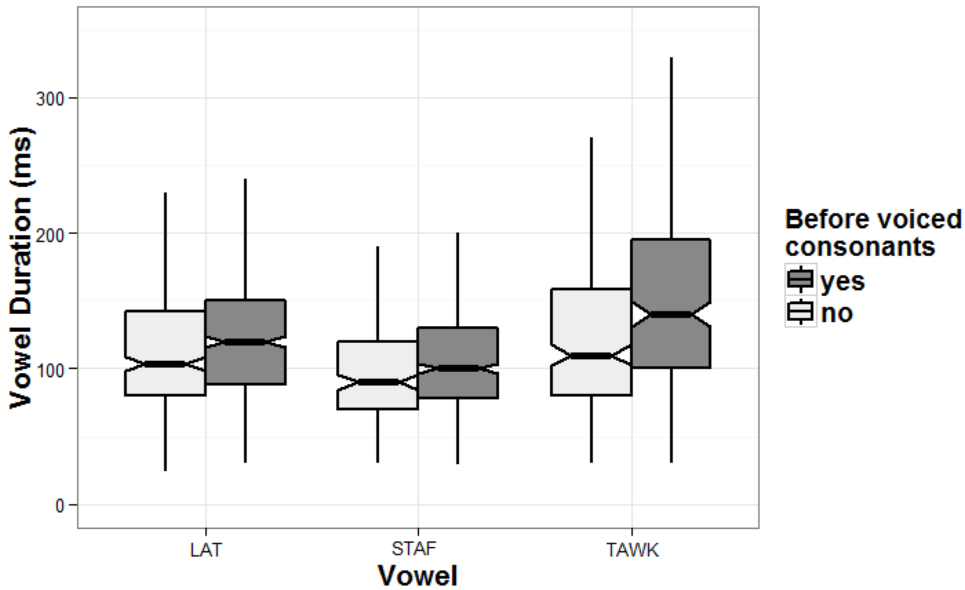


Figure 6.4.2 is a series of boxplots representing vowel duration of each low back vowel over age group. Of note is that vowel duration changes as a function of age group. While TAWK is consistently the longest vowel of the three across age group, there is a striking increase in the duration of TAWK in young IV speakers. In fact, the median value for vowel length across all low back vowels appears to increase over time, so that young IV speakers produce the longest overall vowels. Also of note is that old BC speakers appear to produce the shortest STAF out of all the three age groups. Furthermore, LAT is consistently longer than STAF over all age groups. This finding is noteworthy, as these two vowels exhibit nearly complete spectral overlap in all but young IV speakers (see §6.3.1). This suggests that for relatively older Pidgin speakers, STAF is kept distinct from LAT by vowel duration. A further point of interest is that young IV speakers appear to produce LAT and TAWK with the closest median vowel duration. Figure 6.4.3 shows this more clearly in a line graph of average vowel duration (with standard error) plotted against birthdate. In this graph, LAT approaches TAWK in the youngest age group, suggesting that TAWK and LAT have the most similar vowel duration in the youngest group of speakers. This finding in

conjunction with evidence demonstrating that TAWK has become more spectrally similar to LAT in young IV speakers relative to older speakers (see §6.2.1), suggests that the merging of the two vowel classes also includes vowel duration.

Figure 6.4.2. Vowel durations (ms) of low back vowels plotted against age group (outliers removed)

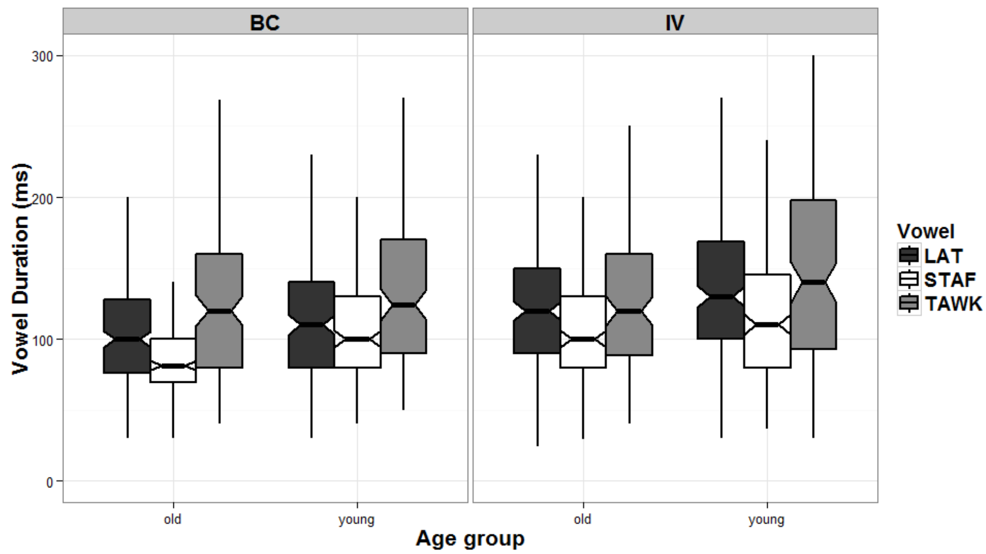
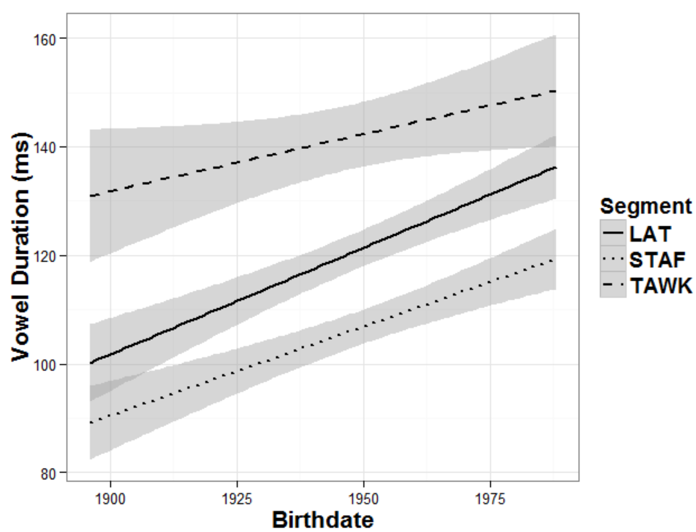


Figure 6.4.3. Mean vowel durations (ms) of low back vowels plotted against birthdate.



To corroborate these findings, a linear mixed-effects model was fit to vowel duration (ms) for all low back vowels, with segment type, age group, pre-voiced environment, and speech rate as predictors (table 6.4.1).[157] Speech rate was included as a predictor to control for vowel duration, as vowel duration and speech rate have been shown to be linked (see, e.g., Lindblom 1963; further discussion in §3.5.2). Table 6.4.1 shows a significant main effect of segment type, age group, pre-voiced environment and speech rate on vowel duration. STAF (~ 104 ms) is significantly shorter than LAT and TAWK, and TAWK (~149 ms) is significantly longer than LAT (~124 ms). In terms of age, young BC and old IV speakers produce significantly longer vowel durations than old BC speakers, and young IV speakers produce the longest vowel durations by far. Pre-voiced environments motivate an expected increase in vowel duration for all vowels, though given figure 6.4.1, this effect is largely a result the increased pre-voiced duration of TAWK. Finally, speech rate exhibits a predictable effect on vowel duration, where higher rates of speech produce significantly shorter vowels. It is worth noting that vowel duration for the low back vowels does not appear to vary as a function of PDM score.

Table 6.4.1. Lmer model fit to vowel duration (ms) of low back vowels for all speakers, with segment type, age group, pre-voiced environment and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	123.939	8.403	14.750
Segment=STAF	-20.130	4.743	-4.244
Segment=TAWK	24.944	5.162	4.832
age=young BC	14.604	6.594	2.215
age=old IV	14.726	6.728	2.189
age=young IV	27.957	6.816	4.102
pre-voiced=yes	23.334	4.375	5.334
speech rate	-5.893	1.868	-3.155

6.5. Discussion of low back vowel findings

Given these results, a few conclusions can be drawn regarding the behavior of the low back vowels LAT, TAWK, and STAF. First, for BC speakers, there is little evidence that LAT and

[157] Because pre-voiced consonant was a predictor in this model, low back vowel tokens in word-final position (five tokens) and before other vowels (one token) were not included in the model.

TAWK comprise a single lexical set distinct from STAF. Instead, BC speakers exhibit LAT and STAF as a single lexical set distinct from TAWK. A system where LAT and TAWK comprise a single lexical set distinct from STAF is only found to some degree in IV speakers. However, the more common pattern for young IV speakers appears to be one where LAT, TAWK, and STAF are distinct (but grouped relatively tightly in the low back area of the vowel space), and LAT and TAWK are close in F1/F2 space, but not completely overlapping. Each of these configurations of the low back vowels is reported as possible in Sakoda and Siegel (2008), though Sakoda and Siegel do not make mention of any changes that have taken place over time in Pidgin. Second, the change in LAT and TAWK over time parallels the LOT-THOUGHT merger in English across the U.S (see, e.g., Labov et al. 2006), a merger that is also nearly complete in all phonological contexts in the speech of young Hawai‘i English speakers (Hay et al. 2013). Additionally, young IV speakers exhibit slightly more monophthongal trajectories for TAWK than older speakers, a finding that is also observed for certain varieties of American English, such as in St. Louis (Majors 2005), North Carolina (Jacewicz et al. 2011), and Kentucky (Irons 2007). The more monophthongal trajectory observed in the TAWK of young IV speakers suggests that the number of spectral cues that serve to distinguish TAWK from LAT is shrinking over time. Temporal cues that distinguish TAWK from LAT also appear to be shrinking, as the vowel durations for TAWK and LAT are most similar in young IV speakers. Together, this provides good evidence that LAT and TAWK have become less distinct over time. Third, that STAF is slightly higher in the vowel space than LAT in the youngest group of speakers indicates the beginning stages of a split in spectral space. This split is mitigated to a degree by high PDM scores, which serve to increase the amount of overlap between the STAF and LAT lexical classes for both BC and IV speakers. However, all groups appear to distinguish STAF from LAT to some extent in terms of vowel duration, suggesting that these two vowel classes are distinct and distinguishable based only on vowel length for the oldest speakers. Evidence from perception experiments is necessary to corroborate whether older speakers of Pidgin can distinguish STAF and LAT lexical sets based purely on vowel duration. The current study predicts that given the distinction in production, it is likely that older speakers can distinguish LAT from STAF based on vowel length. The fronting of TAWK towards LAT and the increased height difference between STAF and LAT parallels a phonological system that is more similar to English, and these changes are very likely the result of long-standing and sustained contact with English in Hawai‘i.

Despite the similarities with an English phonological system, it is clear that in some ways, Pidgin remains phonologically distinct from English. First, the low back vowels are tightly grouped even for young speakers, something that is not characteristic of young Hawai‘i English speakers (Kirtley et al. forthcoming). Not all young speakers exhibit merged (or nearly merged) TAWK and LAT (see, e.g., Kaleo and Myko). Young speakers of Hawai‘i English exhibit a nearly complete merger between these two vowels (Hay et al. 2013), though this observation is based on Hawai‘i English speakers who are younger than the Pidgin speakers reported in this dissertation. Also, pre-lateral TAWK changes very little over time among male speakers, and this serves to inhibit a complete merger with LAT. Among female speakers, pre-lateral environments motivate backer realizations of TAWK only for the young IV age group, suggesting that young IV females have begun backing pre-lateral TAWK. Females in the older age groups do not differentiate pre-lateral TAWK from TAWK in other phonological environments. This suggests that while English has had an effect on the phonology of Pidgin, there are still noteworthy differences between the phonology of Pidgin and the phonology of Hawai‘i English. Furthermore, there is evidence that a heavier use of Pidgin morpho-syntactic features correlates with less English-like realizations of TAWK. Though this effect is implemented differently across corpora (i.e., a high PDM score is more likely to co-occur with relatively backer and higher TAWK in BC speakers, and a higher TAWK in IV speakers), it demonstrates that speakers are able to take advantage of phonological and morpho-syntactic characteristics that set Pidgin apart from English. In this case, the relevant variable appears to be, for some speakers, maintaining a distinction to some extent between TAWK and LAT.

Additional questions remain; namely, why are women leading in the LAT-TAWK merger? Likely, this is due to the fact that females often use a greater number of innovative forms in comparison to men; that is, females lead in changes from below (Labov 2001: 292). Furthermore, it is likely that this change is due in part to the long-standing contact Pidgin has had with English in Hawai‘i, as LOT and THOUGHT in younger speakers of Hawai‘i English are also reported to be merged (see Hay et al. 2013). It is unlikely that the merging of LAT and TAWK constitutes a change from above, that is, a change that is above the level of consciousness and generally associated with a prestigious way of talking (cf. Labov 2001). Women tend to adopt prestige forms at a higher rate than men (Labov 2001: 274). For the merging of LAT and TAWK to be a change from above in Pidgin, the merger would have to be associated with a prestigious way of talking. It is possible that a merged LAT-TAWK is associated with overt prestige, as in Hawai‘i, Standard English is often perceived as educated, intelligent, and upper-class, as well as being associated with “talking proper” or having “appropriate” grammar (Ohama et al. 2000; Marlow & Giles 2008, 2010). Pidgin enjoys covert prestige and holds value in familiar interactions (Ohama et al. 2000), but it is often perceived as “broken English” (Marlow & Giles 2008: 63) and is associated with the speech of ignorant, uneducated, and working class people (Kawamoto 1993: 201). Therefore, it might be possible that the merging of LAT and TAWK is associated with a more prestigious way of speaking, and it would be expected that females would also lead in this kind of change. However, this must be reconciled with the observation from the data that young IV females exhibit the highest mean PDM scores of all speakers in the data set. Given that the morpho-syntactic features of Pidgin are not associated with overt prestige, it is highly unlikely that young females' lead in the LAT-TAWK merger is driven by their desire to sound prestigious. Without more evidence, it is most felicitous in my viewpoint to posit contact with English (motivating a change from below) as the main reason for why young speakers in general exhibit more overlapped LAT and TAWK distributions. Hypotheses for why females lead in this regard need to be investigated further, and these studies need to focus on the perceptual saliency of these two vowels.

Another question raised by the data is why females and males show such a difference between STAF and LAT as a function of age. First, it is possible that LAT raising may be obfuscating the fact that STAF is also higher in young IV females. Because LAT does not change position substantively across age group for male speakers, the fact that STAF is higher than LAT in the youngest age group is perhaps more clear. For females, both STAF and LAT are higher in the vowel space across age group, possibly making it more difficult to measure the difference in height between the two vowels in the youngest speakers. However, it is also possible that the height of STAF is somehow linked to style in Pidgin. In this explanation, females in the data would exploit a variable height in STAF in a way that differed from male speakers. This is a particularly intriguing possibility to consider because BC females exhibit lower PDM scores than IV females, indicating that even though BC females are using fewer markers of Pidgin, they are still more likely to exhibit a low STAF vowel in comparison to younger females. This is an area for future research, as any explanation that takes style shifting within a single speaker into account is outside what this study is able to reliably address.

A subtle difference also arises in LAT with respect to words in Pidgin derived from Hawaiian. These words exhibit higher midpoints in the youngest group of speakers than words that derive from English. There are several reasons for why this difference arises, each of which require more data designed to address this specific question. The difference in height may be tied to the vowel quality of Hawaiian /a/, which is reported to be more similar to [ɐ, ʌ] when short (Schütz 1981; Pukui & Elbert 1986).[158] All Hawaiian-derived words analyzed in this dissertation were phonemically short in Hawaiian; it may therefore be that for young Pidgin speakers, the vowel target for /a/ in Hawaiian words is [ɐ, ʌ] rather than the lower [a]. That this difference only appears in the youngest speakers may have something to do with the history of education in Hawaiʻi. In 1980, the Hawaiʻi Department of Education created the Hawaiian Studies Program (HSP), which mandated that K-12 education in Hawaiʻi include a Hawaiian language and culture component. All of the young IV speakers would have participated in this mandatory education, and they would have had formal education or at least been exposed to the phonological structure of Hawaiian. It is possible (and indeed likely) that this had an impact on their pronunciations of words of Hawaiian origin in Pidgin (and, potentially also in English).[159] This possibility is strengthened by the fact that many of the young IV speakers make open reference to their fondness for and exposure to the Hawaiian language and culture, despite not all speakers

[158] In Hawaiian, there is a phonemic distinction between long and short vowels that also results in a difference of quality.

[159] One possibility is that the vowel target may differ due to the influence of what is often called "University Hawaiian", wherein short /a/ might be mapped to STRUT in English and long /a/ might be mapped to PALM or LOT. However, observations by NeSmith (2005) suggest that speakers of University Hawaiian are less likely to exhibit this short-long distinction in quality (rendering /a/ in forms *maikaʻi* and *makemake* the same), whereas speakers of "Traditional Hawaiian" are more likely to produce a difference. Additionally, recent work by Awai et al. (2014) suggests that English speakers' realizations of Hawaiian place names have become more Hawaiian-like over time.

reporting that they are ethnically Hawaiian or speak Hawaiian. This excerpt from Alika's (young IV male) interview underscores this exposure to and affiliation with Hawaiian:

> mai mejr iz naechro risaws invairmento maenijmin bat daet…ai tek da hawaiyin chri o tu aen da etnik stadiz hawaiyin ishuz jas awn da said…is kain av…yu no wat ai min?...dis dis iz da yunivrsiti…is wan gaeDrin av awl da 'ike awl da nawlij…so ju no if ai don chrai fo tek ful aedvaentij av em nau…jae…bikawz…ai min dis iz a taim fo lrn aen get da risawsis ova hia so…jas figja mait aez wael aen is kain av ju no is…ai fil laik it…mai kain av mai kuleana fo…fo lrn bikawz…da kupunaz iz awl geDin oud yae?...aen da nawlij iz iz awl biyin laws in taim so if ai no du mai pat aen…laik tek da hawaiyin…if ai don tek mai hawaiyin laenggwij o if ai no…if ai no haewp aut laiDaet…is kain av laik…ai nat rili duin mai pat yae?
>
> 'My major is natural resource environmental management but that…I take the Hawaiian 302 and the ethnic studies Hawaiian issues just on the side…it's kind of….you know what I mean?...this this is the university….it's one gathering of all the 'ike all the knowledge…so you know if I don't try for take full advantage of 'em now…yeah…because…I mean this is a time for learn and get the resources over here so...just figure might as well well and it's kind of you know it's…I feel like it…my kind of my kuleana for…for learn because…the kupunas is all getting old yeah?...and the knowledge is is all being lost in time so if I no do my part and…like take the Hawaiian…if I don't take my Hawaiian language or if I no…if I no help out like that…it's kind of like…I not really doing my part yeah?'[160]

Alika situates his desire to learn about Hawaiian culture in the context of the importance it holds in his mind in the community. Despite the fact that he is not ethnically Hawaiian, Alika explicitly references the responsibility (*kuleana*) he feels to take advantage of the university's resources to learn about Hawaiian culture and practices. He also has a sense that his window for learning about Hawaiian customs and culture is closing. He juxtaposes the relatively short time he will be at the university (and thus, will be able to take advantage of Hawaiian classes) with the fact that his elders (*kupuna*) are aging. To some extent, he feels that if he does not take advantage of the knowledge he can gain from these sources, he is not doing all he can to preserve Hawaiian culture in his community. This mindset is not nearly as prevalent in the interviews of speakers from any other age group, underscoring the potential importance Hawaiian cultural and language education has had on the youth of Hawai'i and, crucially, their linguistic patterns.

[160] *'ike* (Hawaiian): knowledge, awareness; *kuleana* (Hawaiian): right, privilege, concern, responsibility; *kupuna* (Hawaiian): grandparent, ancestor.

CHAPTER 7

DIPHTHONGS PRAIS, HAUS, & BOIZ

Both basilectal and mesolectal Pidgin are characterized as having three front upgliding diphthongs, /eɪ/, /ɑɪ/ and /oɪ/, and two back upgliding diphthongs, /ɑʊ/ and /oʊ/ (Sakoda & Siegel 2008:224). As we have already seen, two of these diphthongs, /eɪ/ and /oʊ/, can be described with respect to other vowel subgroups: /eɪ/ (or, FES) is a part of the front vowel system (§4.3) and /oʊ/ (or, JOK) is a stable part of the high back vowel system (§5.3). The behavior of these vowels in the current data set indicates they are not diphthongal in nature, and both of these vowels also fall outside what are sometimes referred to as "true" diphthongs (Labov et al. 2006: 11).[161] This chapter will discuss the diphthongs in Pidgin, PRAIS, HAUS, and BOIZ; each of these diphthongs may be classified as falling (or closing) diphthongs.[162] In the existing literature, all three Pidgin diphthongs are described as being similar to their English counterparts, PRICE, MOUTH, and CHOICE, except that the nucleus of BOIZ varies freely between a more open [ɔɪ] and a more closed [oɪ] in both basilectal and mesolectal Pidgin (Sakoda & Siegel 2008: 222-224). No monophthongization of diphthongs is reported in Pidgin.

Before moving on, a note must be made about how diphthongs are discussed in this chapter. As discussed in §3.2, measurements were taken at seven discrete points throughout each vowel: the 20, 30, 40, 50, 60, 70 and 80% points of the duration of the vowel. Following Drager et al. (2013), the nucleus of diphthongs is measured at 30%, and the offglide is measured at 70%

[161] This terminology is consistent with unary systems of phonemic notation, commonplace in American dialectology (see e.g., Kurath 1939; Carver 1987). Though Pidgin is not a dialect of English, this demonstrates precedent for discussing Pidgin diphthongs PRAIS, HAUS, and BOIZ (that bear a relationship to English PRICE, MOUTH and CHOICE) as comprising a separate category from JOK and FES (which bear a relationship to GOAT and FACE).

[162] In keeping with generally accepted terminology (cf. Donegan 1978), falling refers not to height but to sonority (e.g., the offglide of PRAIS is less sonorous than the nucleus). Closing refers to whether the oral tract is more closed during the production of the offglide than the nucleus.

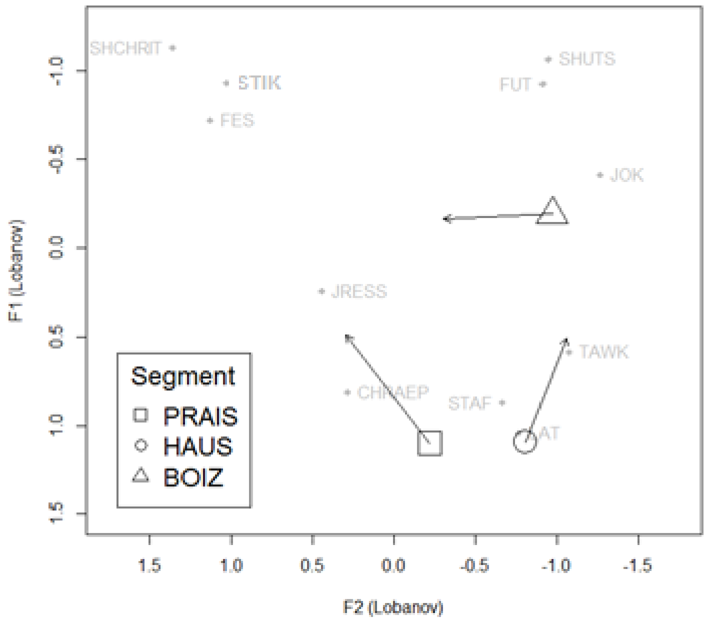
throughout the vowel's duration. Plotting a diphthong like this provides more information about the formant motion over the diphthong as compared with simply noting the direction of the offglide (as in Labov et al. 2006). Additionally, the benefits of choosing these points to represent the nucleus and offglide are that they reduce the influence from the surrounding phonological contexts. However, for the same reason it is more likely that the full range of motion of the vowel is not captured, as some detail is lost from eliminating the measurements at 20% and 80% of the vowel. Throughout the chapter, the measurement at 30% of the vowel represents the nucleus, and the measurement at 70% of the vowel represents the offglide target. When characterizing the behavior of diphthongs, using a measurement at 30% is preferable to using a midpoint value (i.e., a measurement at 50%). This is because diphthongs consist of two separate targets (a nuclear target, followed by an offglide target). Taking a value from the midpoint (50%) of the vowel makes it very likely that the information captured would be the transition (or tongue motion) from the nucleus of the diphthong to the offglide of the diphthong.[163] Therefore, in order to ensure that the most representative measure of the steady-state of the nucleus of the diphthong was taken, the 30% point was chosen.

At first glance observations made by Sakoda and Siegel (2008) appear correct. Figure 7.1 shows the nucleus and offglide of each diphthong, PRAIS, HAUS, and BOIZ. None of the diphthongs' motion is restricted to a single area in the vowel space (another factor that separates them from FES and JOK); instead, each crosses over at least one other lexical set boundary. That PRAIS, HAUS, and BOIZ cross over vowel boundaries signifies that each of these lexical sets

[163] If measurements were indeed taken at the midpoint of the vowel, the results in this chapter would demonstrate that PRAIS and HAUS were relatively higher in the vowel space, and BOIZ would appear relatively fronter.

exhibits formant movement in vowel space that is characteristic of diphthongs.[164] The remainder of these observations as well as insights from the data will be discussed in the following chapters. At the end of the chapter, a discussion of the findings places each vowel in context.

Figure 7.1. Nucleus and offglide targets in diphthongs PRAIS, HAUS, and BOIZ compared with mean midpoint values for other vowel classes; nucleus represented by the measurement at 30% and offglide represented by the measurement at 70% of the vowel's duration.



7.1. PRAIS

There is little phonological description of PRAIS in Pidgin in the existing literature. Sakoda and Siegel (2008: 222-224) transcribe the vowel as [ɑɪ] in both mesolectal and basilectal varieties, implying the diphthong has a somewhat backed nucleus (contrary to a more fronted nucleus, such as [a, ɐ] which might accompany a falling diphthong with a fronting offglide). In English, PRICE is derived from Middle English /i:/. In some dialects of English (e.g., the South; see Labov et al. 2006), PRICE is realized as monophthongal. The following section discusses the findings for Pidgin PRAIS from the current study, and demonstrates that changes across

[164] While BOIZ does not "cross boundaries" in the same way as HAUS or PRAIS because of the lack of a mid-central vowel in Pidgin, the vowel's trajectory is similar to that of the other diphthongs, indicating roughly equivalent movement.

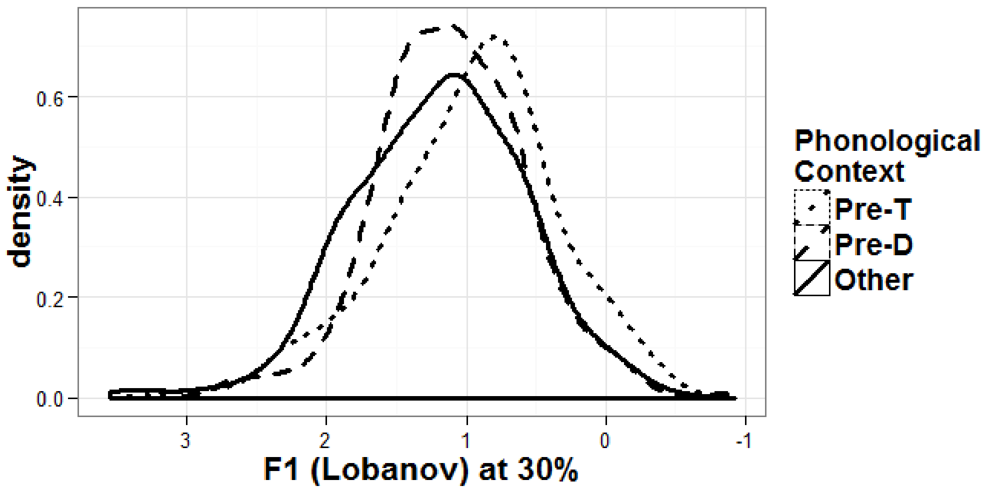
phonological context, gender, and age group are restricted to F1. No changes arise across these groups in F2.

7.1.1. Raising of PRAIS

The results from the current data demonstrate that differences arise in F1 of the nucleus of PRAIS across age group, as well as whether the vowel occurs before a voiceless obstruent. Figure 7.1.1 is a density plot representing the normalized F1 measurement at the 30% point of PRAIS before voiceless obstruents (pre-T) and voiced obstruents (pre-D), as compared with all other tokens of PRAIS.[165] The 30% point of the vowel was chosen to minimize influence from surrounding phonological environments, while capturing the onset of the diphthong. The phonological context "pre-T" indicates any token of PRAIS which occurred before an obstruent that was underlyingly voiceless. Likewise, "pre-D" indicates PRAIS before an obstruent that was underlyingly voiced. [166] Pre-T tokens of PRAIS exhibit higher nuclei relative to PRAIS in other phonological contexts, including pre-D tokens of PRAIS. Pre-D tokens of PRAIS do not exhibit a radically different density peak or density distribution from tokens of PRAIS categorized as "other" (that is, all tokens of PRAIS except those before voiceless obstruents). This finding indicates that the nucleus of PRAIS before voiceless obstruents is articulated higher in the vowel space than all other realizations of PRAIS.

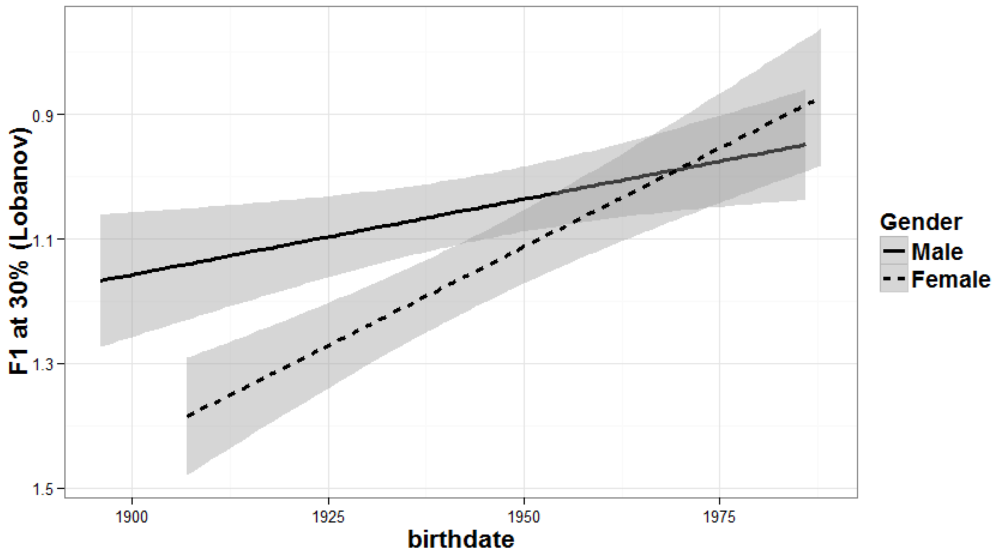
[165] There is precedent for referring to voiceless and voiced obstruents as pre-T and pre-D (see, e.g., Kager 1999: 79).
[166] This study initially used two different ways of categorizing voiceless obstruents: 1) any consonant that was realized at the surface level as voiceless, regardless of its underlying representation was labeled "voiceless" (e.g., treating a final devoiced [d] as voiceless); 2) any consonant that was underlyingly voiceless, regardless of its surface representation was treated as "voiceless" (e.g., the flap in *butter* and *writer* was treated differently from the flap in *daddy* and *rider*). To determine whether vowels behaved differently across these contexts, both ways of treating voiceless obstruents were plotted. No differences arose between the two ways of treating voiceless obstruents. Thus, for the purposes of this study, 'voiceless obstruent' refers to consonants that are underlyingly voiceless, as in (2).

Figure 7.1.1. Density plot of normalized values of nucleus F1 (measured at 30%) of PRAIS across phonological context.



There is also evidence to suggest that age group and gender influence the position of the nucleus of PRAIS. Figure 7.1.2 shows the F1 at the 30% point of PRAIS plotted against birthdate for males and females. For all speakers, PRAIS exhibits a higher nucleus in the vowel space over time, with young IV speakers exhibiting the highest nucleus. Also apparent from the graph is that males exhibit a more gradual raising of the nucleus over age group than females. This is due in large part to the fact that the nucleus of PRAIS is relatively low for old BC females. However, the nucleus of PRAIS is relatively the same for the youngest speakers, irrespective of gender. Together these findings suggest a change in progress in apparent time in the height of the nucleus of PRAIS, which is realized differently in males and females.

Figure 7.1.2. Change in the nucleus (measured at 30%) of PRAIS across gender plotted against birthdate.



To corroborate the above findings, a linear mixed-effects model was fit to normalized F1 at 30% through PRAIS for all speakers, with phonological context, age group and speech rate as predictors (table 7.1.1). Gender was not included in the final model, as it did not improve the overall fit of the model. This indicates that while figure 7.1.2 suggests that females exhibit a lower nucleus for PRAIS, this difference is not statistically significant.[167] There is a significant main effect of pre-T context on F1 at the 30% point of PRAIS, indicating that the nucleus of PRAIS before voiceless obstruents exhibits a lower F1 value (~ higher PRAIS nucleus) in comparison both to "other" phonological contexts and pre-D contexts. Pre-D contexts also appear to show a slight difference in height with respect to "other" phonological contexts, but this difference only approaches significance (t = -1.641). There is also a significant main effect of young IV speakers, indicating that young IV speakers produce lower F1 values in the nucleus of PRAIS (~ higher PRAIS nucleus) than old BC speakers. No other age group returns a significant effect,

[167] It is worth noting that when gender is included in the model, it corroborates that females produce higher F1 values (~ lower PRAIS nucleus). However as described above, this difference is not significant.

suggesting that the raising of the nucleus of PRAIS is not constant across age group. Instead, the raising largely appears to be a feature of the youngest speakers. However, old IV and young BC speakers both show non-significant effects in the same direction, indicating that a certain amount of raising of the nucleus of PRAIS is observed even for these age groups.

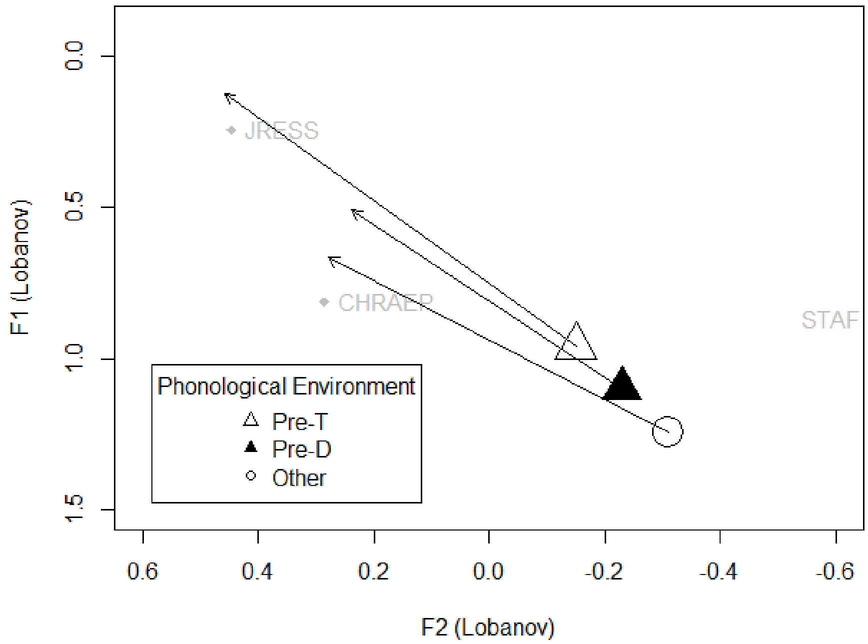
Table 7.1.1. Lmer model fit to F1 at 30% point of PRAIS for all speakers, with phonological context, age group, and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.31363	0.12346	10.640
phonological context=Pre-D	-0.08889	0.05416	-1.641
phonological context=Pre-T	-0.29148	0.05304	-5.496
age=young BC	-0.08115	0.12580	-0.645
age=old IV	-0.14339	0.12668	-1.132
age=young IV	-0.40521	0.12731	-3.183
speech rate	0.01090	0.02455	0.444

7.1.2. A note on the effect of PRAIS raising on formant trajectory

As identified in §7.1.1, the height of the nucleus of PRAIS is dependent on the voicing of the following consonant. Parallels to this phonologically conditioned raising can be found in English varieties. Canadian English, for example, exhibits a higher PRICE nucleus before voiceless obstruents (e.g., *tight* [tʌi̯t] vs. *tide* [tai̯d]). The phonetic impetus for this shift is sometimes attributed to the interplay in English between vowel duration and the voicing of consonants (Chambers 1989: 84). Namely, the voicing of following consonants in English predictably influences vowel duration; vowels before voiceless consonants are shorter than vowels before voiced consonants. Therefore, the phonetic distance between the nucleus and offglide of [ai̯] is reduced in pre-voiceless contexts as compared to pre-voiced contexts because the diphthong has ‘less time to move’ from its canonical nucleus position to a high front lax offglide (Menclik 2013). However, it appears that no such relationship exists in the Pidgin speakers used in this study. Figure 7.1.3 is a plot of the vowel trajectory of PRAIS in pre-T and pre-D contexts as compared with all other instances of PRAIS. The nucleus is represented as the measurement taken at 30% through the vowel's duration, and the offglide is represented as the measurement taken at 70% through the vowel's duration. These points were selected in order to reduce influence from the surrounding phonological contexts, while retaining information about the formant motion over the diphthong. This plot suggests that the trajectory movement does not change drastically across phonological context, in comparison to what is sometimes reported for English. The movement over the duration of the vowel before voiceless obstruents is just as long as it is other phonological contexts. The only substantial difference is the location of the nucleus of the vowel. This suggests that while Pidgin speakers exhibit raising of the nucleus of PRAIS before voiceless obstruents similar to what is found in some English dialects (e.g., Canadian English), there are differences in the way the vowel behaves over its trajectory. It is possible that the similarity in contour motion is in line with claims that Pidgin is a syllable-timed language, as compared with English, which is described as stress-timed (Vanderslice & Pierson 1967). In a syllable-timed language, vowels are said to occupy a similar amount of time in the speech stream (see Nespor et al. 2011). Therefore, it might be expected that the nucleus and offglide of a diphthong in a syllable-timed language would occupy relatively more similar amounts of time and also exhibit less vowel reduction (see Dauer 1983).

Figure 7.1.3. Nucleus (measured at 30%) and offglide (measured at 70%) of PRAIS across phonological environment.



7.1.3. Summary of PRAIS findings

In sum, the position of the nucleus of PRAIS is conditioned by some phonological environments and age group. Before voiceless obstruents, PRAIS exhibits a higher nucleus and offglide, but not less vowel motion over its trajectory. Young IV speakers also exhibit significantly higher PRAIS nuclei compared with older speakers (specifically old BC speakers), suggesting a change in progress. No changes arise in F2. Finally, vowel variation is not conditioned by PDM score or gender.

7.2. HAUS

Like PRAIS, there is little phonological description of HAUS in Pidgin in the existing literature. Sakoda and Siegel (2008: 222-224) transcribe the vowel as [ɑʊ] in both mesolectal and basilectal varieties, implying the diphthong has a somewhat backed nucleus. The reported back nucleus suggests that Pidgin HAUS may behave differently from the MOUTH of many English varieties. MOUTH in many English varieties (especially those on the North American mainland) exhibits a fronted nucleus, paralleling the behavior of the other tense back vowels, GOOSE and GOAT (see §5).[168] The following discussion addresses the behavior of Pidgin HAUS using the data from the current study.

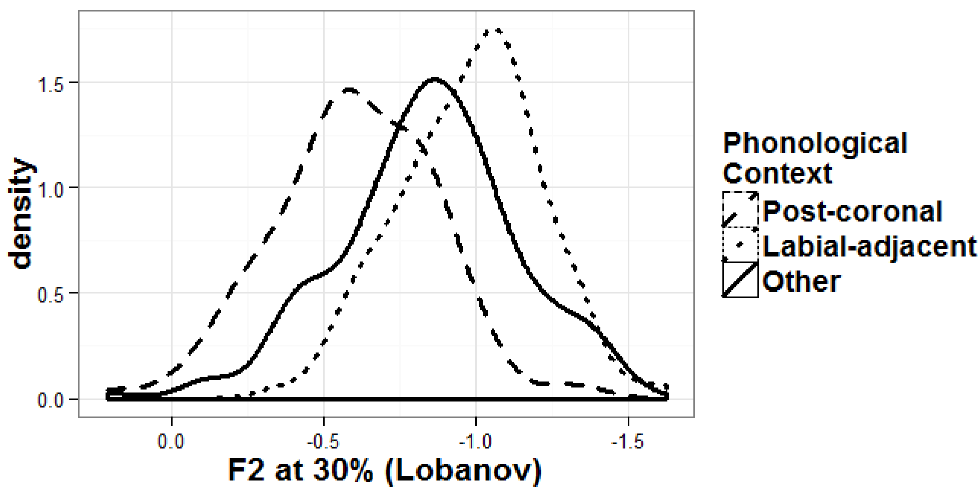
7.2.1. Fronting of HAUS

The results from the current data demonstrate that the nucleus of HAUS exhibits significant changes in F2 as a function of two phonological environments: post-coronal position and labial-adjacent position.[169] Figure 7.2.1 shows the nucleus (measured at 30%) of HAUS in labial-adjacent contexts and post-coronal contexts in comparison to all other phonological environments. The 30% point of the vowel was chosen to minimize influence from surrounding phonological environment, while capturing the onset steady state of the diphthong. First, the nucleus of HAUS exhibits a lower F2 value in the presence of a labial consonant.[170] In these contexts, the position of HAUS exhibits a density peak slightly back of -1.0 in F2, relative to "other" phonological contexts, which show a density peak just front of -1.0. Labial-adjacent contexts may motivate lower F2 values due the extension of the oral tract that occurs due to lip rounding (de Jong 1995: 69; Flemming 2013: 6). Second, HAUS exhibits a fronter nucleus in post-coronal position, paralleling changes that typify those found in SHUTS and FUT (see §5). This same pattern of post-coronal fronting is observed in several mainland English dialects, including the Midland and Mid-Atlantic region, Eastern New England, Canada, the North, Western Pennsylvania and the West (Labov et al. 2006: 158). However, these dialects exhibit relatively minimal fronting in pre-lateral position, and MOUTH before nasals is "considerably more fronted

[168] MOUTH in English is derived from Middle English /u:/ which diphthongized in the Great Vowel Shift (Labov et al. 2006: 14).
[169] This group includes words such as *kauboi* 'cowboy', *pauwa* 'power', *mauntin* 'mountain', and *maut* 'mouth'.
[170] This analysis does not include two instances of the word (*shauwa* 'shower'), which is both labial adjacent and post-coronal. The mean normalized nucleus F2 value for this word was -.95, indicating that the HAUS vowel in *shauwa* patterns more closely with other labial-adjacent vowels than with post-coronal vowels.

as a rule" (Labov et al. 2006: 155).[171] HAUS in Pidgin exhibits no such pre-nasal fronting, nor do pre-lateral environments motivate backer realizations of the nucleus of HAUS. Despite the difference Pidgin exhibits with respect to many mainland varieties of English, Pidgin HAUS does bear some resemblance to Hawai‘i English MOUTH. Kirtley et al. (forthcoming) identify Hawai‘i English as having a relatively back nucleus for MOUTH compared with what is found in the Atlas of North American English (Labov et al. 2006: 105).[172]

Figure 7.2.1. Normalized F2 nucleus values (measured at 30%) of HAUS in post-coronal and labial adjacent contexts compared with other phonological environments.



That the F2 of the nucleus of HAUS changes as a function of post-coronal and labial-adjacent environments is corroborated by a linear mixed-effects model fit to normalized F2 values at 30% through HAUS, with phonological environment and speech rate as predictors (table 7.2.1). There is a significant main effect of post-coronal environments, indicating that post-coronal realizations of HAUS exhibit significantly higher F2 values in the nucleus of HAUS (~ fronter vowels) than all other phonological contexts. Labial-adjacent contexts also return a

[171] Labov et al. (2006) note that fronting before nasals is a general property of all /aw/ tokens, making it all the more surprising that no fronting effect was found in HAUS before nasals.
[172] Kirtley et al. (forthcoming) do not cite any effects of phonological environment on MOUTH in Hawai‘i English, so it is unclear whether Hawai‘i English and Pidgin are similar in this regard.

significant main effect, indicating that these phonological contexts motivate significantly lower F2 values in the nucleus of HAUS (~ backer vowels) than all other phonological contexts. As with the results graphed in figure 7.2.1, results that were both post-coronal and labial-adjacent were not included in the model in table 7.2.1.

Table 7.2.1. Lmer model fit to F2 at the 30% point of HAUS with phonological context and speech rate as predictors.

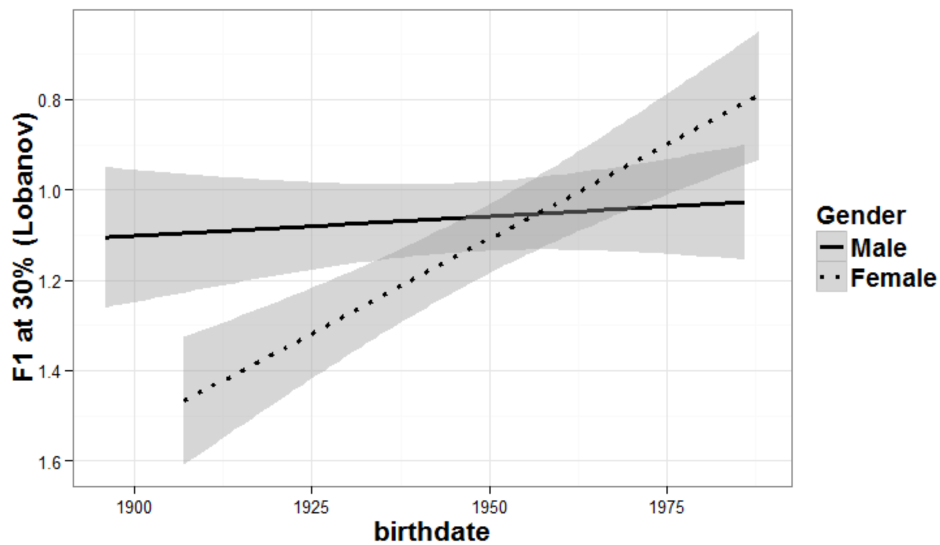
	Estimate	Std. Error	t value
(Intercept)	-0.77016	0.06371	-12.088
phonological context=Labial-adjacent	-0.13397	0.03796	-3.530
phonological context=Post-coronal	0.23131	0.03979	5.814
speech rate	-0.01944	0.01420	-1.369

7.2.2. Raising of HAUS

In contrast with PRAIS, the results from the current data demonstrate that the height of the nucleus of HAUS is not affected by phonological environment.[173] However, the height of the nucleus of HAUS changes with respect to gender and age group. Figure 7.2.2 shows the mean F1 value at the 30% point of HAUS plotted against birthdate for males and females. First, males exhibit no discernable differences across age group; the mean nucleus values of HAUS remains between roughly 1.2 and 1.0 in F1 for all age groups. However, females exhibit a tendency to produce higher realizations of the nucleus of HAUS over age group. The oldest female speakers exhibit mean nucleus values at around 1.4, and the youngest females exhibit relatively higher midpoint nucleus values closer to 1.0.

[173] There is some evidence to suggest that in English, raising of the nucleus of PRICE before voiceless obstruents is more common than raising of the nucleus of MOUTH before voiceless obstruents (Labov et al. 2006: 112-113). If some Pidgin speakers do exhibit parallel raising of PRAIS and HAUS, they are not represented in this study.

Figure 7.2.2. Smoothed mean of F1 of the nucleus of HAUS (measured at 30%) for males and females over birthdate.



This finding is corroborated by a linear mixed-effects model fit to F1 at the 30% point of HAUS for female speakers, with age group and speech rate as predictors (table 7.2.2). There is a significant main effect of old IV speakers and young IV speakers, indicating that females exhibit lower F1 values in the nucleus of HAUS (~ higher nuclei) in these age groups. This suggests a change in progress in real time, where females raise the height of the nucleus of HAUS. An identical model was fit to males, which returned no significant effects. This model corroborates that males do not exhibit any principled changes in the height of HAUS as a function of age group.

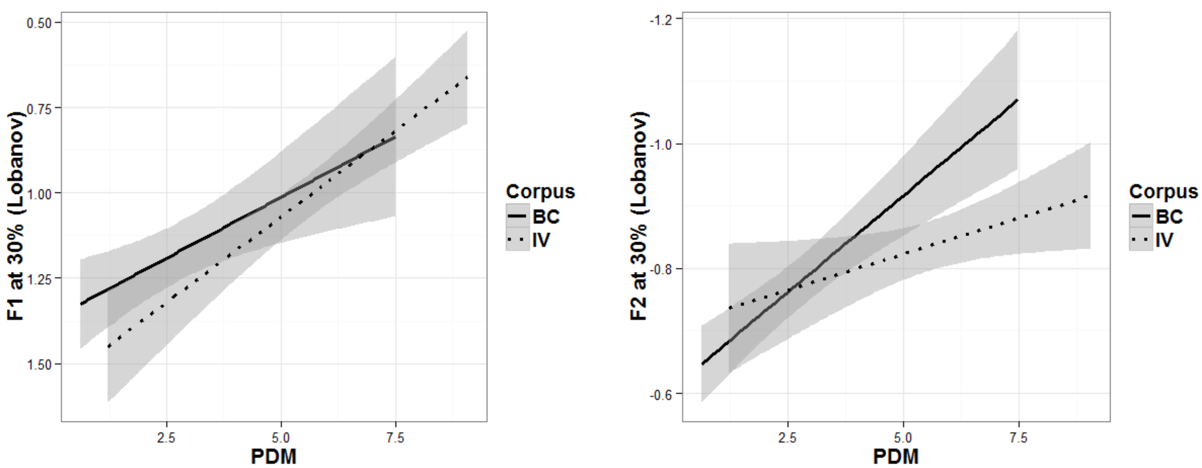
Table 7.2.2. Lmer model fit to F1 at the 30% point of HAUS for females, with age group and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.31461	0.18888	6.960
age=young BC	0.12203	0.11499	1.061
age=old IV	-0.23837	0.11698	-2.038
age=young IV	-0.54678	0.12813	-4.267
speech rate	-0.01183	0.05204	-0.227

7.2.3. Effect of PDM on HAUS

The results from the current data demonstrate that the position of the nucleus of HAUS varies as a function of PDM score in both formant dimensions. Figure 7.2.3 shows the normalized F1 and F2 at the 30% point of HAUS for both corpora. In terms of F1, both IV and BC speakers appear more likely to exhibit a higher nucleus of HAUS in the vowel space as PDM score increases. In other words, as a speaker's use of Pidgin morpho-syntax increases, the nucleus height of HAUS increases (or, speakers with a high PDM are less likely to produce HAUS with a low nucleus). In terms of F2, both BC and IV speakers articulate the nucleus of HAUS towards the back of the vowel distribution. This relationship is perhaps more evident in BC speakers, as the slope of the line is noticeably steeper in comparison to IV speakers. This suggests that, for BC speakers at the very least, speakers with a high PDM are less likely to produce HAUS with a front nucleus.

Figure 7.2.3. Mean F1 (left) and F2 (right) values of the nucleus of HAUS (measured at 30%) plotted against PDM across corpus.



To corroborate these findings, separate linear mixed-effects models were fit to normalized F1 and F2 values at the 30% point of HAUS for IV and BC speakers, with PDM score and speech rate as predictors.[174] BC and IV speakers were tested using separate models due to the differences in the distributions of PDM scores (see §3). Tables 7.2.3-7.2.4 report the models fit to BC speakers for F1 and F2, respectively. There is a significant main effect of PDM score in the model fit to normalized F1 (table 7.2.3), indicating that the F1 of the nucleus of HAUS decreases (~ nucleus raises in the vowel space) as PDM score increases. There is also a significant main effect of PDM score in the model fit to normalized F2 (table 7.2.4), indicating that the F2 of the nucleus of HAUS decreases (~ nucleus backs in the vowel space) as PDM score increases. The results of these models corroborate that as PDM score increases for BC speakers, the nucleus of HAUS is more likely to be articulated towards the higher and backer portion of distribution of HAUS.

Table 7.2.3. Lmer model fit to normalized F1 values at the 30% point of HAUS for BC speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.85501	0.20028	9.262
PDM	-0.06829	0.02740	-2.492
speech rate	-0.14512	0.05414	-2.681

Table 7.2.4. Lmer model fit to normalized F2 values at the 30% point of HAUS for BC speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-0.6312674	0.1048055	-6.023
PDM	-0.0572389	0.0233671	-2.450
speech rate	-0.0007862	0.0204049	-0.039

Table 7.2.5 reports the model fit to normalized F1 values at the 30% point of HAUS for IV speakers, with PDM score and speech rate as predictors. There is a significant main effect of PDM score on the nucleus of HAUS, indicating that the F1 of the nucleus of HAUS decreases (~

[174] There is a significant effect of speech rate on realizations of the F1 nucleus of HAUS, suggesting that speakers raise the nucleus of HAUS as speech rate increases. This effect is in the expected directed (see, e.g., Gay 1978), as increased speech rate often involves formant undershoot.

nucleus raises in the vowel space) as PDM score increases. An identical model fit to F2 of the nucleus of HAUS did not return significance. These results corroborate that while PDM has no significant effect on the backness of HAUS's nucleus, higher use of Pidgin morpho-syntax increases the likelihood that IV speakers will exhibit a relatively high nucleus in HAUS.

Table 7.2.5. Lmer model fit to normalized F1 values at the 30% point of HAUS for IV speakers, with PDM score and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	1.64156	0.20153	8.146
PDM	-0.10241	0.01931	-5.302
speech rate	-0.01299	0.04197	-0.309

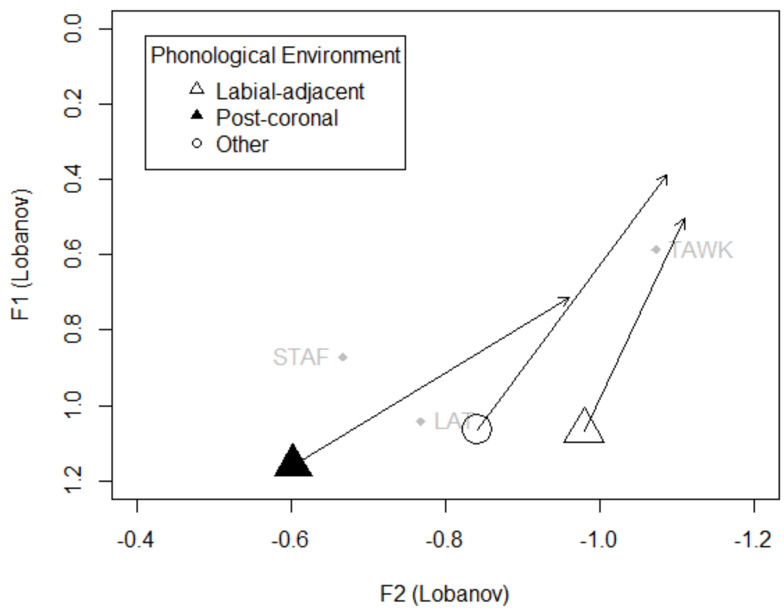
As a final point, it is worth noting that while the nucleus of HAUS varies with respect to PDM, formant values for the offglide of HAUS do not change significantly as a result of higher PDM scores. Separate linear-mixed effects models fit to F1 and F2 at the 70% point of HAUS corroborate this finding, as no model returns a significant main effect of PDM score. This along with the finding that the nucleus of HAUS raises (and for BC speakers, backs) suggests that the trajectory of HAUS decreases as PDM increases. Possible explanations for this finding are discussed in §7.4.

7.2.4. Trajectory of HAUS

Though HAUS exhibits differences in its nucleus values in post-coronal and labial-adjacent positions (see §7.2.1), the results from the current data demonstrate that the contour motion of HAUS is not strongly affected. Figure 7.2.4 shows the trajectory of HAUS in post-coronal and labial-adjacent positions as compared with other phonological contexts. The vowel is plotted from the nucleus (measured at 30%) to the offglide (measured at 70%) to reduce influence from surrounding phonological contexts, while retaining formant motion. Despite the noticeably fronter nucleus, post-coronal positions do not appear to alter the trajectory length of

HAUS compared to the vowel in other phonological contexts. On the other hand, labial-adjacent contexts appear to exhibit a shorter formant contour compared to both post-coronal context and all other phonological contexts. However, the difference in trajectory is relatively small. In general, results indicate that while there may be some difference in trajectory length of HAUS, it is minimal and not strongly affected by phonological context. No changes were found in the trajectory of HAUS across age group or gender.

Figure 7.2.4. Nucleus (measured at 30%) and offglide (measured at 70%) of HAUS across phonological environment.



7.2.5. Summary of HAUS findings

In sum, the behavior of HAUS is conditioned by phonological environment, gender, age group and PDM score. Labial-adjacent contexts motivate a backer nucleus and a shorter vowel trajectory in HAUS. Similar to SHUTS and FUT, post-coronal contexts motivate fronting of the nucleus of HAUS. Unlike PRAIS, the nucleus of HAUS is not affected by preceding voiceless obstruents. The height of the nucleus of HAUS is also conditioned by age group for female speakers. The nucleus of HAUS is realized as higher in old IV and young IV females than in BC females, pointing to a change in real time for female speakers in the height of the nucleus of HAUS. No change over age group is observed in male speakers. The height and backness of the nucleus of HAUS is also significantly affected by PDM score for BC and IV speakers. BC speakers with relatively high PDM scores are more likely to exhibit higher and backer nuclei in HAUS. IV speakers with relatively high PDM scores are more likely to exhibit higher (but not backer) nuclei in HAUS. No changes are observed in the formant trajectory of HAUS as a function of gender, age group, or PDM score.

7.3. BOIZ

Few observations about the phonological characteristics of BOIZ exist in the literature. Sakoda and Siegel (2008: 222-224) report that the nucleus of the vowel varies freely between an open [ɔɪ] and a closed [oɪ] across basilectal and mesolectal varieties of Pidgin. In the current data, patterns in BOIZ are more problematic to generalize, given the relatively low frequency with which this lexical set occurs. This is due in large part to the infrequency of the lexical set in English, which circumscribes a small class of words (largely from early French loans) (Labov et al. 2006: 13; Algeo & Butcher 2013: 161). In the current data set, there are only 99 instances of BOIZ, as compared with 412 instances of HAUS, and 899 instances of PRAIS. At 380 instances, FUT is the closest lexical set in number to BOIZ, with almost four times the number of instances. Certain age groups have noticeably fewer instances of BOIZ than others; old BC speakers, for example, have only nineteen instances of the vowel, and old BC females only exhibit six instances as a group. As such, it is difficult to draw conclusions across virtually any of the range of phonological and social contexts. Of the available phonological environments, only post-coronal was frequent enough in the current study to be considered across the range of speakers. Figure 7.3.1 is a plot of BOIZ at the 30% point of the vowel in post-coronal contexts compared to all other instances of BOIZ. The 30% point of the vowel was chosen to minimize influence from surrounding phonological environment, while capturing the onset steady state of the diphthong. Similar to high back vowels and HAUS, the nucleus of BOIZ is fronted with respect to other contexts. This is corroborated by a linear mixed-effects model fit to F2 at the 30% point of BOIZ, with phonological context and speech rate as predictors (table 7.3.1).[175] There is a significant main effect of post-coronal environment in this model, indicating that post-coronal contexts motivate significant fronting of the nucleus of BOIZ.

Figure 7.3.1. Normalized nucleus F2 values (measured at 30%) of BOIZ across phonological environment.

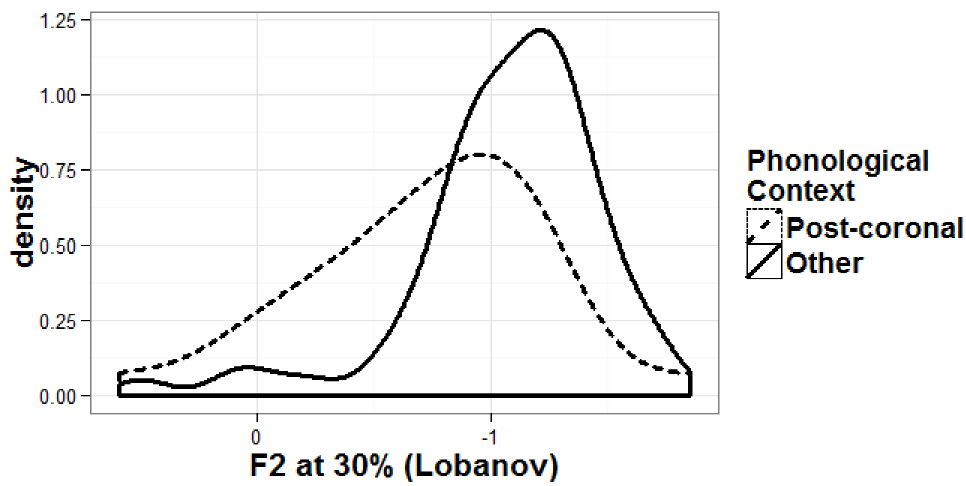


Table 7.3.1. Lmer model fit to normalized F2 at the 30% point of BOIZ with phonological context and speech rate as predictors.

	Estimate	Std. Error	t value
(Intercept)	-1.35189	0.21086	-6.411
phonological context=Post-coronal	0.34343	0.10002	3.433
speech rate	0.07853	0.05532	1.420

Outside of the fronting associated with post-coronal position, variation in BOIZ across age group, gender or PDM is not evident in the data. In the case of phonological features, there are

[175] The model reported here was also fit to F2 at 20%, 40% and 50% through the vowel. At 20% and 40% through the vowel, post-coronal position motivated significantly higher F2 values (~ fronter realizations of BOIZ). No significant effect was observed in F2 at 50% of the way through the vowel.

simply not enough tokens of BOIZ to reliably test how environments like pre-lateral and pre-nasal position impact realizations of BOIZ. In the case of social and age-based groups, there is not a consistent enough distribution of BOIZ tokens across test groups to reliably report any observed variation.

7.4. Discussion of the findings for the diphthongs

Given the results presented in this chapter, a few conclusions can be drawn about the behavior of diphthongs PRAIS, HAUS, and BOIZ in Pidgin. First, post-coronal position motivates fronting of the nucleus of HAUS and BOIZ much like it motivates the fronting of the midpoint of FUT and SHUTS. Little more can be said about whether BOIZ exhibits any principled change over time, as the number of tokens of BOIZ is distributed unevenly across age group. However, the fronting that takes place in HAUS does not appear to motivate general fronting of the nucleus of HAUS over time as it does with both SHUTS and FUT. Furthermore, the post-coronal fronting exhibited by the nucleus of HAUS parallels the fronting that is found in post-coronal LAT (see §6.1.3). It is worth noting that the fronting exhibited by the nucleus of HAUS is less pronounced than what is found in many English dialects, which often exhibit a fronted nucleus that "might well be represented as /æw/ rather than /aw/" (Labov et al. 2006: 158). In Pidgin HAUS, the nucleus is centered closer to the space occupied by STAF rather than CHRAEP.

There is ample evidence to show that PRAIS and HAUS undergo rather disparate changes with respect to each other. First, PRAIS does not show any fronting in post-coronal position, despite the fact that the quality of its nucleus might also be described as similar to LAT. This may be a result of the fact that PRAIS already exhibits a relatively fronter nucleus, occupying a position that is roughly where post-coronal LAT and the nucleus of MOUTH are. Second, the nucleus of PRAIS exhibits raising before voiceless obstruents, a feature not evident in HAUS.

Though pre-voiceless obstruent raising in one of these diphthong pairs does not imply raising in the other diphthong, it is worth noting that some English varieties (e.g., Canadian English) exhibit parallel raising before voiceless obstruents (Labov et al. 2006). However, there is some evidence to suggest that in English, raising of the nucleus of PRICE before voiceless obstruents is more common than raising of the nucleus of MOUTH before voiceless obstruents (Labov et al. 2006: 112-113). Third, there is evidence that both HAUS and PRAIS demonstrate raising over time, though realizations differ in how they manifest. The nucleus of PRAIS is undergoing a change in progress in apparent time, as young IV speakers exhibit higher nuclei in comparison to all other age groups. On the other hand, raising of the nucleus of HAUS only clearly takes place over time in females. IV females exhibit significantly higher nuclei than BC females. These findings suggest that the raising of the nucleus of HAUS over time and the (possibly inchoate) raising of the nucleus of PRAIS are unconnected phenomena.

Finally and perhaps most interestingly, HAUS is the only diphthong to exhibit principled variation as a function of PDM score. BC speakers with relatively high PDM scores are more likely to exhibit higher and backer nuclei in HAUS, and IV speakers with relatively high PDM scores are more likely to exhibit higher (but not backer) nuclei in HAUS. There is also no significant difference between the offglide target for HAUS as a function of PDM, suggesting that the trajectory of HAUS is shorter for speakers who exhibit a high rate of Pidgin morpho-syntactic features in their speech. This finding allows for the possibility that having a short trajectory as the result of a higher (and, for BC speakers, backer) nucleus in the HAUS diphthong is a salient marker that a person is speaking Pidgin. This variable may therefore be instrumental in both speaker productions of and listener evaluations of a Pidgin style, making HAUS a potentially important variable to implement when a speaker uses a more Pidgin-like style of speaking.

However, it is also possible that this variable is more generally connected to being Local. Similar to its realization in Pidgin, MOUTH in Hawaiʻi English exhibits a trajectory that is quite short in comparison to the mainland United States (Kirtley et al. forthcoming). The diphthong begins in a low central space and exhibits an offglide target near the vicinity of LOT/THOUGHT.[176] In other words, HAUS in Pidgin behaves similarly to MOUTH in Hawaiʻi English. It is therefore possible that altering the nucleus of HAUS or MOUTH achieves the similar impact of indexing Localness, as both variables are associated with Hawaiʻi speakers. In order to address this possibility further, additional research must be undertaken that focuses on the stylistic use of HAUS in Pidgin and MOUTH in Hawaiʻi English, as well as work in perception to confirm that HAUS is indeed a salient marker of Pidgin speech.

[176] Kirtley et al. (forthcoming) observe that the nucleus of MOUTH in Hawaiʻi English begins in a low area in the vowel space occupied by TRAP, which in Hawaiʻi English is realized as relatively lowered and retracted. Over its duration, MOUTH moves into the space occupied by LOT and THOUGHT, which are realized as merged in young Hawaiʻi English speakers. However, this pattern is only true for MOUTH tokens taken from spontaneous speech data. Wordlist exemplars of MOUTH exhibited a much longer offglide, terminating near GOAT.

CHAPTER 8

GENERAL DISCUSSION AND CONCLUDING REMARKS

The study reported in this dissertation was concerned with identifying acoustic variation in the vowel systems of 32 Pidgin speakers from across Hawai‘i. Data were analyzed from existing interviews taken in the 1970s and the 2000s. Vowel data from fourteen lexical sets were investigated using quantitative acoustic analysis, and variation in vowel realizations was identified across age group, PDM score, gender, and phonological context. The most important points that can be taken away from the findings of this dissertation are as follows: (1) the youngest generation of Pidgin speakers exhibits a vowel space that is more similar to the vowel space of English than the older generation of speakers; (2) speakers sampled in the 2000s produce more conservative vowels (that is, more basilectal Pidgin-like vowels) as they use more Pidgin morpho-syntactic features; this group also exhibits the highest average PDM scores (i.e., the morpho-syntactic variants they produce are most divergent from English); (3) in comparison to English, Pidgin speakers exhibit few differences in vowel realizations across gender.

What follows is a discussion of the findings from this dissertation, first focusing on the changes that arose across age group (§8.1), then variation that arose as a function of PDM score (§8.2), gender (§8.3), and phonological environment (§8.4). Finally, §8.5 offers some concluding remarks, focusing on the contributions of this work, challenges that completing this dissertation faced, and opportunities for future research.

8.1. Changes across age group

Changes over time were established using longitudinal data taken from speakers from two corpora collected at two discrete points in time: the corpora of BC speakers, collected in the

1970s, and the corpora of IV speakers, collected in the 2000s. Speakers in each corpus were further divided into relatively older and younger speakers.[177] These divisions yielded four total age groups (old BC, young BC, old IV, and young IV speakers) over which change in the Pidgin vowel system was identified.

Age group was generally the strongest, non-linguistic predictor of change in the vowel system of Pidgin. Of the fourteen Pidgin vowel categories identified in this study, the only vowel categories not to exhibit change in real or apparent time were JRES, JOK, and BOIZ (for a visual summary, see figures 8.1 and 8.2). Relative to old BC speakers, the non-low front vowels SHCHRIT and FES exhibit fronter midpoints in young and old IV speakers, and STIK exhibits a lower midpoint in young IV speakers. Results from Pillai scores suggest that young and old IV speakers exhibit less spectral overlap between SHCHRIT and STIK in comparison to all BC speakers. The high back vowels SHUTS and FUT also exhibit fronter midpoints in young IV speakers relative to old BC speakers. Young IV speakers exhibit lower FUT vowels relative to old BC speakers. The dissimilarity exhibited in spectral space over time between the high vowels SHCHRIT and STIK as well as SHUTS and FUT suggests that these vowels have undergone a reduction of overlap in spectral space, the results of which are most evident in young IV speakers. The low front vowel CHRAEP exhibits lowered and more retracted realizations in young and old IV speakers relative to all BC speakers; this change increases the difference between CHRAEP and JRES in spectral space.

The low back vowels TAWK and STAF also exhibit changes over age group. TAWK exhibits a fronter midpoint in young and old IV speakers relative to old BC speakers, and STAF exhibits a higher midpoint (and greater difference from LAT) in young IV speakers, relative to old BC speakers. Results from Pillai scores suggest that young and old IV speakers exhibit more spectral

[177] See §3.1 for a discussion of the slight differences in relative age exhibited between the corpora.

overlap between TAWK and LAT relative to old BC speakers. Additionally, the diphthong PRAIS exhibits a higher nucleus in young IV speakers, relative to old BC speakers.

Finally, two changes over age group manifest only for female speakers: LAT exhibits higher midpoint values in young and old IV females relative to old BC females, and the nucleus of HAUS exhibits higher midpoint values in young and old IV females relative to old BC females. In each of the cases of change in F1 or F2 over age group, when IV speakers exhibit different midpoints from BC speakers, young IV speakers exhibited the most advanced stages of the changes.

A visual representation and summary of the changes that have taken place in the midpoints of monophthongs across corpora can be found in figure 8.1. In this figure, black arrows indicate statistically significant changes across corpora reported in this dissertation. The direction of these changes is indicated by the direction of the arrow (e.g., SHCHRIT exhibits significant fronting over age group, but no significant changes in F1; FUT, by contrast, exhibits significant changes in both F1 and F2). Gray arrows indicate changes that are only exhibited by females. Dotted lines indicate that there is a significant lowering of the Pillai scores (correlating to increased overlap of vowel classes) calculated from two vowel classes. Diphthongs can be found represented in the same way in figure 8.2.

Figure 8.1. Representation of change in vowel midpoint values over age group in monophthongs; starting point of arrow represents old BC speakers midpoint values, and the end point of arrow represents young IV speakers; dotted lines indicate a significant lowering of Pillai scores; gray arrows are those changes exhibited only by females.

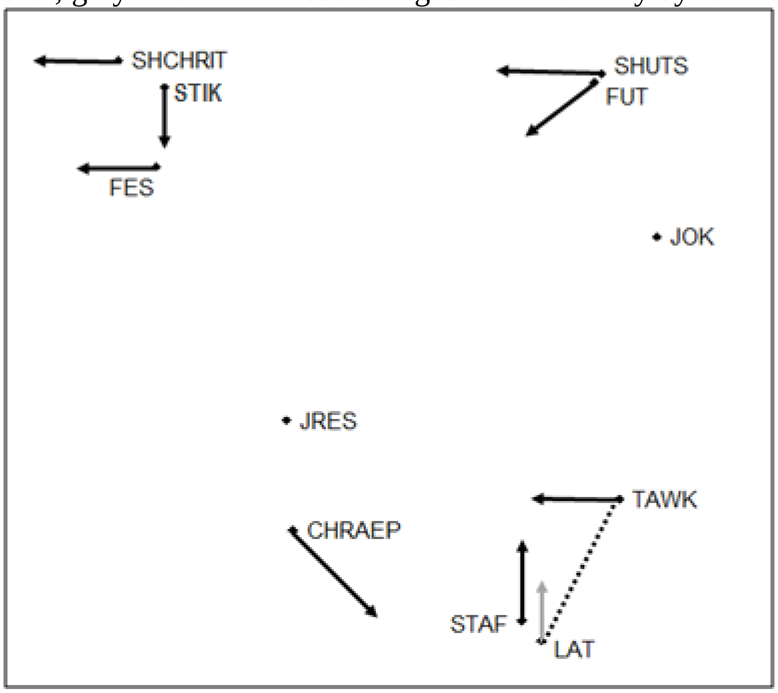
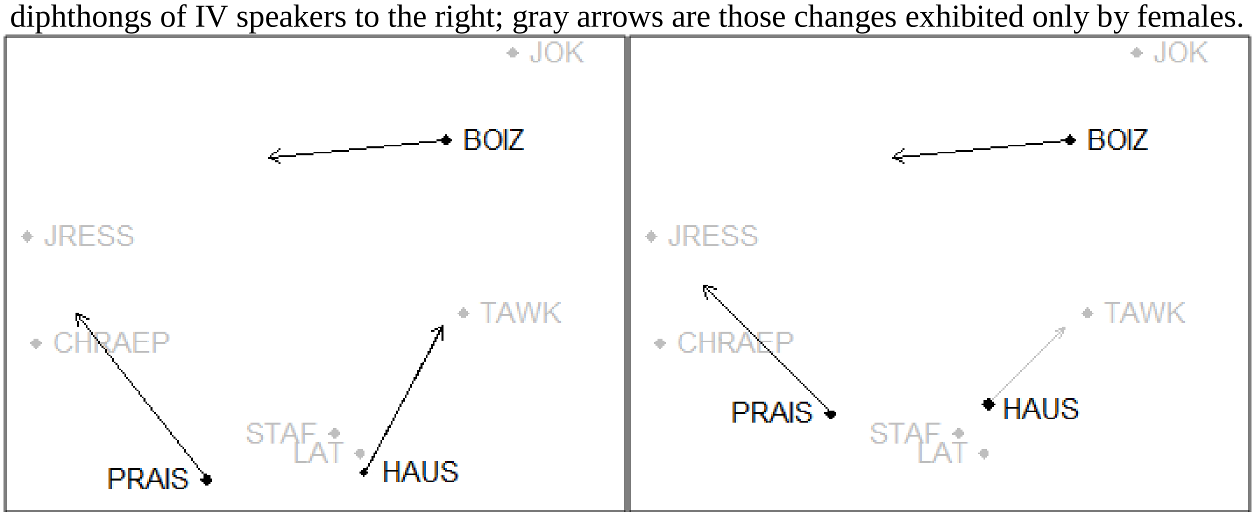


Figure 8.2. Representation of change in nucleus values (measured at 30% of the duration of the diphthong) over age group in diphthongs; diphthongs of old BC speakers are on the left and diphthongs of IV speakers to the right; gray arrows are those changes exhibited only by females.



Many of the age-related changes exhibited by IV speakers are consistent with long-term, sustained contact with English in spite of the fact that IV speakers produce higher PDM scores relative to BC speakers (see discussion in §8.2). These changes include the reduction of overlap over time exhibited by SHCHRIT-STIK, SHUTS-FUT, and STAF-LAT (and to some extent CHRAEP-JRES). For most English speakers (including Hawai‘i English speakers), each of these vowel pairs are held as distinct in spectral space. In addition to the reduction of overlap in spectral space exhibited over time, the direction of some of the vocalic changes is further evidence of the influence English has had on the vowel structure of Pidgin. The fronting of SHCHRIT in IV speakers is in line with Sakoda and Siegel’s (2008: 222) claim that SHCHRIT may undergo tensing (which this study demonstrates is fronting) as a result of English contact. Similarly, SHUTS for IV speakers exhibits fronting that is most evident in post-coronal phonological environments, which is characteristic of many English varieties worldwide. Similar fronting in post-coronal environments is observed for young speakers of Hawai‘i English (Simpson et al. 2014) who are younger than the Pidgin speakers discussed in this dissertation.

Low vowels and diphthongs have also undergone changes in Pidgin over time that suggest influence from heavy contact with English. The behavior of CHRAEP across age group in Pidgin is reminiscent of TRAP retraction that is taking place in apparent time in Hawai‘i English speakers (Drager et al. 2013). Additionally, STAF raises away from and becomes less overlapping with LAT. At the same time, TAWK fronts from its relatively back position to become more overlapped with LAT. These changes to the low back vowels are apparent in IV speakers and reflect a vowel configuration that mirrors the configuration of low back vowels in Hawai‘i English (Kirtley et al. forthcoming). Furthermore, that TAWK exhibits an overlapping distribution with LAT parallels the LOT-THOUGHT merger characteristic of English around North America (Labov et al. 2006); this merger is also nearly complete in all phonological environments in the speech of young Hawai‘i English speakers (Hay et al. 2013). There is some similarity between diphthong PRAIS in Pidgin and the diphthong PRICE in English as well. Both /ai/ vowels exhibit a raised nucleus before voiceless obstruents (cf. Kirtley et al. forthcoming), though not in as pronounced a way as what is observed in Canadian English (cf. Labov 2001). The behavior of vowels in Pidgin is reminiscent of the behavior of English vowels, suggesting that it is most felicitous to posit that the changes over time are a result of the heavy contact that has taken place between co-existing Pidgin and English systems.

Despite this, some of the changes discussed above differ from what is observed in Hawaiʻi English. First, not all young IV speakers exhibit merged (or nearly merged) TAWK and LAT, indicating that this merger is incomplete in Pidgin, or at least for the speakers addressed in this dissertation. This finding stands in contrast to the findings for young Hawaiʻi English speakers, who (despite being younger than the young IV Pidgin speakers reported here) demonstrate merged LOT-THOUGHT in nearly all phonological environments (Hay et al. 2013). Second, LOT and THOUGHT in English occupy a low back position, with a relatively higher STRUT (Kirtley et al. forthcoming). However, in Pidgin, LAT, TAWK, and STAF appear in close proximity in spectral space. This is likely due to the relative similarity exhibited by STAF over age group even in the youngest speakers (potentially as related to PDM score; see §8.2), as STAF has not clearly raised away from LAT in the vast majority of speakers. Third, while SHUTS exhibits fronting in post-coronal position in young speakers of Pidgin, young Hawaiʻi English speakers appear to produce GOOSE in a relatively fronter position (see results in Kirtley et al. forthcoming).[178]

Comparing results from short front vowels in the current study with Drager et al.'s (2013) discussion of the short front vowels also illuminates some differences (and similarities) between Pidgin and Hawaiʻi English. First, differences across gender arise in Hawaiʻi English in both KIT

[178] A potential topic of interest here would be if the vowels SHUTS and GOOSE would be realized differently in the speech of the same bilingual speaker of English and Pidgin.

and DRESS, where males exhibit lower midpoint values than females. In contrast, JRES in Pidgin exhibits no differences as a function of gender, but females were found to produce *lower* realizations of STIK in comparison to males in Hawai‘i English. Though these contrasting findings may represent differences between Hawai‘i English and Pidgin, it is difficult to conclude anything definite without comparing the data directly.[179] The data in Drager et al. (2013) is returned to in the discussion of PDM score in §8.2.

As a final note, many of the changes described in the current study are strikingly similar with what is observed in many varieties of English, including Hawai‘i English. This raises the question of whether speakers of Pidgin and Hawai‘i English have different phonologies for both languages. If this is the case, do speakers of both Pidgin and Hawai‘i English exhibit phonologies in line with that of balanced bilinguals in other languages? The nature of the data described in this dissertation is not equipped to address this; however, this is an opportunity for future research.

8.1.1. The importance of duration on characterizing reduction of overlap of vowel classes

In every case where there was evidence for a reduction in spectral overlap over age group, the vowel pair exhibited temporal differences; that is, in each example (SHUTS-FUT, SHCHRIT-STIK, LAT-STAF), one vowel surfaced as phonetically longer than the other. The shorter of the two vowels was the vowel that was phonetically shorter in English as well (e.g., FUT, STIK, and STAF).[180] This finding raises two points of interest. First, while there is evidence for reduction in overlap in spectral space, speakers maintain a distinction between spectrally

[179] Drager et al. (2013) also note that generalizations about gender for KIT may require a more balanced data set.
[180] See Langstrof (2009) for a discussion of differences in vowel length within the class of short front vowels in New Zealand English. Furthermore, Labov et al. (1972) has related the concept of "peripherality" to vowel length, indicating that non-peripheral vowels in English are phonetically shorter than their peripheral counterparts. In addition, Kirtley et al. (forthcoming) report durations for each lexical set from wordlist data and interview data in their appendix; these numbers corroborate that tense vowels FLEECE, LOT, and GOOSE are generally longer than lax vowels KIT, STRUT, and FOOT.

overlapped pairs via vowel length, regardless of age group. This finding is a heretofore undocumented aspect of Pidgin. Second, that older speakers of Pidgin appear to maintain contrast between the relevant vowel oppositions in terms of vowel duration suggests that these changes are not indicative of a complete reshuffling of phonological categories, but a phonetic change within already existing phonemic space (cf. discussion of secondary split in Hoenigswald 1978). For example, old speakers differentiate SHCHRIT from STIK by length and younger speakers differentiate these two vowels by both length and vowel quality. A difference between STIK and SHCHRIT, however, was already extant in the phonological vowel system of Pidgin. Therefore, while the phonetic implementation of the contrast between STIK and SHCHRIT has changed, the number of phoneme categories has not. Third, if older speakers of Pidgin exhibit consistent vowel length distinctions between overlapped vowel pairs in production, these speakers should also be able to discriminate word-pairs based on vowel length. In other words, it is a reasonable prediction that Pidgin speakers would be able to distinguish 'feet' from 'fit', for example, by vowel length only, even when the vowel quality is identical. It is interesting to note that Jamaican Creole, another English-lexified creole, exhibits similar temporal differences between pairs of high-front /iː, ɪ/ (which might correspond to SHCHRIT and STIK in Pidgin) and high-back /uː, ʊ/ (which might correspond to SHUTS and FUT in Pidgin) (Wassink 1999, 2001, 2006). A length distinction is also cited as existing at one time in a Dutch-lexified creole (Sabino 1996).[181] This raises the possibility that phonemic vowel length might arise generally in creoles if the main lexifier language exhibits a short-long opposition in a similar area of the vowel space, even if that phonemic distinction also arises in vowel quality in the lexifier language.

[181] This creole (Nergerhollands) is no longer spoken natively, but Sabino (1996) describes the last speaker as exhibiting a quality difference between, for example, high vowel pairs where older speakers were described to have a length distinction.

8.2. The effect of PDM score on vowel realizations

The Pidgin Density Measure (PDM) was created in an attempt to capture the stylistic differences that are reported between relatively basilectal and mesolectal speakers of Pidgin (see, e.g., Sakoda & Siegel 2008). This measure was based on the Dialect Density Measure, which is occasionally used in sociolinguistic (Van Hofwegen & Wolfram 2010) and speech pathology work (Craig & Washington 2006) as a measure of the "degree" of dialect use. In the context of this study, a speaker's PDM score is the sum of the morpho-syntactic features as a ratio of the number of words in the interview used by a speaker. To some degree, PDM score serves to quantify labels such as "basilect" or "mesolect", as these terms represent more qualitative characterizations of a speaker's variety.[182]

In this study, PDM score proved to be an effective predictor of the vocalic variation exhibited by SHCHRIT, STIK, FES, JOK, TAWK and the nucleus of HAUS, as well as the overlap exhibited between three vowel pairs: SHCHRIT-STIK, SHUTS-FUT, and STAF-LAT (for a visual summary, see figures 8.3 and 8.4). Furthermore, IV speakers are more likely to exhibit a lower SHCHRIT, a fronter STIK, and a lower FES as PDM score increases. BC speakers with high PDM scores are more likely to produce lower realizations of JOK. TAWK is more likely to be realized as relatively higher in the vowel space for IV speakers with relatively higher PDM scores. The nucleus of HAUS is also higher and backer for BC speakers as PDM score increases, and it is higher (but not backer) for IV speakers as PDM score increases. SHUTS and FUT exhibit more overlapped distributions as PDM score increases for both IV and BC speakers. Similarly, STAF and LAT exhibit more overlapped distributions for BC and IV speakers as PDM score increases.

A visual representation and summary of the variation captured by PDM in monophthongs across corpora can be found in figure 8.3. In this figure, black arrows indicate significant

[182] For a more in-depth discussion of the rationale behind the formulation of the PDM, see §3.3.

differences in midpoint values of relatively high PDM scores. The direction of these differences is indicated by the direction of the arrow (e.g., as PDM increases for IV speakers, the midpoint of SHCHRIT lowers; no significant changes take place in F2). Dotted lines indicate that there is a significant lowering of the Pillai scores (correlating to increased overlap of vowel classes) as a function of PDM score. Diphthongs can be found in figure 8.4. The extra thin arrow in these graphs signifies the offglide target of the vowel. The diagonal arrow associated with the nucleus of HAUS for BC speakers in figure 8.4 indicates the significant effect of PDM in both formant dimensions.

Figure 8.3. Representation of the effect of relatively high PDM score on the midpoint of monophthongs in BC and IV speakers; starting point of arrow indicates speakers with relatively low PDM scores (less basilectal speakers); ending point of arrow indicates speakers with relatively high PDM scores (more basilectal speakers).

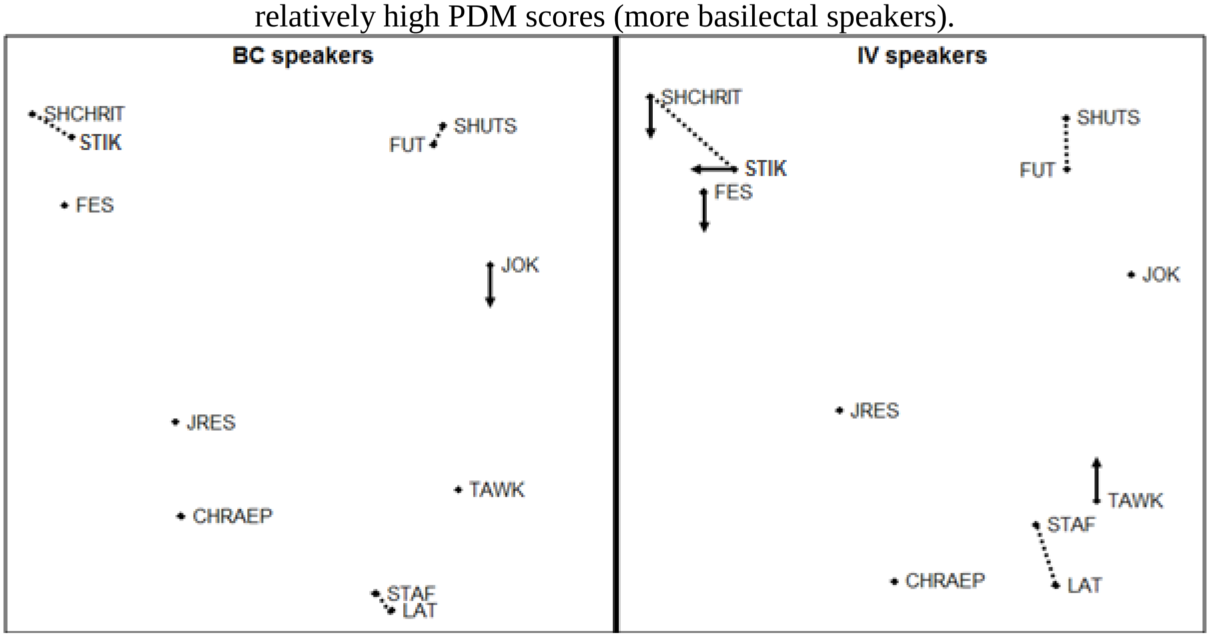
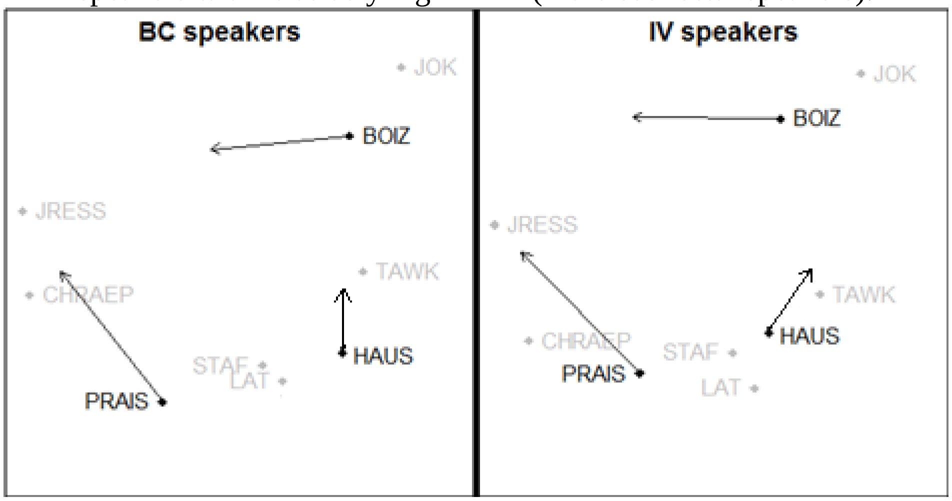


Figure 8.4. Representation of the effect of relatively high PDM score on the nucleus of diphthongs (measured at 30% of the duration of the vowel) in BC and IV speakers; arrow represents offglide target of diphthong; starting point of arrow indicates mean nucleus value for speakers with relatively high PDM (more basilectal speakers).



Importantly, PDM score affects IV speakers disproportionately more than BC speakers (see figure 3.3). In terms of midpoint F1 and F2 values, PDM score affects five vowels in either F1 (SHCHRIT, TAWK, FES, and HAUS) or F2 (STIK), whereas BC speakers exhibit only two midpoint effects (F1 of JOK and F1 and F2 of HAUS).[183] A high PDM score correlates with low Pillai scores of the SHCHRIT-STIK, SHUTS-FUT, and STAF-LAT vowel pairs for speakers in both corpora. However, in all of the Pillai score findings, the effect of PDM score is noticeably larger for IV speakers than it is for BC speakers. There are two possible explanations for why IV speakers exhibit a higher number (and a stronger effect) of PDM effects compared to BC speakers. First, because PDM scores were lower for BC speakers in comparison with IV speakers, it could be that there was less of an opportunity for BC speakers to exhibit differences

[183] There are two further points of interest here. First, generally speaking, PDM effects are observed in F1. Labov (2001: 167-168) makes the claim that F1 is chiefly used for cognitive differentiation of vowel phonemes, whereas F2 is used by speech communities to establish social identity. It is not clear if this preference for PDM to affect F1 is at all related to the cognitive differences between Pidgin and Hawai‘i English vowel spaces in the minds of speakers. Second, the formant dimension which exhibits variation as a function of PDM is not the formant which has showed significant change across age group. For example, SHCHRIT and STIK have fronted and lowered, respectively, over age group, but the vowels lower and front, respectively, as a function of PDM. It is unclear what the motivation for this tendency might be, but speculatively, there may be some structural pressure to relegate stylistic variation to a formant dimension that has not exhibited a change over time.

across PDM. However, if this were the case, BC speakers might not be expected to showcase vocalic differences as a function of PDM score at all. The fact that BC speakers do demonstrate principled vowel variation as a function of PDM score, and that this variation mirrors that of IV speakers (with the exception of the effect of PDM score on JOK in BC speakers), suggests that PDM was effective in characterizing variation in spite of the differences in average PDM score across corpora. The second possibility is, in my view, more in line with what is suggested by the data. IV speakers who exhibit high PDM scores (~ use more Pidgin morpho-syntax) exhibit a vowel space that is more similar to the vowel space exhibited by BC speakers regardless of the BC speakers' PDM score. Furthermore, BC speakers exhibit a vowel system that is more in line with Sakoda and Siegel's (2008) phonological description of basilectal Pidgin (see discussion in §8.1). IV speakers, by contrast, have undergone changes in their vowel system that are largely the result of English contact (and thus, may not be viewed as canonically "Pidgin" by IV speakers). It is possible that the changes that have taken place over time are inconsistent with speaker perceptions of what Pidgin should sound like or be pronounced like. Younger speakers are able to counteract these changes away from canonically Pidgin vowels by producing a greater number of Pidgin morpho-syntactic features alongside more Pidgin-like phonological features. This suggests that to a large extent PDM is measuring style shifting across speakers, and that the changes observed as a function of PDM are socially motivated. That these changes don't affect all of the changes that have taken place over age group suggests that not all the changes that have taken place are necessarily crucial components of what it means to "sound" like a Pidgin speaker. A corollary of this argument is that the vowel categories that speakers alter as they use more Pidgin morpho-syntax are exactly the vowels that speakers may rely on to do socio-indexical work. In other words, these vowels indicate to others that the speaker is speaking Pidgin (or potentially, speaking “Local”; see §8.3).

The effectiveness of the PDM score in characterizing variation can also be seen by comparing the results from the short front vowels to Drager et al.’s (2013) study of the short front vowels in Hawai‘i English. Drager et al. report vocalic differences between Hawai‘i English speakers who report an ability to speak Pidgin (who they call “Pidgin speakers”) versus those speakers who do not report an ability to speak Pidgin (“non-Pidgin speakers”). In their data, Pidgin speakers exhibit a backing offglide during the production of DRESS, whereas non-Pidgin speakers show a fronting offglide in DRESS. This backing offglide is consistent with what is found in Pidgin in the current study, signifying that Drager et al.’s speakers were potentially cognizant of and able to employ vocalic trajectory differences that exist between the language varieties. Drager et al. also note that the young female Pidgin speakers in their study exhibit realizations of KIT that are higher than young female non-Pidgin speakers. The raising exhibited by Hawai‘i English Pidgin speakers may reflect a tendency to increase the proximity of KIT and FLEECE for these speakers in Drager et al.’s data. This interpretation would be consistent with what is observed for Pidgin speakers in the current study as well, as there is a tendency to reduce the distinction between SHCHRIT and STIK as PDM score increases.[184] The findings in Drager et al. (2013) and findings from the current study are consistent with the fact that “speaking Pidgin” (whether this is a reported ability or a measured density of Pidgin features) is linked with a social ideology that has a measurable impact on vocalic realizations.

The findings in this dissertation with respect to PDM score also have ramifications for the purported decreolization (the gradual replacing of basilectal creole forms with acrolectal forms)

[184] Another (unlikely) possibility that does not appeal to PDM score is that young female Pidgin speakers in Drager et al.’s data are approximating what older BC speakers around them do when they speak Pidgin.

that has taken place over time in Pidgin (see Sato 1993). Specifically, while phonological features are said to decreolize at a slower rate than morpho-syntactic features (Escure 1981), findings from this study suggest that this may depend on both the phonological features in question (or the social functions of those features) and how the speaker uses other, non-phonological markers of Pidgin. The vowels addressed in this dissertation show striking similarity over time to their realizations in English, suggesting that these features have undergone strong decreolization. However, vowel realizations are tied to the number of Pidgin morpho-syntactic features a speaker exhibits, meaning that at least for the speakers with high PDM scores, phonological decreolization is stalled to some extent.[185]

8.3. The limited role of gender

An intriguing aspect of the current study is that there were relatively few gender effects across the analyzed speakers. In comparison to males, females exhibit lower STIK realizations, more overlapped LAT-TAWK vowel distributions, lower TAWK in pre-lateral environments, as well as a raised LAT midpoint and HAUS nucleus over age group. That there are few gender differences in the current Pidgin dataset is noteworthy because English (a language that is the main lexifier for Pidgin, and which has experienced sustained contact with Pidgin) exhibits numerous examples of gender differences in vowel realizations. Labov (2001: 274-279) has identified that gender plays a crucial role in two types of changes: change from above (that is, change that is above the level of consciousness and associated with a prestigious form of talking) and change from below (change that is below the level of consciousness that operates within the system).[186] In changes from above, "women adopt prestige forms at a higher rate than men" (Labov 2001:

[185] The current study has not engaged in an in-depth discussion of the way morpho-syntactic features have changed across corpora, so it cannot speak directly to which variables have (or have not) decreolized.
[186] Labov (2001: 293) generalizes this into one principle, stating that "[women] conform more closely than men to sociolinguistic norms that are overtly prescribed, but conform less than men when they are not."

274). In English, this includes examples such as /u/-fronting across North America (Baranowski 2008; Koops 2010), /ɛ/ raising in Belfast (Milroy & Milroy 1978), and /r/ pronouncing in New York (Labov 1966). In changes from below, “women use higher frequencies of innovative forms more than men do” (Labov 2001: 292). In English, this includes examples such as the raising of /æ/ and /ɔ/ in New York City (Labov 1966), nearly all of the vowels involved in the Northern Cities Shift in the Inland North (Fasold 1969; Eckert 1989; Labov 2001; Labov et al. 2006),[187] the fronting of /aʊ/ in Vancouver and Toronto (Chambers & Hardwick 1985), the fronting of /ow/ in Berkeley, California (Luthin 1987), and the backing of /æ/ in California (Kennedy & Grama 2012). In comparison to English then, it seems somewhat unexpected for speakers of Pidgin to exhibit so few differences across gender.

The fact that realizations of vowels are not as clearly different across genders speaks to the social position of Pidgin in Hawaiʻi. There is ample evidence to suggest that while Pidgin is not in a diglossic relationship with English (see §2), Pidgin is in many ways ideologically opposed to English. In Hawaiʻi, English is often perceived as educated, intelligent, and upper-class. English is also perceived by Locals as being associated with “talking proper” or having “appropriate grammar” (Ohama et al. Marlow & Giles 2008, 2010). By contrast, Pidgin enjoys covert prestige and holds value in familiar interactions (Ohama et al. 2000), but it is nonetheless perceived as “broken English” (Marlow & Giles 2008: 63), associated with the speech of ignorant, uneducated, and working class people (Kawamoto 1993: 201). Even among those who speak it, Pidgin does not generally have overt prestige or equivalent linguistic capital in

[187] Labov (2001: 289) identifies only (ohr) raising, (ay0) raising, and (ʌ) raising as being led by men out of the reported 16 sound changes; two changes (uwF) fronting and (i) lowering show no gender preference.

comparison to English, and it is not generally viewed as normative in formal contexts (Marlow & Giles 2010).[188]

That Pidgin is non-normative in comparison to English means that Pidgin occupies a more restricted range of use across social domains (see Marlow & Giles 2008, 2010). Therefore, while females in many communities shift towards the prestige forms, women in Hawai‘i who would otherwise shift to prestige forms in Pidgin are instead shifting to English. This means that prestige forms in Pidgin that females might shift to are not considered in the current dissertation because they are being effectively filtered out by the social position occupied by English.[189] If this is the case, it may be that females and males in the current data set are aiming for similar social meanings by speaking Pidgin. In other words, speaking Pidgin is sufficient to index certain social meanings, such as "Localness" (Meyerhoff 2004: 69-70).

As an additional point, the gender differences over time reported in this dissertation (e.g., raising of the midpoint of LAT and the nucleus of HAUS) are both led by females. The other differences that arise across gender (e.g., lower STIK in females) are all consistent over time; that is, females are always in advance of males. These changes are likely changes from below, due in large part to the fact that these changes are not likely above the level of consciousness. This bears further investigation using data from perception studies; however, anecdotally, there is

[188] Instead, studies like Marlow and Giles (2008) have shown that some speakers use Pidgin as a resource to aid conversational goals and, sometimes, contribute to social legitimacy.

[189] At present, it is not clear what a prestige feature in Pidgin would look like. It is possible that prestige features might overlap with English, which would mean that the "prestige form" would be, essentially, the English form. However, I find this unlikely given both the social situation of Pidgin with respect to English, and the fact that younger speakers in the current data do not exhibit pronunciations that are more English-like as their use of Pidgin morpho-syntax increases. Therefore, it is likely that a prestige form in Pidgin would index Localness, not the standardness that accompanies speaking English. From what the current study finds, it seems that prestige forms in Pidgin might actually be those that most strongly suggest that a speaker is speaking Pidgin (e.g., overlap between SHCHRIT and STIK, or exhibiting distinct TAWK or a short trajectory in HAUS), as these seem to be the features that co-occur in all age groups with heavy use of Pidgin morpho-syntax (see §8.2). This is an area that merits further research.

little evidence to suggest that any of the changes reported in this dissertation which exhibit gender-based differences are above the level of consciousness.

An overview of the findings discussed in §8.1-8.4 above can be found in tables 8.1 and 8.2. Table 8.1 provides an overview of the findings from midpoint/steady state data across age group, gender, and PDM score.[190] Table 8.2 provides an overview of the findings from Pillai measures of spectral overlap across age group, gender and PDM score.

[190] Changes that are both age-related and gender-related are placed under the column for gender.

Table 8.1. Overview of findings from midpoint/steady-state data across age, gender, and PDM.

Vowel	Age	Gender	PDM
SHCHRIT	Fronter for younger speakers	--	Lower for IV speakers with high PDM
STIK	Lower for younger speakers	Lower for female speakers	Fronter for IV speakers with high PDM
FES	Fronter for younger speakers	--	Lower for IV speakers with high PDM
JRES	--	--	--
CHRAEP	Lower and more retracted for younger speakers	--	--
SHUTS	Fronter for younger speakers	--	--
FUT	Lower and fronter for younger speakers	--	--
JOK	--	--	Lower for BC speakers with high PDM
LAT	--	Higher for younger female speakers	--
TAWK	Fronter for younger speakers	Lower for female speakers before /l/	Higher for IV speakers with high PDM
STAF	Higher for younger speakers	--	--
PRAIS	Higher for younger speakers	--	--
HAUS	--	Higher nucleus for younger, female speakers	Higher, fronter nucleus for BC speakers with high PDM; higher nucleus for IV speakers with high PDM
BOIZ	--	--	--

Table 8.2. Overview of findings from Pillai score data across age group, gender, and PDM.

Vowel pair	Age	Gender	PDM
SHCHRIT-STIK	Less overlap for younger speakers	--	More overlap for BC and IV speakers with high PDM
SHUTS-FUT	--	--	More overlap for BC and IV speakers with high PDM
LAT-TAWK	More overlap for younger speakers	More overlap for female speakers	--
STAF-LAT	Less overlap for younger speakers	--	More overlap for BC and IV speakers with high PDM

8.4. On the phonetic motivation of observed phonological effects

The phonological effects on vowels identified in this study were largely in line with cross-linguistic tendencies. The following section discusses the phonetic motivation of each of these phonological changes. First, the effects of post-coronal positions mirrored what is observed in many languages. In Pidgin, post-coronal position motivates some degree of fronting of all back vowels with the exception of TAWK, which is likely due in part to the tendency for a high F2 locus to be associated with coronal consonants (Harrington 2007; Harrington et al. 2008). Post-coronal fronting in Pidgin can then be viewed, to some extent, as assimilation.

Pre-lateral positions in Pidgin motivate general backing of vowels, and this effect is most evident in front vowels, particularly JRES, which has merged with CHRAEP in pre-lateral position.[191] This was the only phonological environment that motivated complete merger for any vowel. Some backing also takes place in pre-lateral STIK, though not to the same extent. The backing effect of pre-lateral positions is also apparent in back vowels in Pidgin, including in FUT and LAT. Furthermore, pre-lateral TAWK occupies a generally higher and backer position in the

[191] Pre-lateral JRES also shows concomitant lowering, which might be expected as a corollary of pre-lateral backing; that is, as a vowel backs, tongue position is also likely to lower somewhat (see Bernard 1985).

vowel space, relative to other realizations of TAWK. Each of the instances of /l/ under discussion in this dissertation was velarized. These findings are consistent with findings from Cox and Palethorpe (2003), who find that dark /l/ has a backing effect on vowels for female speakers of English from Victoria and New South Wales in Australia.[192] For the current data, pre-lateral positions did not significantly affect SHUTS or JOK, despite the well-documented backing effect of /l/ on preceding non-low vowels (cf. Labov et al. 2006: 150-155). At least in the case of JOK, it may be that this represents a ceiling effect, as JOK is already so far back that it may not be able to back any more than it already is. It is unknown whether pre-lateral position motivates backer realizations of GOOSE and GOAT in Hawai‘i English, so it is unclear whether the absence of an effect of pre-lateral environments on SHUTS and JOK marks divergence from English spoken in Hawai‘i.

Pre-nasal position affected the midpoint of vowels in two main ways: the ‘flattening’ of the vowel space in F1, and the increasing of peripherality in F2. Pre-nasal environments then have an expected acoustic effect on vowel height in Pidgin, where low vowels are likely to be raised and high vowels are likely be lowered in pre-nasal environments (Beddor 1982; Beddor et al. 1986). CHRAEP exhibits this pre-nasal raising to a small but significant degree, though the raising is not nearly to the extent observed in many North American English varieties (Labov et al. 2006). It is worth noting that this parallels the behavior of young Hawai‘i English speakers, who exhibit a similar small but significant effect of pre-nasal raising on TRAP (Drager et al. 2013). Pre-nasal environments also motivate changes in F2. Each of the front vowels, SHCHRIT, FES, KIT, JRES and CHRAEP, in the present data exhibits fronter realizations before nasal consonants. For the back vowels, only JOK exhibits backer realizations before nasals. It is at present unclear what the phonetic motivation might be for why nasals have a tendency to

[192] Cox and Palethorpe (2003) demonstrate this effect is strongest for the vowels /ɪ, e, u ɜ/.

increase the peripherality of these vowels; however, there is precedent in English for pre-nasal positions to promote fronting relative to oral consonants, for example, in MOUTH fronting (Labov et al. 2006: 155), split nasal TRAP systems (Labov et al. 2006: 172-173), and the *pin-pen* merger (Strelluf 2014: 231). Furthermore, Drager et al. (2013) observe a similar fronting in pre-nasal environment in Hawai‘i English TRAP and KIT, but report no such effect for DRESS. By contrast, the current data demonstrates that JRES in Pidgin exhibits fronter realizations before nasals.

Vowel realizations were also influenced by the voicing of coda consonants. Raising is observed for PRAIS before voiceless obstruents. Though this raising occurs, there is little change in the contour motion of PRAIS, suggesting that this raising is not likely due to the fact that voicing of obstruent coda segments motivates phonetically shorter vowels with a different vowel quality. However, it is unclear at present why this effect is restricted to PRAIS, but does not extend other dipthongs. It is worth noting that in PRAIS, pre-voiceless obstruent environments do not motivate the degree of raising seen in, for example, Canada (see Labov et al. 2006). Similar to what is observed in CHRAEP before voiceless fricatives, it could be that the raising observed in PRAIS before voiceless obstruents is due to the English spoken around the time of Western contact in Hawai‘i.

An effect of preceding and following labial position on F2 can also be seen in two lexical sets (STAF and HAUS). This too has phonetic motivation, as vowels in the presence of labials may exhibit lower F2 values due the extension of the oral tract that occurs due to lip rounding (de Jong 1995: 69; Flemming 2013: 6).[193]

[193] It is noteworthy that the observed lowering of F2 in the midpoint of STAF and the nucleus of HAUS may not actually represent backing, but simply an extension of the oral tract that accompanies the production of labial consonants. In other words, even if the tongue position is in the same place, F2 will appear lower if the oral tract is lengthened. Furthermore, research suggests that the effect of lip-rounding or tongue backing on F2 is variable across speakers (Perkell et al. 1993; Savariaux et al. 1995). Speakers may therefore use different articulatory means (more lip-rounding or more tongue backing) to achieve the same acoustic effect on F2. In terms of the current data, the effect size of labial-adjacent positions on the F2 of HAUS is larger than the effect size of pre-labial position on STAF,

Word-final position motivates the backing of tense front vowels SHCHRIT and FES, as well as the fronting of JOK to some degree. However, these effects do not appear to be associated with diphthongization, as the vowels in this position do not exhibit greater contour movement. This effect may parallel the generally more central position occupied by unstressed, final vowels (compare, for example, final vowels in analyzed in Received Pronunciation in Flemming & Johnson 2007). However, the vowels in the current study were stressed. It is unclear, therefore, what the phonetic motivation is for why these stressed word-final vowels are realized as less peripheral, as a targets an undershoot account would predict a more peripheral vowel in this environment.

Pre-/g/ raising was observed in STIK. The front vowel STIK exhibits pre-/g/ fronting and raising, which is reminiscent of what is reported for some English dialects for other, lower short front vowels DRESS and TRAP, for example, in the Pacific Northwest (see, e.g., Wassink 2011; Wassink & Riebold 2013; Freeman 2014).

Finally, CHRAEP before voiceless fricatives exhibits lower midpoints than CHRAEP in other phonological environments. Rather than having an acoustic phonetic motivation, this effect is likely due to the TRAP-BATH split that would have been evident in English spoken around the time of Western contact in Hawai‘i (see discussion in §4.5.1), a finding that is reinforced by the predictable phonetic environment in which this difference was observed. In sum, phonological environment in Pidgin was a good predictor of variation in vowel position, as expected.

suggesting that these two lexical sets may differ in terms of how they are affected by labial environments. If the lowering in both lexical sets is chiefly from rounding, only time will tell whether future generations of listeners will interpret the lower F2 as backing and then produce backer variants of subsequent productions (Drager personal communication).

8.5. Concluding remarks

This study provides an understanding of the ways in which the vowel system of Pidgin has changed over time. Using a variationist approach, this study employed acoustic phonetic analysis to identify and characterize variation in Pidgin vowels, and establish what factors constrain and influence this variation. What follows is a discussion of the contributions of this study to the field of linguistics, the challenges faced during the completion of this study, and opportunities for future research.

8.5.1. Contributions to the field of linguistics

The clearest contribution of this dissertation is that it provides new, acoustic phonetic information about variation and change for a language that is widely spoken throughout Hawaiʻi. In existing linguistic work on Pidgin (e.g., Bickerton & Odo 1976; Odo 1975; Sakoda & Siegel 2008), there is sometimes an implication that while Pidgin exhibits significant phonetic and phonological variation, this variation is both expected, due to Pidgin's status as a creole, and context free. This dissertation demonstrates that the variation exhibited by Pidgin is not context free, but rather conditioned by age, phonological environment, the degree to which a speaker uses morpho-syntactic elements of Pidgin, and to a lesser extent, gender. These findings add to the body of literature that focuses on variation in creole systems, as well as the body of literature which specifically addresses the structure of Pidgin as spoken in Hawaiʻi.

These findings also provide quantitative acoustic phonetic evidence of phonemic change driven by language contact, as many of the changes observed over time in Pidgin are consistent with what would be expected from continued and sustained contact with English. This suggests that other creoles might exhibit change in a similar way over time where the creole system co-exists to some degree with the main lexifier language.

Findings from this dissertation also contribute to an understanding of gender differences in language use. One of the more widely accepted claims about linguistic differences across gender is that women favor prestige varieties and men favor value “vernacular” variants (Trudgill 1998; Labov 2001). Therefore, females might be more likely to produce variants in the direction of the standard, contributing to the leveling of differences between the creole and the standard. However despite high levels of gender variation in English, Pidgin speakers do not exhibit large changes across gender. This suggests that males and females may be aiming for similar social meanings (e.g., “Localness”, see Meyerhoff 2004) when they speak Pidgin. While Pidgin has changed over time, females do not appear to be leading the charge towards standardization as might be expected, but are instead likely shifting to English.

This dissertation also highlights the utility of existing data for variationist research. Using archival data, it is possible to describe, characterize, investigate and quantify sociolinguistic variation using rigorous acoustic analysis. That existing data can be used in this way also underscores the importance of continued data collection and good archiving practices, which are essential to good research.

Finally, this dissertation has also showed that a density measure can serve as a useful predictor of variation in a creole language. The PDM score is a way to quantify how basilectal a variety of Pidgin a speaker uses by counting the total number of Pidgin morpho-syntactic items a speaker uses in an interview and expressing this score as a ratio of the total words in an interview. Since the PDM score is calculated based on linguistic variables that are not the test variables (e.g., vowels), it is possible to assess whether speakers that are more basilectal exhibit different phonetic realizations with regard to sound change than more acrolectal speakers. The PDM score has the added benefit of allowing for increased objectivity on the part of the researcher, who has before assigned the terms basilectal, mesolectal and acrolectal to certain speakers based on, for example, region (see, e.g., Wassink 1999). In this way, it is possible for the researcher to be sure that the PDM score is independent of the test variable, which is not the case with researcher-imposed categories. The PDM score also treats the basilect-acrolect continuum as continuous rather than categorical, which is desirable from a research standpoint because it more accurately reflects the behavior of creole languages. Use of the PDM may have application to the study of other creole communities, though the specific morpho-syntactic variables would need to be tailored to match those found in the relevant creole variety.

8.5.2. Challenges in completing this study

There were a number of challenges to completing this study. Perhaps the greatest of these was the difficulty of working with existing data. Despite the benefits that accompanied having access to a readily available corpus of previously collected data, it was extremely difficult and time-consuming to create a balanced dataset with the interviews that were available. Due to the sometimes inconsistent demographic information and limited scope of the metadata associated with each interview in the corpora, an enormous amount of time was devoted to familiarizing myself with the interview data prior to selecting appropriate files. The interviews were also often conducted by different interviewers, who had very different interviewing styles, and some were more likely than others to spend a majority of the interview discussing topics that dealt explicitly with the metalinguistic awareness of Pidgin. Though acoustic analysis of these sections was avoided, interviewees may have felt less comfortable using Pidgin during these interviews because of the history of language hegemony in Hawai‘i and this may have affected the interviewee’s vowel realizations. However, perhaps the most challenging aspect of using existing data was that all the information available about each interviewee was entirely contained in one (sometimes two) interviews. This led to a very restricted understanding of what each individual was like, and it was quite difficult for me to reconcile the fact that an audio interview was all I had to characterize who the interviewee was.[194] The nature of the data also meant it was impossible to ask follow-up questions (regarding, e.g., ethnicity, occupation, life history, etc.). These difficulties are discussed more fully in §3.1.

Another challenge of this study was the difficulty of examining a creole language that is similar in many respects to its main lexifier language. Though it is sometimes relatively easy to identify speech as Pidgin or English (especially if the variety used exhibits high numbers of Pidgin or English lexical and morpho-syntactic items), it is more difficult to identify someone's speech as Pidgin when the speaker is not using large numbers of morpho-syntactic markers. Implementation of the PDM addressed this to a large extent, but there remained a difficulty associated with initially selecting a speaker as a good candidate for analysis in this dissertation. As discussed in §3.1, this study attempted to address this problem by taking data from interviews conducted by Pidgin speakers, and restricting the available pool of interviews only to those speakers who were born and raised on the Hawaiian Islands. In this way, speech which could reasonably be construed as either Pidgin or English was largely avoided, even when those interviews might have produced good data.

A final challenge of this study was simply time. This study attempts to bring together data from many different speakers and address the behavior of each of the vowels in Pidgin, an undertaking which had not yet been done using acoustic phonetic analysis. Though this study attempted to present data for all vowels, certain topics had to be glossed over, such as the

[194] My initial reticence in characterizing speakers with only one interview is founded in the knowledge that people accommodate their speech depending on who they are talking to and who is present during the discourse (Bell 1984; Giles et al. 1991). Because Pidgin use is tied to a speaker's communicative goals/needs (see e.g., Marlow & Giles 2008), it stands to reason that the interlocutor (and his/her goals) would have an effect on a speaker. Other methodologies like ethnography (see, e.g., Narayan 1993) are much better at addressing the many ways speakers use language in multiple scenarios with many different interlocutors.

behavior of vowels before /r/, and realizations of vowels in unstressed environments. Sakoda and Siegel (2008) and Bickerton and Odo (1976) observe that Pidgin speakers produce less centralized vowels in unstressed syllables that many English varieties would reduce to [ə] or [ɨ], a phenomenon which has also been noted for Hawaiʻi English (Sato 1993). Sakoda and Siegel (2008) also report that mesolectal Pidgin speakers are more likely than basilectal Pidgin speakers to exhibit /r/-ful variants of words like *skwea* 'square' or *foas* 'force' (see also Odo 1975). Though these topics involve vowel realizations, time did not permit an in-depth discussion of these topics, despite the fact that they merit research.

8.5.3. Opportunities for future research

Findings from this dissertation present a number of avenues for future research. Among these is continued research on the vowel system of Pidgin. As has been demonstrated, the vowel space in Pidgin has become more similar to that of English in many ways, especially in the younger generations. Despite this, younger speakers in this study exhibit the highest average PDM scores, and they are most likely to alter the way they produce vowels as the number of Pidgin morpho-syntactic features increases (and indicates a more basilectal variety). Continued research will be able to address the social motivations behind this variation, and may be able to address how future generations of speakers speak Pidgin (e.g., will subsequent generations continue to exhibit vowel spaces that are similar to English?). It is also unknown how the youngest generation (kids, teenagers, and those in their early 20s) are currently using Pidgin. Future research may be able to address this by using the findings in this research as a benchmark for what to expect.

Another potential future avenue of research is using the PDM score to address questions of how individuals implement style across utterances and social situations to construct identity.

Each speaker in the current dissertation was assigned a single PDM score. Therefore, no real claims can be made about stylistic differences within speaker, only the broad stylistic differences that may arise across speakers. Perhaps my favorite metaphor some Locals have used to describe their Pidgin use is that "Pidgin is a dimmer switch; you have to know when to turn it up and when to turn it down." I believe implementing the PDM score can help address and quantify this "dimmer switch" question. In the future, PDM might be employed at a level more suited to addressing how style is implemented by Pidgin speakers across utterances. A PDM score could, for example, be assigned to every utterance, and then linguistic variables in utterances which exhibit higher PDM scores might be compared to linguistic variables in utterances which exhibit lower PDM scores. Additionally, for some of the speakers discussed in this dissertation, there are accompanying interviews with non-Pidgin speakers, and though speech accommodation research suggests that speakers alter the way they speak depending on their interlocutor (e.g., Giles et al. 1991), it remains to be seen whether, how, and across what lines this variation takes place in Hawaiʻi. Another potential re-tooling of the PDM score would be to weight some morpho-syntactic categories or variables more heavily than others in the calculation of PDM score. It is possible (and indeed probable) that certain morpho-syntactic elements might occur at higher rates for Pidgin speakers, or that certain elements might be more salient to Pidgin speakers. These are open questions to be discussed in further research.

There is also a wealth of research that may be undertaken in perception. It is unclear if Pidgin speakers discriminate what appears to be a long/short pair (e.g., SHCHRIT-STIK) in perception by vowel duration. Additionally, future studies could address whether the discussed changes across age group and PDM score are imbued with any social meaning in perception. For example, do Local listeners perceive speakers who produce more similar SHCHRIT and STIK vowel realizations differently from speakers who produce more distinct realizations of these vowel classes? Furthermore, do these perceptions hinge on the way in which two vowel realizations are similar? Finally, future work could address whether any of the changes across age group, gender, or PDM score discussed in this dissertation are above the level of consciousness.

Future research should also look at the effect other social factors (e.g., occupation, ethnicity) have on vowel realizations. There is, for example, a link in the minds of some Locals between a speaker's ethnicity and the way that speaker talks (Drager & Grama 2014); however, the way different ethnic groups vary their language use in Hawaiʻi remains a topic to be addressed.

While this study addresses the behavior of vowels, there remains the question of how consonants vary in their realizations across speakers. Sato (1993) has shown that vocalization of post-vocalic /r/ shows little evidence of decreolization in four speakers over their lifetime; however, it remains an open question whether, for example, vocalization of post-vocalic /r/ varies with respect to gender or age (or, indeed, PDM score). Other consonant realizations (e.g., /d/ where English speakers might exhibit /ð/) might also vary across speakers, as they have been reported to exist in Hawaiʻi English and potentially be markers of Pidgin use as well (Sato 1993). These topics are candidates for future research, as little is known regarding consonant variation in Pidgin.

From a broader perspective, this dissertation underscores the need for further variationist research on creole varieties. Despite the unique sociolinguistic situations that many creoles are born out of, few have been studied from a variationist perspective, especially with respect to acoustic phonetic variation (although see, e.g., Veatch 1991; Sabino 1996, 2012; Wassink 1999, 2001, 2006). Variation is inherent in the structure of languages, and creoles are no exception. Taking a variationist approach to the study of creoles and contact languages can vastly improve the understanding of how creole languages are related to and exhibit variation with the adstrate languages from which they derive their structure.

REFERENCES

Adank, Patti, Roel Smits, and Roeland van Hout. 2004. A comparison of vowel normalization procedures for language variation research. *Journal of the Acoustical Society of America*, 116: 3099–3107.

Akers, Glen Alan. 1981. *Phonological Variation in the Jamaican Continuum.* Ann Arbor: Karoma.

Algeo, John, and Carmen A. Butcher. 2013. *The Origins and Development of the English Language*. Cengage Learning: 7th edition.

Ash, Sharon. 1996. Freedom of movement: /uw/-fronting in the Midwest. In J. Arnold, R. Blake, B. Davidson, S. Schwenter, and J. Solomon (eds.), *Sociolinguistic variation: Data, theory, and analysis*. Stanford, CA: Center for the Study of Language and Information, Stanford University, 3–25.

Awai, Clinton, Holly Britton, Meagan Dailey, Katie Drager, Jonny Kim, M. Joelle Kirtley, Catherine Lee, Claire Stabile. 2014. Factors influencing the pronunciation of Hawaiian place names. Paper presented at *New Ways of Analyzing Variation-Asia Pacific 3* in Wellington, New Zealand, May 2014.

Babbit, E. H. 1896. The English of the lower classes in New York City and vicinity. *Dialect Notes*, 1: 457–464.

Baranowski, Maciej. 2008. The fronting of the back upgliding vowels in Charleston, South Carolina. *Language Variation and Change*, 20(3): 527–551.

Barras Claude, E Geoffrois, Z Wu, and M Liberman. 2000. Transcriber: development and use of a tool for assisting speech corpora production. *Speech Communication*, 33(1/2).

Bates, Douglas. 2008. Fitting mixed-effects models using the lme4 package in R. Paper presented at the *International Meeting of the Psychometric Society*. New Hampshire, USA, June 2008.

Bates. Douglas. 2006, May 19. lmer, p-values and all that. Message posted to R-help mailing list. https://stat.ethz.ch/pipermail/r-help/2006-May/094765.html

Bates, Douglas, Martin Maechler, Ben Bolker, and Steven Walker. 2014. lme4: Linear mixed-effects models using S4 classes. R package version 1.1-7. http://CRAN.R-project.org/package=lme4

Bauer, Laurie, and Paul Warren. 2004. New Zealand English phonology. In B. Kortmann, W. Schneider, K. Burridge, R. Mesthrie, and C. Upton (eds.), *A Handbook of Varieties of English: A Multimedia Reference Tool*. Berlin: Mouton de Gruyter, 1, 580–602.

Becker, Kara, Anna Aden, Katelyn Best, Haley Jacobson. 2015. Variation in West Coast English: The case of Oregon. *2015 Meeting of the Linguistics Society of America*, Portland, OR, January, 2015.

Beddor, Patrice S. 1982. Phonological and phonetic effects of nasalization on vowel height. Ph.D. dissertation, University of Minnesota.

Beddor, Patrice S., Rena A. Krakow, and Louis M. Goldstein. 1986. Perceptual constraints and phonological change: A study of nasal vowel height. *Phonology Yearbook*, 3: 197–217.

Beechert, Edward D. 1985. *Working in Hawaii: A Labor History*. Honolulu: University of Hawaiʻi Press.

Bell, Allan. 1984. Language style as audience design. *Language in Society* 13: 145–204.

Bernard, J. 1985. Some local effects of post-vocalic [l]. *Festschrift in Honour of Arthur Delbridge*. Beitrage Zur Phonetik und Linguistik, 48: 319–332.

Bickerton, Derek. 2008. *Bastard Tongues: A Trail-Blazing Linguist Finds Clues to Our Common Humanity in the World's Lowliest Languages*. Hill and Wang: New York.

Bickerton, Derek. 1983. Creole languages. *Scientific American*, 249(1): 116–122.

Bickerton, Derek. 1981. *Roots of language*. Ann Arbor: Karoma.

Bickerton, Derek. 1977. *Change and Variation in Hawaiian English II: Creole Syntax*. Final Report on NSF Project No. GS-39748.

Bickerton, Derek, and Carol Odo. 1976. *Change and Variation in Hawaiian English I: General phonology and Pidgin syntax*. Final report on NSF No. GS-39748.

Blake, Renée, and Meredith Josey. 2003. The /ay/ diphthong in a Martha's Vineyard community: What can we say 40 years after Labov? *Language in Society*, 32: 451–485.

Boersma, Paul. 2001. Praat, a system for doing phonetics by computer. *Glot International, 5:* 341–345.

Bradley, James. 2009. *The Imperial Cruise: A secret history of empire and war*. New York: Little, Brown and Company.

Bybee, Joan. 2002. Word frequency and context of use in the lexical diffusion of phonetically conditioned sound change. *Language Variation and Change* 14: 261–290.

Carignan, Christopher, Ryan Shosted, Chilin Shih, and Panying Rong. 2010. Oral co-articulatory response to vowel nasalization. Paper presented at UIUC Linguistics Colloquium, Urbana, IL, September, 2010.

Carver, Craig M. 1987. *American Regional Dialects: A World Geography*. Ann Arbor: University of Michigan Press.

Chambers, J. K. 1989. Canadian Raising: Blocking, fronting, etc. *American Speech*, 64(1): 75–88.

Chambers, J. K., and Margaret F. Hardwick. 1985. Dialect homogeneity and incipient variation: Changes in progress in Toronto and Vancouver. In J. Harris and R. Hawkins (eds.), *Sheffield working papers in language and linguistics,* Sheffield: School of Modern Language and Linguistics, University of Sheffield, 28–49.

Chen, Matthew. 1970. Vowel length variation as a function of the voicing of the consonant environment. *Phonetica* 22: 129–159.

Chock, Eric. 1998. Da glove. In Eric Chock, James R. Harstad, Darrell H. Y. Lum, and Bill Teter (eds.), *Growing Up Local*, 28–29.

Clarke, Sandra, Ford Elms, and Amani Youssef. 1995. The third dialect of English: Some Canadian evidence. *Language Variation and Change*, 7(2): 209–228.

Clopper, Cynthia G., David B. Pisoni, and Kenneth de Jong. 2005. Acoustic characteristics of the vowel systems of six regional varieties of American English. *Journal of the Acoustical Society of America*, 118(3): 1661–1676

Collerson, Kenneth D., and Marshall I. Weisler. 2007. Stone adze compositions and the extent of ancient Polynesian voyaging and trade. *Science*, 317: 1907–1911.

Cox, Felicity. 1999. Vowel change in Australian English. *Phonetica* 56: 1–27.

Cox, Felicity, and Sallyanne Palenthorpe. 2003. The border effect: Vowel differences across the NSW - Victorian Border. *Proceedings of the 2003 Conference of the Australian Linguistic Society*, 1–14.

Craioveanu, Radu. 2011. Using two-dimensional box plots to visualize the vowel space: A study of rounded vowel allophones in Tigrinya. *Canadian Acoustics*, 39(3): 156–157.

Craig, Holly K., and Julie A. Washington. 2006. *Malik Goes to School: Examining the Language Skills of African American Students from Preschool-5th Grade*. Mahwah, New Jersey: Lawrence Erlbaum Associates.

Da Pidgin Coup. 1999. Pidgin and education: A position paper. University of Hawaiʻi. http://www.hawaii.edu/sls/pidgin.html

Daur Rebecca M. 1983. Stress-timing and syllable-timing re-analysed. *Journal of Phonetics* 11: 51–62.

Day, Richard. 1972. Patterns of variation in copula and tense in the Hawaiian post-creole continuum. Ph.D. dissertation. University of Hawaiʻi at Mānoa.

DeCamp, David. 1971. Towards a generative analysis of post-creole speech continuum. In D. Hymes (ed.), *Pidginization and Creolization of Languages*, Cambridge: Cambridge University Press, 349–370.

DeCamp, David. 1961. Social and geographical factors in Jamaican dialects. In R. LePage (ed.) *Creole Language Studies II*, London: Macmillan, 61–84.

de Jong, Kenneth. 1995. On the status of redundant features: The case of backing and rounding in American English. In Bruce Connell and Amalia Arvaniti (eds.) *Phonology and Phonetic Evidence: Papers in Laboratory Phonology IV*, New York, NY: Cambridge University Press.

de Jong, Nivja H., and Ton Wempe. 2009. Praat script to detect syllable nuclei and measure speech rate automatically. *Behavior Research Methods*, 41(2): 385–390.

Delattre, Pierre. 1962. Some factors of vowel duration and their cross-linguistic validity. The *Journal of the Acoustical Society of America*, 34(8): 1141–1143.

DiCanio, Christian. 2013, October 22. Visualizing vowel space in R: from points to contour maps. http://christiandicanio.blogspot.com/2013/10/visualizing-vowel-spaces-in-r-from.html

Donegan, Patricia. 1978. On the natural phonology of vowels. Ph.D. dissertation. The Ohio State University.

Donegan, Patricia, and David Stampe. 2009. Hypotheses of natural phonology. *Poznan Studies in Contemporary Linguistics*, 45(1): 1–31.

Drager, Katie. in prep. Introducing SOLIS.

Drager, Katie. 2012. Pidgin and Hawaiʻi English: an overview. *Journal of Language, Translation and Intercultural Communication*, 1(1): 61–73.

Drager, Katie, and James Grama. 2014. ‘de tawk dakain ova dea’: Mapping language ideologies on Oʻahu. *Dialectologia*, 12: 23–51.

Drager, Katie, M. Joelle, James Grama, and Sean Simpson. 2013. Language variation and change in Hawai‘i English: KIT, DRESS, and TRAP. *University of Pennsylvania Working Papers in Linguistics*, 19(2): 41–50.

Drager, Katie, M. Joelle Kirtley, James Grama, Sean Simpson, and Rebecca Clifford. 2012. Phonetic variation and change in Hawai‘i English. Linguistics Tuesday Seminar, University of Hawai‘i at Mānoa, May 2012.

Durian, David. 2012. A new perspective on vowel variation across the 19th and 20th centuries in Columbus, OH. Ph.D. dissertation, the Ohio State University.

Eckert, Penelope. n.d. The trouble with authenticity. In Véronique Lacoste, Jakob Leimgruber, and Thiemo Breyer (eds.), *Indexing authenticity: Sociolinguistic perspectives*. Berlin & New York: de Gruyter, p. 43–54.

Eckert, Penelope. 2008. Where do ethnolects stop? *International Journal of Bilingualism,* 12(1/2): 25–42.

Eckert, Penelope. 1989. *Jocks and burnouts: Social identity in the High School*. New York: Teachers College Press.

Escure, Geneviève. 1981. Decreolization in a creole continuum: Belize. In A. Highfield and A. Valdman (eds.) *Historicity and variation in creole studies*. Ann Arbor: Karoma Publishers.

Evanini, Keelan, Ingrid Rosenfelder and Josef Fruehwald. 2012. stat_ellipse. Available at https://raw.github.com/low-decarie/FAAV/master/r/stat-ellipse.R

Fasold, Ralph. 1969. A sociolinguistic study of the pronunciation of three vowels in Detroit speech. Mimeographed.

Ferguson, Charles A. 1959. Diglossia. *Word*, 15: 325–340.

Flemming, Edward S. 2013. *Auditory Representations in Phonology*. New York, NY: Routledge.

Flemming, Edward, and Stephanie Johnson. 2007. Rosa’s roses: reduced vowels in American English. *Journal of the International Phonetic Association*, 37(1): 83–96.

Francis, Alexander L., Valter Ciocca, and Jojo Man Ching Yu. 2003. Accuracy and variability of acoustic measures of voicing onset. *Journal of the Acoustical Society of America*, 113(3): 1025–1032.

Freeman, Valerie. 2014. Bag, beg, bagel: Prevelar raising and merger in Pacfici Northwest English. *University of Washington Working Papers in Linguistics*, 32.

Fridland, Valerie, Tyler Kendall, and Craig Fickle. 2015. It's Neva-ae-da, not nev-ah-da! *2015 Meeting of the Linguistics Society of America*, Portland, OR, January, 2015.

Fromont, Robert, and Jennifer Hay. 2012. LaBB-CAT: An annotation store. In *Proceedings of Australasian Language Technology Association Workshop*, 10: 113–117.

Fry, D. B., Arthur D. Abramson, Peter D. Eimas, and Alvin M. Liberman. 1962. The identification and discrimination of synthetic vowels. *Language and Speech*, 5: 171–189.

Gay, Thomas. 1978. Effect of speaking rate on vowel formant movements. *Journal of the Acoustical Society of America*, 63(1): 223–230.

Gay, Thomas. 1968. Effect of speaking rate on diphthong formant movements. *Journal of the Acoustical Society of America*, 44(6): 1570–1573.

Giles, Howard, Nikolas Coupland, and Justine Coupland. 1991. Accommodation theory: Communication, context, and consequence. In Howard Giles, Justine Coupland, and Nikolas Coupland (eds.) *Contexts of Accommodation*, New York, NY: Cambridge University Press.

Gordon, Matthew J. 2004. New York, Philadelphia, and other northern cities: phonology. In Edgar W. Schneider, Kate Burridge, Bernd Kortmann, Rajend Mesthrie, and Clive Upton (eds.) *A Handbook of Varieties of English: Vol 1: Phonology*, Berlin: Mouton de Gruyter, 282–299.

Gorter, Durk. 2006. (Ed.) *Linguistic Landscape: New Apporach to Multilingualism*. Clevedon: Multilingual Matters.

Grimes, Joseph E. 2010. From terse to loose: Translating Hebrew poetry into Hawai'i Pidgin. *SIL e-Books*, 19: 416–433.

Hall-Lew, Lauren. 2010a. Ethnicity and sociolinguistic variation in San Francisco. *Language and Linguistics Compass*, 4(7):458–472.

Hall-Lew, Lauren. 2010b. Improved representation of variance in measures of vowel merger. *Proceedings of Meetings on Acoustics*, 9(1): 1–10.

Hall-Lew, Lauren. 2009. Ethnicity and phonetic variation in a San Francisco neighborhood. Ph.D. dissertation. Stanford University.

Hall-Lew, Lauren. 2004. The western vowel shift in northern Arizona. Manuscript, Stanford University. URL http://www.stanford.edu/~dialect/Hall-Lew%20QP1.pdf

Harrington, Jonathan. 2007. Evidence for a relationship between synchronic variability and diachronic change in the Queen's annual Christmas broadcasts. In J. Cole and J. Hualde *Laboratory Phonology 9,* Berlin: Mouton de Gruyter, 125–143.

Harrington, Jonathan, Felicitas Kleber, and Ulrich Reubold. 2008. Compensation for coarticulation, /u/-fronting, and sound change in standard southern British: An acoustic and perceptual study. *Journal of the Acoustical Society of America*, 123(5): 2825–2835.

Harrington, Jonathan, and Steve Cassidy. 1999. *Techniques in Speech Acoustics*. Kluwer Academic Publishers: Dordrecht, The Netherlands.

Hay, Jennifer, Katie Drager, and Brynmor Thomas. 2013. Using nonsense words to investigate vowel merger. *English Language and Linguistics*, 17(2): 241–269.

Hay, Jennifer, Aaron Nolan, and Katie Drager. 2006. From fush to feesh: Exemplar priming in speech perception. *The Linguistic Review*, 23: 351–379.

Hickey, Raymond. 2004. The phonology of Irish English. In B. Kortmann and C. Upton (eds.), *Varieties of English 1: The British Isles*, Berlin/New York: Mouton de Gruyter, 68–97.

Higgins, Christina, Richard Nettell, Gavin Furukawa, and Kent Sakoda. 2012. Beyond contrastive analysis and codeswitching: Student documentary filmmaking as a challenge to linguicism in Hawai'i. *Linguistics and Education*, 23: 46–61.

Hoenigswald, Henry M. 1978. Secondary split, typology, and universals. In J. Fisiak (ed.), *Recent Developments in Historical Phonology*, The Hague: Mouton.

House, Arthur S. 1961. On vowel duration in English. *The Journal of the Acoustical Society of America*, 33(9): 1174–1178.

Irons, Terry Lynn. 2007. On the status of low back vowels in Kentucky English: More evidence of merger. *Language Variation and Change*, 19: 137–180.

Jacewicz, Ewa, Robert Allen Fox, and Joseph Salmons. 2011. Cross-generational vowel change in American English. *Language Variation and Change*, 23: 45–86.

Johnson, Keith. 2012. *Acoustic and Auditory Phonetics, 3rd edition*. U.S. and U.K.: Wiley/Blackwell.

Kager, Rene. 1999. *Optimality Theory*. Cambridge: Cambridge University Press.

Kawamoto, Kevin Y. 1993. Hegemony and language politics in Hawai'i. *World Englishes*, 12(2): 193–207.

Kearns, Yokanaan. 2000. *Pidg Latin and How Kitty Got Her Pidgin Back*. Honolulu: Honolulu Theatre for Youth & Kumu Kahua Theatre.

Kennedy, Robert, and James Grama. 2012. Chain shifting and centralization in California vowels: An acoustic analysis. *American Speech*, 87(1): 39–56.

Kent, Ray D. 1996. Hearing and believing: Some limits to the auditory-perceptual assessment of speech and voice disorders. *American Journal of Speech-Language Pathology*, 5: 7–23.

Kent, Noel J. 1993. *Hawaii: Islands Under the Influence*. Honolulu: University of Hawaiʻi Press.

Kessinger, Rachel H., and Sheila E. Blumstein. 1998. Effects of speaking rate on voice-onset time and vowel production: Some implications for perception studies. *Journal of Phonetics* 26: 117–128.

Kirtley, M. Joelle, Katie Drager, James Grama, and Sean Simpson. forthcoming. An acoustic analysis of the vowels of Hawaiʻi English.

Klatt, Dennis H. 1976. Linguistic uses of segmental duration in English: Acoustic and perceptual evidence. *The Journal of the Acoustical Society of America*, 59(5): 1208–1221.

Koops, Christian. 2010. /u/-fronting is not monolithic: Two types of fronted /u/ in Houston Anglos. *University of Pennsylvania Working Papers in Linguistics*, 16(2): 113–122.

Kurath, Hans. 1939. *Handbook of the Linguistic Geography of New England*. Providence, RI: Brown University.

Labov, William. 2008. Triggering events. In S. Fitzmaurice and D. Minkova (eds.), *Studies in the History of the English Language IV: Empirical and Analytical Advances in the Study of English Language Change*. Berlin: Mouton de Gruyter, 11–54.

Labov, William. 2001. *Principles of Linguistic Change, Volume 2: Social Factors*. Massachusetts: Wiley/Blackwell.

Labov, William. 1994. *Principles of Linguistic Change, Volume 1: Internal Factors*. Massachusetts: Wiley/Blackwell.

Labov, William. 1972. Some principles of linguistic methodology. *Language in Society*, 1: 97–120.

Labov, William. 1971[1990]. On the adequacy of natural language: the development of tense. In J. V. Singler (ed.) *Pidgin and Creole Tense-Mood-Aspect Systems*, Amsterdam/Philadelphia: John Benjamins, 1–58.

Labov, William. 1966. *The social stratification of English in New York City*. Washington D.C.: Center for Applied Linguistics.

Labov, William. 1963. The social motivation of a sound change. *Word*, 19: 273–209.

Labov, William, Malcah Yaeger, and Richard Steiner. 1972. *A Quantitative Study of Sound Change in Progress*. Report on National Science Foundation Contract GS-3287. Philadelphia: U.S. Regional Survey.

Labov, William, Sharon Ash, and Charles Boberg. 2006. *The Atlas of North American English.* New York: Mouton de Gruyter.

Langstrof, Christian. 2009. On the role of vowel duration in the New Zealand English front vowel shift. *Language Variation and Change*, 21: 437–453.

Lawton, David Lloyd. 1963. Suprasegmental phenomena in Jamaican Creole. Ph.D. dissertation, Michigan State University.

LePage, Robert. 1980. Theoretical aspects of sociolinguistic studies in pidgin and creole languages. In A. Valdman and A. Highfield (eds.) *Theoretical Orientations in Creole Studies*, New York: Academic Press, 331–351.

LePage, Robert. 1960. *Jamaican Creole: An historical introduction to Jamaican Creole*. London: Macmillan.

LePage, Robert, and Andrée Tabouret-Keller. 1985. *Acts of Identity*. Cambridge: Cambridge University Press.

Lewis, M. Paul, Gary F. Simons, and Charles D. Fennig (eds.). 2015. *Ethnologue: Languages of the World, Eighteenth edition*. Dallas, Texas: SIL International. Online version: http://www.ethnologue.com

Lindblom, B. 1963. Spectrographic study of vowel reduction. *Journal of the Acoustical Societal America*, 35(11): 1173–1781.

Lisker, Leigh. 1988. On the articulatory interpretation of vowel “quality”: The dimension of rounding. *Journal of the International Phonetic Association*, 19(1): 24–30.

Lobanov, B. M. 1971. Classification of Russian vowels spoken by different speakers. *The Journal of the Acoustical Society of America*, 49(2): 606–608.

Lum, Darrel H. Y. 1999. YMCA: The weightroom. In John R. Rickford and Suzanne Romaine (eds.) *Creole Genesis, Attitudes and Discourse: Studies Celebrating Charlene J. Sato*, Amsterdam/Philadelphia: John Benjamins, 19–27.

Luthin, H. W. 1987. The story of California (ow): the coming-of-age of English in California. In K. M. Denning, S. Inkelas, F. C. McNair-Knox, and J. R. Rickford (eds.), *Variation in Language: NWAV-XV at Stanford,* Stanford: Department of Linguistics, Stanford University, 312–324.

Mack, Molly. 1982. Voicing-dependent vowel duration in English and French: Monolingual and bilingual production. *The Journal of the Acoustical Society of America*, 71(1): 173–178.

Majors, Tivoli. 2005. Low back vowel merger in Missouri speech: Acoustic description and explanation. *American Speech*, 80(2): 165–179.

Marlow, Mikaela L., and Howard Giles. 2010. 'We won't get ahead speaking like that!' Expressing and managing language criticism in Hawai'i. *Journal of Multilingual and Multicultural Development*, 31(3): 237–251.

Marlow, Mikaela L., and Howard Giles. 2008. Who you tink you, talkin propah? Hawaiian Pidgin demarginalized. *Journal of Multicultural Discourses*, 3(1): 53–68.

Menclik, Corinna. 2013. Canadian raising: Phonetic and social factors. Ph.D. dissertation. Universität Wien.

Meyerhoff, Miriam. 2004. Attitudes to gender and creoles: A case study on mokes and titas. *Te Reo* 47: 63–82.

Milroy, J. and L. Milroy. 1978. Belfast: change and variation in an urban vernacular. In P. Trudgill (ed.), *Sociolinguistic patterns in British English*. London: E. Arnold, 19–36.

Moore, Christopher. 2010, September 7. Linear mixed-effects regression p-values in R: A likelihood ratio test function. http://blog.lib.umn.edu/moor0554/canoemoore/2010/09/lmer_p-values_lrt.html

Narayan, Kirin. 'How native is a "native" anthropologist?' *American Anthropologist* 95(3): 657–686.

Neary, Terrance M. 1977. *Phonetic Features System for Vowels*. Ph.D. dissertation. University of Alberta. Reprinted 1978 by the Indiana University Linguistics Club.

NeSmith, Keao. 2003. Tutu's Hawaiian and the emergence of a Neo-Hawaiian language. *'Oiwi: A Native Hawaiian Journal*, 3: 68–77.

Nespor, Marina, Mohinish Shukla, and Jacques Mehler. 2011. Stress-timed vs. syllable-timed languages. In Marc van Oostendorp, Colin J. Ewen, Elizabeth Hume and Keren Rice (eds.), *Companion to Phonology*, Blackwell, 1147–1159.

Odo, Carol. 1977. Phonological representation in Hawaiian English. *University of Hawai'i Working Papers in Linguistics*, 9:77–85.

Odo, Carol. 1975. Phonological processes in the English dialect of Hawaii. Ph.D. dissertation. University of Hawai'i at Mānoa.

Odo, Carol. 1970. English patterns in Hawaii. *American Speech*, 45(3/4): 234–239.

Oetting, Janna B., and Janet L. McDonald. 2002. Methods for characterizing participants' nonmainstream dialect use in child language research. *Journal of Speech, Language, and Hearing Research*, 45: 505–518.

Ohama, Mary Lynn Fiore, Carolyn C. Gotay, Ian S. Pagano, Larry Boles, and Dorothy D. Craven. 2000. Evaluations of Hawaii Creole English and Standard English. *Journal of Language and Social Psychology*, 19: 357–377.

Ohnuma, Keiko. 2002. Local Haole – a contradiction of terms? The dilemma of being white, born and raised in Hawaiʻi. *Cultural Values* 6(3): 273–285.

Olson, Chester L. 1976. On choosing a test statistic in multivariate analysis of variance. *Psychological Bulletin*, 83(4): 579–586.

Overstreet, Maryann. 2005. And stuff, und so: Investigating pragmatic expressesions in English and German. *Journal of Pragmatics* 37: 1845–1864.

Patrick, Peter L. 2009. Pidgins, creoles and linguistic variation. In S. Kouwnberg and J. V. Singler (eds.) *The Handbook of Pidgins and Creoles*, Mahwah MA: Blackwell, 461–487.

Patrick, Peter L. 1999. Testing the creole continuum. *University of Pennsylvania Working Papers in Linguistics,* 6(2): 109–120.

Penhallurick, Robert. 2008. Welsh English: phonology. In B. Kortmann and C. Upton (eds.), *Varieties of English 1: The British Isles*, Berlin/New York: Mouton de Gruyter, 105–121.

Perkell, Joseph S., Melanie L. Matthies, Mario A. Svirsky, and Michael I. Jordan. 1993. Trading relations between tongue-body raising and lip rounding in production of the vowel /u/: A pilot "motor equivalence" study. *The Journal of the Acoustical Society of America* 93(5): 2948–2961.

Phillips, Betty S. Word frequency and the actuation of sound change. *Language* 60: 320–342.

Pukui, Mary Kawena, and Samuel H. Elbert. 1986. *Hawaiian Dictionary: Hawaiian-English, English-Hawaiian*. University of Hawaiʻi Press.

Purcell, April K. 1984. Code shifting Hawaiian style: Children's accommodation along a decreolizing continuum. *International Journal of the Sociology of Language,* 46: 71–86.

Purcell, April K. 1979. Variation in speech by children in Hawaii. Unpublished Ph.D. thesis, University of Hawaiʻi.

Purnell, Thomas C. 2008. Prevelar raising and phonetic conditioning: The role of labial and anterior tongue gestures. *American Speech*, 83(4): 373–402.

R Core Team. 2013. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL http://www.R-project.org/

Reinecke, John E. 1969. *Language and Dialect in Hawaii*. Honolulu, HI: University of Hawai‘i Press.

Reinecke, J. E. 1938. ‘Pidgin English’ in Hawai‘i: A local study in the sociology of language. *American Journal of Sociology*, 43(5): 778–789.

Reynolds, S. B. 1999. Mutual intelligibility?: Comprehension problems between American Standard English and Hawai‘i Creole English in Hawai‘i’s public schools. In J. R. Rickford and S. Romaine *Creole Genesis, Attitudes and Discourse,* Amsterdam/Philadelphia: John Benjamins, 303–322.

Rickford, John R. 1987. *Dimensions of a Creole Continuum*. Stanford University Press.

Ripley, Brian D. n.d. loess: local polynomial regression fitting. Available at http://www.netlib.org/a/

Roberts, Sarah J. 2011. The copula in Hawai‘i Creole English and substrate reinforcement. In Claire Lefebrve (ed.) *Creoles, Their Substrates, and Language Typology*, Amsterdam/Philadelphia: John Benjamins, 557–573.

Roberts, Sarah J. 2004. The role of style and identity in the development of Hawaiian Creole. In G. Escure and A. Schwegler (eds.) *Creoles, Contact, and Language Change: Linguistic and social implications*, 1–20.

Roberts, Sarah J. 1998. The role of diffusion in the genesis of Hawaiian Creole. *Language* 74: 1–39.

Romaine, Suzanne. 1999. Changing attitudes to Hawai‘i Creole English: Fo’ find one good job, you gotta know how fo’ talk like one haole. In John R. Rickford and Suzanne Romaine (eds.) *Creole Genesis, Attitudes and Discourse: Studies celebrating Charlene J. Sato,* Amsterndam/Philadelphia: John Benjamins, 287–302.

Sabino, Robin. 2012. *Language contact in the Danish West Indies: Giving Jack his Jacket*. Brill Publishers.

Sabino, Robin. 1996. A peak at death: Assessing continuity and change in an underdocumented language. *Language, Variation and Change* 8(1): 41–61.

Sakoda, Kent, and Jeff Siegel. 2008. Hawai‘i Creole: phonology. In Berndt Kortmann and Edgar W. Schneider (eds.) *A Handbook of Varieties of English, Volume I: Phonology*. Berlin: Mouton de Gruyter, 729–749.

Sakoda, Kent, and Jeff Siegel. 2003. *Pidgin Grammar: An Introduction to the Creole English of Hawai'i*. Bess Press, Inc.

Sankoff, Gillian. 2006. Apparent time and real time. *Elsevier Encyclopedia of Language and Linguistics*. Amsterdam: Elsevier, 110–116.

Sankoff, Gillian, and Helene Blondeau. 2007. Language change across the lifespan: /r/ in Montreal French. *Language* 83(3): 560–588.

Sato, Charlene J. 1993. Language change in a creole continuum: decreolization? In Kenneth Hyltenstam and Åke Viberg (eds.), *Progression & regression in language: Sociocultural, neuropsychological & linguistic perspectives.* Cambridge: Cambridge University Press, 122–143.

Sato, Charlene J. 1991. Sociolinguistic variation and language attitudes in Hawai'i. In Jenny Cheshire (ed.) *English Around the World: Sociolinguistic Perspectives*. Cambridge: Cambridge University Press, 647–663.

Savariaux, Christophe, Pascal Perrier, and Jean Pierre Orliaguet. 1995. Compensation strategies for the perturbation of the rounded vowel [u] using a lip tube: A study of the control space in speech production. *The Journal of the Acoustical Society of America* 96(5): 2428–2442.

Scaglion, Richard, and María-Auxiliadora Cordero. 2011. Did ancient Polynesians reach the New World? Evaluating evidence from the Ecuadorian Gulf of Guayaquil. In T. Jones, A. A. Storey, E. A. Matisoo-Smith, and J. M. Ramírez-Aliaga (eds.) *Polynesians in America: Pre-Columbian Contacts with the New World*, Atlamira Press, Landham, MD, 171–193.

Schütz, Albert J. 1981. A reanalysis of the Hawaiian vowel system. *Oceanic Linguistics* 20(1): 1–44.

Siegel, Jeff. 2000. Substrate influence in Hawai'i Creole English. *Language in Society*, 29(2): 197–236.

Simonson, Douglas, Pat Sasaki, and Ken Sakata. 2005. *Pidgin to Da Max: 25th Anniversary Edition*. Bess Press, Inc.

Simpson, Sean. 2014. Phonetic cues to Localness in Hawai'i English: Feature clusters influencing perception. Paper presented at *New Ways of Analyzing Variation 43*, Chicago, USA, October 2014.

Simpson, Sean. 2013. Preliminary results: Phonetic variation and perceived Localness in Hawai'i. Paper presented at *The 17th Annual Graduate Student Conference of the College of Languages, Linguistics, and Literature.*

Simpson, Sean, Katie Drager, James Grama, and Joelle Kirtley. 2014. Variation and change in the back vowels of Hawai‘i English. Paper presented at *New Ways of Analyzing Variation 43*. Chicago, USA, October 2014.

St. Clair, Robert N., and Harold M. Murai. 1974. Code switching in Hawaiian creole. *Kansas Journal of Sociology* 10(1): 75–82.

Strelluf, Christopher. 2014. ‘We have such a normal, non-accented voice’: A sociophonetic study of English in Kansas City. Colombia, MO: University of Missouri Ph.D. dissertation.

Stuart-Smith, Jane. 2008. Scottish English: Phonology. In B. Kortmann and C. Upton (eds.), *Varieties of English 1: The British Isles*, Berlin/New York: Mouton de Gruyter, 48–70.

Sullivan, Gail M, and Richard Feinn. 2012. Using effect size—or why the p-value is not enough. *Journal of Graduate Medical Education*, 4(3): 279–282.

Tamura, Eileen H. 1993. The English-only effort, the anti-Japanese campaign, and language acquisition in the education of Japanese Americans in Hawai‘i, 1915-40. *History of Education Quarterly*, 33(1): 37-58.

Thomas, Erik. 2001. *An Acoustic Analysis of Vowel Variation in New World English.* Duke University Press.

Tonouchi, Lee A. 1998. Where to put your hands. In Eric Chock, James R. Harstad, Darrell H. Y. Lum, and Bill Teter (eds.), *Growing up local: An anthology of poetry and prose from Hawai‘i*, 245–252.

Trager, George L., and Bernard Bloch. 1941. The syllabic phonemes of English. *Language* (17: 223–246.

Trudgill, Peter. 1999[2011]. Standard English: what it isn’t. In Tony Bex and Richard J. Watts (eds.) *Standard English: the widening debate*. London: Routledge, 117–128).

Trudgill, Peter. 1988. Norwich revisited: Recent linguistic changes in an English urban dialect. *English World-Wide*, 9: 33–49.

Tsuzaki, Stanley M. 1971. Coexistent systems in language variation: The case of Hawaiian English. In D. Hymes (ed.) *Pidginization and Creolization of Languages*. Cambridge: Cambridge University Press, 327–340.

U.S. Census Bureau. 2010. Race data. Retrieved (August 2014) from http://www.census.gov/en.html and http://www.censusrecords.com/

Van Hofwegen, Janneke, and Walt Wolfram. 2010. Coming of age in African American English: A longitudinal study. *Journal of Sociolinguistics*, 14, 4: 427–455.

Vanderslice, Ralph, and Laura Shun Pierson. 1967. Prosodic features of Hawaiian English. *Quarterly Journal of Speech*, 53: 156–166.

Veatch, Thomas C. 1991. English vowels: Their surface phonology and phonetic implementation in vernacular dialects. Ph.D. dissertation, University of Pennsylvania.

Vellupillai, Viveka Lalitha. 2003. *Hawaiʻi Creole English: A typological analysis of the tense-mood-aspect system*. Bassingstoke: Palgrave Macmillan.

Walworth, Mary. 2014. Eastern Polynesian: The linguistic evidence revisited. Oceanic Linguistics, Volume 53(2): 256–272.

Wang, William S. Y. 1969. Competing changes as a cause of residue. *Language* 49: 9–25.

Wassink, Alica Beckford. 2011. Vowel reduction and merger in Pacific Northwest English. *The Journal of the Acoustical Society of America*, 129(4): 2452.

Wassink, Alicia Beckford. 2006. A geometric representation of spectral and temporal vowel features: Quantification of vowel overlap in three linguistic varieties. *The Journal of the Acoustical Society of America*, 119(4): 2334–2350.

Wassink, Alicia Beckford. 2001. Theme and variation in Jamaican vowels. *Language Variation and Change*, 13: 135–159.

Wassink, Alicia Beckford. 1999. A sociophonetic analysis of Jamaican vowels. Ph.D. dissertation. University of Michigan.

Wassink, Alicia Beckford and John Riebold. 2013. Individual variation and linguistic innovation in the American Pacific Northwest. *Chicago Linguistic Society (CLS 49) Workshop on Sound Change Actuation*, 18–20..

Watson, Catherine I., Margaret Maclagen, and Jonathan Harrington. 2000. Acoustic evidence for vowel space in New Zealand English. *Language Variation and Change*, 12: 51–68.

Weisler, Marshall. 1998. Hard evidence for prehistoric interaction in Polynesia. *Current Anthropology*, 39(4): 521–532.

Wells, John C. 2010. Lexical sets. Blogpost retrieved from http://phonetic-blog.blogspot.com/2010/02/lexical-sets.html

Wells, John C. 1982. *Accents of English*. Cambridge: Cambridge University Press.

Whitehead, John S. 1993. The anti-statehood movement and the legacy of Alice Kamokila Campbell. *The Hawaiian Journal of History*, 27: 43–63.

Wickham, Henry. 2014. ggplot2: elegant graphics for data analysis. Spring New York, 2009.

Wilmshurst, Janet M., Terry L. Hunt, Carl P. Lipo, and Atholl J. Anderson. 2011. High precision radiocarbon dating shows recent and rapid initial human colonization of East Polynesia. *Proceedings of the National Academy of Sciences*, 108(5): 1815–1820.

Wolfram, Walt and Janneke Van Hofwegen. 2012. Composite dialect indexes confront variationism: The case of AAE. Paper presented at *New Ways of Analyzing Variation 41*. Bloomington, IN, October 2012.

Wong, Laiana. 1999. Language varieties and language policy: The appreciation of Pidgin. In Thom Huebner, Kathryn A. Davis and Joseph L. Bianco (eds.) *Sociopolitical Perspectives on Language Policy and Planning in the USA*. Philadelphia, PA: John Benjamins, 205–222.

Yokota, Thomas. 2008. The ‘Pidgin problem’: Attitudes about Hawai‘i Creole. *Educational Perspectives*, 41: 22–29.

Young, Steven J. 1994. The HTK hidden markov model toolkit: Design and Philosophy. *Entropic Cambridge Research Laboratory, Ltd.*, 2: 2–44.

Zeller, Christine. 1997. The investigation of a sound change in progress: /æ/ to /e/ in Midwestern American English. *Journal of English Linguistics*, 25(2): 142–155.

APPENDIX A

THE ODO ORTHOGRAPHY

The Odo Orthography is a spelling system for Hawai‘i Creole (Pidgin) created by the late Dr. Carole Odo in the 1970s for the Nonstandard Hawaiian English Project, directed by Dr. Derek Bickerton (Professor Emeritus, Linguistics, University of Hawai‘i at Mānoa). Modifications were made by the late Dr. Charlene (Charlie) Sato and Kent Sakoda in the early 1990s. The orthography is adopted throughout this dissertation. This information has been adopted from the Sakoda and Siegel (2003: 24-25) and the 2014 handout (circulated biannually at *Da Pidgin Coup* (*da pijin ku[p]*).

Consonants	Examples	English equivalent
p	*pau, pepa*	‘finish (v.)/finished (adj.)’ (Hwn.), paper
t	*tin, tita, fait*	thin/tin, ‘sister’ (Eng. through Hwn.), fight
k	*tek, joka*	take, joker
b	*be, raba*	bay, robber
d	*brid, dawg, kad*	breathe/breed, dog, cod/card
g	*gaDa, baga*	gotta, bugger
h	*hauzit, haed*	‘how’s it/hello’(Eng.) had
f	*fani, aefta*	funny, after
v	*neva, haev*	never (never/didn’t/haven’t), have
s	*samting, mas*	something, must
z	*izi, briz*	easy, breeze
ch	*chrai, bachi, chok*	try, ‘retribution’ (Jp.), choke
sh	*shchrit, shuga, shev*	street, sugar, shave
j	*jraiv, meja, baj*	drive, measure/major, barge/badge
m	*make, mek, hemo*	‘die’ (Hwn.), make, ‘remove’ (Hwn.)
n	*nais, entatein*	nice, entertain
ng	*ring, baengk*	ring, bank
r	*rabish, krai*	rubbish, cry
l	*lolo, ple, pul*	‘stupid’ (Hwn.), play, pull
y	*yae, kyut*	yeah, cute
w	*wea, kwik*	where/wear, quick
D	*kaDaoke, taDantaDan, faDa*	karaoke, ‘acting stupid’, father/farther/farter
ts	*tsunami, shiatsu*	tsunami, shiatsu
‘	*Hawai‘i, Nu‘uanu*	Hawai‘i, Nu‘uanu

Vowels	**Examples**	**English equivalent**
i	*hit, liv, mi*	hit/heat, live (v.)/leave, me
ei	*eij, leit*	age, late
e	*ea, mek, tude, jres, met*	air, make, today, dress, mate/met
ae	*aek, faes, gaes, naechro*	act, fast, gas, natural
a	*aloha, leita, bat, kat*	aloha (Hwn.), later, but/butt/bot, cot/cut/cart
aw	*awf, tawk, dawg*	off, talk, dog
o	*oke, brok*	okay, broke
ou	*vout, gout*	vote, goat
u	*shuz, su, luk, ruki, babuz*	shoes, sue/Sue, look/Luke, rookie, ‘fool’ (Prt.)
ai	*ai, laik, gaiz*	I/eye, like, guys/guise
au	*maut, aut, wau, mauka*	mouth, out, wow, ‘towards the mountains’ (Hwn.)
oi	*boi, joi*	boy, joy
r	*rt, wrd, prifr*	earth, word, prefer

APPENDIX B

DEMOGRAPHICS BY RACE/ETHNICITY FROM 1900 TO 2010 IN HAWAIʻI

The table below shows demographic information collected by of the U.S. Census Bureau separated by decade of the total population of Hawaiʻi, and the percentage of the population across race/ethnicity. The data under each racial/ethnic category is represented as a percent of the total population. "NA" indicates that there is no data for that cell. The option to choose two or more racial or ethnic affiliations was not made available until the 2000 U.S. Census (making it difficult to acquire representative historical data on self-reported mixed racial/ethnic affiliation). Therefore, the percentages reported in this table under "Percent Race" include only those respondents who selected a single race/ethnicity affiliation. When interpreting these results, it is important to remember that census data often underrepresents diversity. Until the year 2000, the U.S. census treated "Asian and Pacific Islander" as one racial category, but provided a breakdown of Native Hawaiians as separate from "Asian and Pacific Islander". For the 2000 U.S. Census, Asian and Pacific Islander was split into two groups: Asian American" and "Native Hawaiian and Other Pacific Islander".

In this table, the column "Other" represents the percentage of people who did not fit into the other categories on this chart. Data for Hawaiʻi from 1910 to 1940 also included one or more other Pacific islands. Race/ethnicity data for these islands was not published separately. For more in-depth U.S. Census numbers across race/ethnic categories, see: http://www.census.gov/topics/population/race.html.

Census Year	Total population	Percent Race											
		White (%)	Black (%)	American Indian, Eskimo, and Aleut (%)	Asian and Pacific Islander[1] (%)	Chinese (%)	Filipino (%)	Japanese (%)	Korean (%)	Vietnamese (%)	Native Hawaiian (full or part)[2] (%)	Other (%)	Two or More Races (%)
2010	1,360,301	24.7	1.6	0.3	40.5	4.0	14.5	13.6	1.8	0.7	5.9	9.3	23.6
2000	1,211,537	24.3	1.8	0.3	47.4	4.7	14.1	16.7	1.9	0.6	9.4	4.8	21.4
1990	1,108,229	33.4	2.5	0.5	61.8	6.2	15.2	22.3	2.2	0.5	12.5	4.7	NA
1980	964,961	33.0	1.8	0.3	60.5	5.8	13.9	24.8	1.9	0.4	12.0	6.1	NA
1970	768,561	38.8	1.0	0.1	57.7	6.8	12.2	28.3	1.1	NA	9.3	2.4	NA
1960	632,772	32.0	0.8	0.1	65.3	6.0	10.9	32.2	NA	NA	16.2	1.8	NA
1950	499,794	22.9	0.5	NA	74.2	6.5	12.2	36.9	1.4	NA	17.2	2.4	NA
1940	423,330	24.5	0.1	NA	73.3	6.8	12.4	37.3	1.6	NA	15.2	2.1	NA
1930	368,336	21.8	0.1	NA	78.0	7.4	17.1	37.9	NA	NA	13.8	1.9	NA
1920	255,912	21.3	0.1	NA	78.4	8.4	8.2	42.7	1.9	NA	16.3	1.1	NA
1910	191,909	23.0	0.3	NA	76.5	11.3	1.2	41.5	2.4	NA	20.1	0.2	NA
1900	154,001	18.7	0.1	NA	80.9	16.7	NA	39.7	NA	NA	24.5	0.3	NA

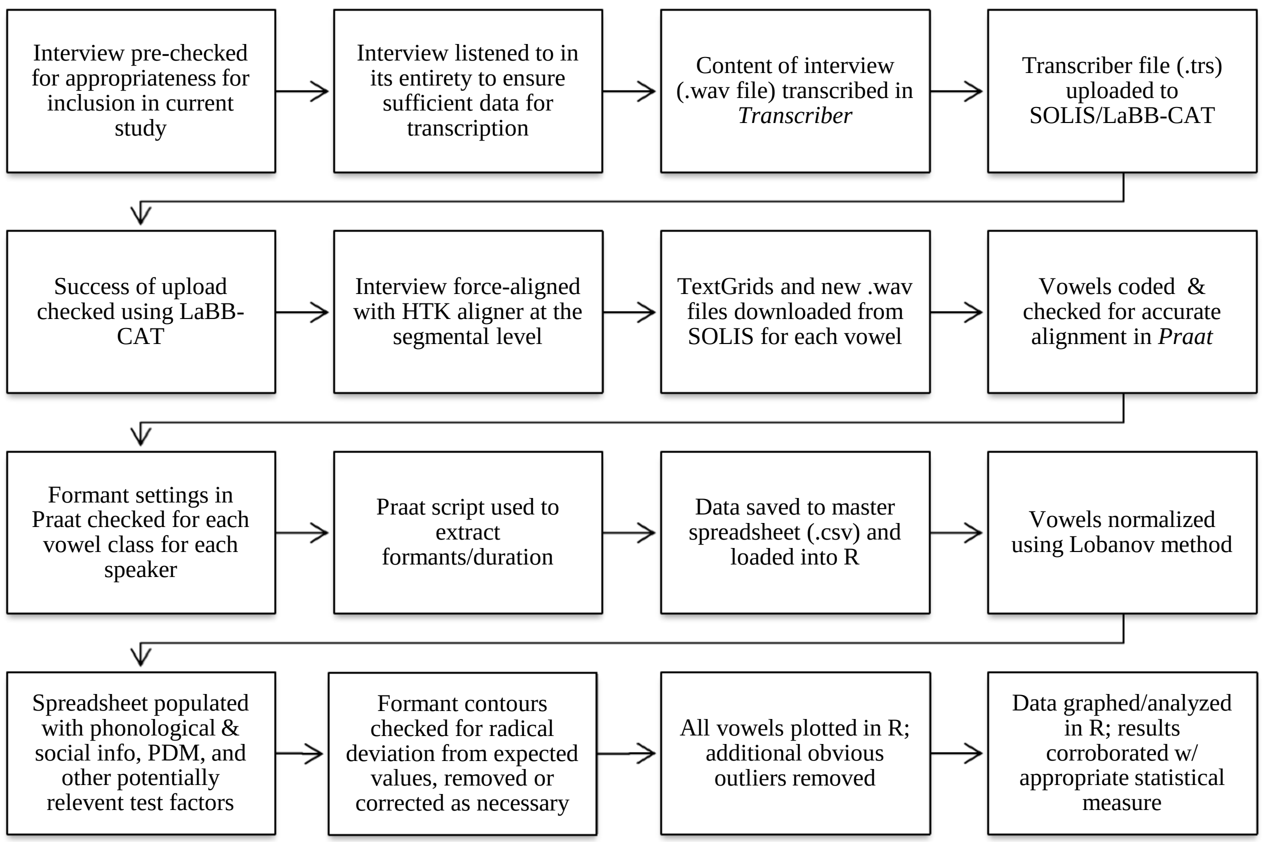
[1] This is a total count of all people who reported any ethnicity classified by the Census as “Asian” or “Pacific Islander”. The subsequent categories (e.g., Chinese, Japanese) include only the five most common ethnicities through history.

[2] Full and Part Hawaiian has been an available Census option since 1900.

APPENDIX C

WORKFLOW CHART OF METHODOLOGY FROM PRE-SELECTION OF INTERVIEW TO ANALYSIS

The chart below is a workflow chart representing the process used in this dissertation from selection of the interviews to analyzing those interviews. The chart is meant as a shorthand reference for those wishing to replicate the methodology of this study.



APPENDIX D

VISUAL REPRESENTATION OF FORCED ALIGNMENT WITH HTK

These images represent a visual approximation of how alignment at the word and segment level takes place in HTK forced aligner. Both images are adopted from labbcat.sourceforge.net. Words transcribed using English orthography are compared with dictionary transcriptions of these words. Each segment is then "forced" into alignment with the accompanying waveform.

Figure F.1. Representation of automatic annotation prior to forced alignment in HTK (based on the CELEX dictionary).

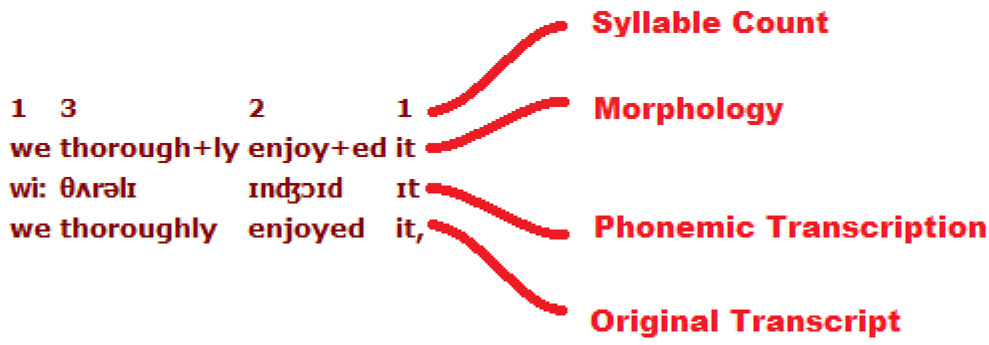
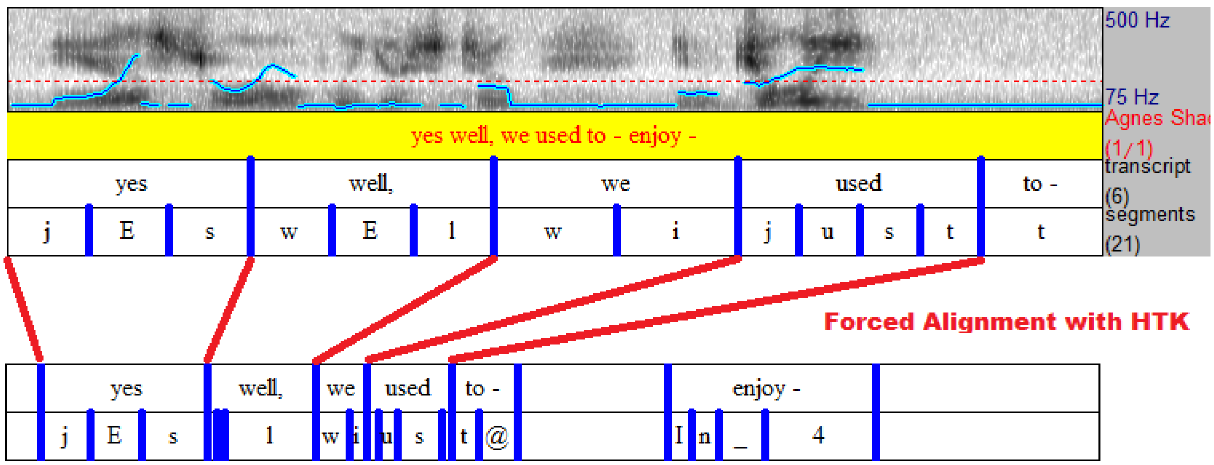


Figure F.2. Visual representation of transcribed information forced aligned with HTK.



APPENDIX E

SPEAKER-SPECIFIC INFORMATION INPUT TO PRAAT FOR FORMANT EXTRACTION

The information in this appendix is what was supplied to Praat in the script used during formant extraction. Information in the table below was input to the dialog box in Praat (figure E.1) for each vowel for each speaker. For all speakers, "window length (s)" and "pre-emphasis from (Hz)" was unchanged from the values in figure F.1. This information is included for those who might wish to replicate the findings of this dissertation.

Figure F.1. Dialog box for Praat script querying formant analysis parameters

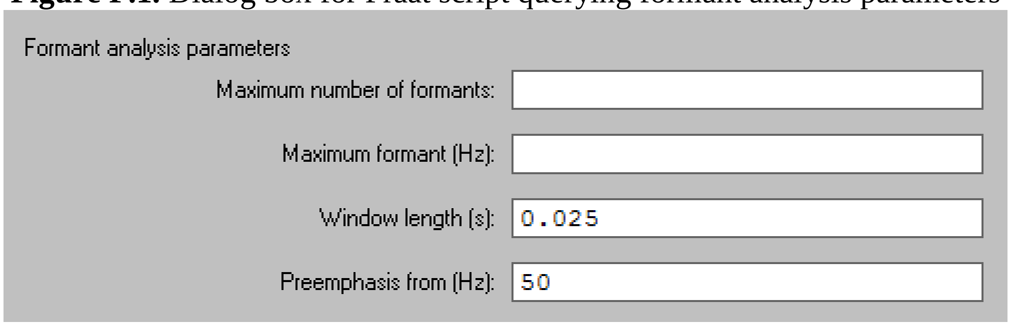


Table F.1. Breakdown of values used during formant extraction for each speaker and speaker's vowel.

Corpus & Age	Speaker Pseudonym	Gender	Vowel identity	Maximum number of formants	Maximum formant (Hz)
old BC	Keiko	f	BOIZ	3	4000
old BC	Keiko	f	JRES	3	4000
old BC	Keiko	f	FES	3	4000
old BC	Keiko	f	SHCHRIT	3	3900
old BC	Keiko	f	FUT	3	4000
old BC	Keiko	f	JOK	3	3500
old BC	Keiko	f	SHUTS	3	3500
old BC	Keiko	f	STIK	3	4000
old BC	Keiko	f	LAT	3	4000
old BC	Keiko	f	HAUS	3	4000
old BC	Keiko	f	PRAIS	3	3500
old BC	Keiko	f	STAF	3	3000
old BC	Keiko	f	TAWK	3	3000
old BC	Keiko	f	CHRAEP	3	4200
old BC	Manny	m	BOIZ	3	3000
old BC	Manny	m	JRES	3	3500
old BC	Manny	m	FES	3	4000
old BC	Manny	m	SHCHRIT	3	4500

old BC	Manny	m	FUT	3	2500
old BC	Manny	m	JOK	3	3000
old BC	Manny	m	SHUTS	4	3500
old BC	Manny	m	STIK	3	4000
old BC	Manny	m	LAT	3	3000
old BC	Manny	m	HAUS	3	2300
old BC	Manny	m	PRAIS	3	4000
old BC	Manny	m	STAF	2	2400
old BC	Manny	m	TAWK	3	2500
old BC	Manny	m	CHRAEP	3	3900
old BC	Joseph	m	BOIZ	3	3000
old BC	Joseph	m	JRES	3	4000
old BC	Joseph	m	FES	3	4000
old BC	Joseph	m	SHCHRIT	3	4000
old BC	Joseph	m	FUT	3	2800
old BC	Joseph	m	JOK	3	2500
old BC	Joseph	m	SHUTS	3	3000
old BC	Joseph	m	STIK	3	4000
old BC	Joseph	m	LAT	3	3000
old BC	Joseph	m	HAUS	3	3000
old BC	Joseph	m	PRAIS	3	3000
old BC	Joseph	m	STAF	3	3000
old BC	Joseph	m	TAWK	3	2500
old BC	Joseph	m	CHRAEP	3	3500
old BC	Miki	f	BOIZ	2	2500
old BC	Miki	f	JRES	3	4000
old BC	Miki	f	FES	3	4500
old BC	Miki	f	SHCHRIT	3	4500
old BC	Miki	f	FUT	3	4000
old BC	Miki	f	JOK	3	4000
old BC	Miki	f	SHUTS	3	4000
old BC	Miki	f	STIK	3	5000
old BC	Miki	f	LAT	2	2500
old BC	Miki	f	HAUS	3	4000
old BC	Miki	f	PRAIS	3	4500
old BC	Miki	f	STAF	2	2500
old BC	Miki	f	TAWK	2	2500
old BC	Miki	f	CHRAEP	3	4500
old BC	Kaimana	f	BOIZ	3	4000
old BC	Kaimana	f	JRES	3	4000
old BC	Kaimana	f	FES	3	4500
old BC	Kaimana	f	SHCHRIT	3	4500

old BC	Kaimana	f	FUT	3	3000
old BC	Kaimana	f	JOK	3	3000
old BC	Kaimana	f	SHUTS	3	3000
old BC	Kaimana	f	STIK	3	4500
old BC	Kaimana	f	LAT	3	3000
old BC	Kaimana	f	HAUS	3	3000
old BC	Kaimana	f	PRAIS	3	4000
old BC	Kaimana	f	STAF	3	3000
old BC	Kaimana	f	TAWK	3	3000
old BC	Kaimana	f	CHRAEP	3	4000
old BC	Malia	f	BOIZ	3	3000
old BC	Malia	f	JRES	3	4200
old BC	Malia	f	FES	3	4200
old BC	Malia	f	SHCHRIT	3	4200
old BC	Malia	f	FUT	3	3000
old BC	Malia	f	JOK	3	3500
old BC	Malia	f	SHUTS	3	3500
old BC	Malia	f	STIK	3	4200
old BC	Malia	f	LAT	3	3000
old BC	Malia	f	HAUS	3	3000
old BC	Malia	f	PRAIS	3	4000
old BC	Malia	f	STAF	3	3000
old BC	Malia	f	TAWK	3	3000
old BC	Malia	f	CHRAEP	3	4000
old BC	Kawika	m	BOIZ	3	3000
old BC	Kawika	m	JRES	3	4000
old BC	Kawika	m	FES	3	4000
old BC	Kawika	m	SHCHRIT	3	4100
old BC	Kawika	m	FUT	3	3000
old BC	Kawika	m	JOK	3	3000
old BC	Kawika	m	SHUTS	3	3000
old BC	Kawika	m	STIK	3	4000
old BC	Kawika	m	LAT	3	3000
old BC	Kawika	m	HAUS	3	3000
old BC	Kawika	m	PRAIS	3	4000
old BC	Kawika	m	STAF	3	3000
old BC	Kawika	m	TAWK	3	3000
old BC	Kawika	m	CHRAEP	3	4000
old BC	Kimo	m	BOIZ	3	3000
old BC	Kimo	m	JRES	3	4000
old BC	Kimo	m	FES	3	4000
old BC	Kimo	m	SHCHRIT	3	4000

old BC	Kimo	m	FUT	3	3000
old BC	Kimo	m	JOK	3	3000
old BC	Kimo	m	SHUTS	3	3000
old BC	Kimo	m	STIK	3	4000
old BC	Kimo	m	LAT	3	3000
old BC	Kimo	m	HAUS	3	3000
old BC	Kimo	m	PRAIS	3	4000
old BC	Kimo	m	STAF	3	3000
old BC	Kimo	m	TAWK	3	2500
old BC	Kimo	m	CHRAEP	3	3000
young BC	Danny	m	BOIZ	3	2800
young BC	Danny	m	JRES	3	3500
young BC	Danny	m	FES	3	4000
young BC	Danny	m	SHCHRIT	3	4000
young BC	Danny	m	FUT	3	3000
young BC	Danny	m	JOK	3	3000
young BC	Danny	m	SHUTS	3	2800
young BC	Danny	m	STIK	3	4000
young BC	Danny	m	LAT	3	3000
young BC	Danny	m	HAUS	3	3000
young BC	Danny	m	PRAIS	3	3000
young BC	Danny	m	STAF	3	3000
young BC	Danny	m	TAWK	3	3000
young BC	Danny	m	CHRAEP	3	4000
young BC	Glen	m	BOIZ	3	3000
young BC	Glen	m	JRES	3	4000
young BC	Glen	m	FES	3	4000
young BC	Glen	m	SHCHRIT	3	4000
young BC	Glen	m	FUT	3	2800
young BC	Glen	m	JOK	3	2800
young BC	Glen	m	SHUTS	3	2800
young BC	Glen	m	STIK	3	4000
young BC	Glen	m	LAT	3	3500
young BC	Glen	m	HAUS	3	3000
young BC	Glen	m	PRAIS	2	3000
young BC	Glen	m	STAF	3	3000
young BC	Glen	m	TAWK	3	3000
young BC	Glen	m	CHRAEP	3	4000
young BC	Leilani	f	BOIZ	3	3000
young BC	Leilani	f	JRES	3	4000
young BC	Leilani	f	FES	3	4000
young BC	Leilani	f	SHCHRIT	3	4500

young BC	Leilani	f	FUT	3	3000
young BC	Leilani	f	JOK	3	3000
young BC	Leilani	f	SHUTS	3	3000
young BC	Leilani	f	STIK	3	4000
young BC	Leilani	f	LAT	3	3000
young BC	Leilani	f	HAUS	3	3000
young BC	Leilani	f	PRAIS	3	3000
young BC	Leilani	f	STAF	3	3000
young BC	Leilani	f	TAWK	3	3000
young BC	Leilani	f	CHRAEP	3	3000
young BC	Mona Lisa	f	BOIZ	3	3500
young BC	Mona Lisa	f	JRES	3	5000
young BC	Mona Lisa	f	FES	3	6500
young BC	Mona Lisa	f	SHCHRIT	3	6500
young BC	Mona Lisa	f	FUT	3	3000
young BC	Mona Lisa	f	JOK	3	3000
young BC	Mona Lisa	f	SHUTS	3	3000
young BC	Mona Lisa	f	STIK	3	5000
young BC	Mona Lisa	f	LAT	3	4000
young BC	Mona Lisa	f	HAUS	3	5000
young BC	Mona Lisa	f	PRAIS	2	3500
young BC	Mona Lisa	f	STAF	3	3000
young BC	Mona Lisa	f	TAWK	3	3000
young BC	Mona Lisa	f	CHRAEP	3	5200
young BC	Victor	m	BOIZ	3	2500
young BC	Victor	m	JRES	3	3500
young BC	Victor	m	FES	3	3500
young BC	Victor	m	SHCHRIT	3	3500
young BC	Victor	m	FUT	3	2500
young BC	Victor	m	JOK	3	2500
young BC	Victor	m	SHUTS	3	2500
young BC	Victor	m	STIK	3	3500
young BC	Victor	m	LAT	3	2500
young BC	Victor	m	HAUS	3	2500
young BC	Victor	m	PRAIS	3	2500
young BC	Victor	m	STAF	3	2500
young BC	Victor	m	TAWK	3	2500
young BC	Victor	m	CHRAEP	3	2500
young BC	Teresa	f	BOIZ	3	3000
young BC	Teresa	f	JRES	3	4000
young BC	Teresa	f	FES	3	4200
young BC	Teresa	f	SHCHRIT	3	5000

young BC	Teresa	f	FUT	3	3000
young BC	Teresa	f	JOK	3	3000
young BC	Teresa	f	SHUTS	3	3000
young BC	Teresa	f	STIK	3	5000
young BC	Teresa	f	LAT	3	3000
young BC	Teresa	f	HAUS	3	3000
young BC	Teresa	f	PRAIS	3	3000
young BC	Teresa	f	STAF	3	3000
young BC	Teresa	f	TAWK	3	3000
young BC	Teresa	f	CHRAEP	3	4000
young BC	Delia Jane	f	BOIZ	3	3500
young BC	Delia Jane	f	JRES	3	3000
young BC	Delia Jane	f	FES	3	3500
young BC	Delia Jane	f	SHCHRIT	3	3500
young BC	Delia Jane	f	FUT	3	3500
young BC	Delia Jane	f	JOK	3	3500
young BC	Delia Jane	f	SHUTS	3	3500
young BC	Delia Jane	f	STIK	3	3500
young BC	Delia Jane	f	LAT	3	3500
young BC	Delia Jane	f	HAUS	3	3500
young BC	Delia Jane	f	PRAIS	3	3500
young BC	Delia Jane	f	STAF	3	3000
young BC	Delia Jane	f	TAWK	3	3200
young BC	Delia Jane	f	CHRAEP	3	3200
young BC	Eddie	m	BOIZ	3	3500
young BC	Eddie	m	JRES	3	3500
young BC	Eddie	m	FES	3	3500
young BC	Eddie	m	SHCHRIT	3	4000
young BC	Eddie	m	FUT	3	3500
young BC	Eddie	m	JOK	3	2000
young BC	Eddie	m	SHUTS	3	2000
young BC	Eddie	m	STIK	3	3500
young BC	Eddie	m	LAT	3	3500
young BC	Eddie	m	HAUS	3	3500
young BC	Eddie	m	PRAIS	3	3500
young BC	Eddie	m	STAF	3	3500
young BC	Eddie	m	TAWK	3	3000
young BC	Eddie	m	CHRAEP	3	3000
old IV	Grant	m	BOIZ	3	3000
old IV	Grant	m	JRES	3	3500
old IV	Grant	m	FES	3	3500
old IV	Grant	m	SHCHRIT	3	3500

old IV	Grant	m	FUT	3	2500
old IV	Grant	m	JOK	3	2500
old IV	Grant	m	SHUTS	3	2500
old IV	Grant	m	STIK	3	3000
old IV	Grant	m	LAT	3	2500
old IV	Grant	m	HAUS	3	2500
old IV	Grant	m	PRAIS	3	3000
old IV	Grant	m	STAF	3	2500
old IV	Grant	m	TAWK	3	2500
old IV	Grant	m	CHRAEP	3	3000
old IV	Pua	f	BOIZ	3	2500
old IV	Pua	f	JRES	3	3200
old IV	Pua	f	FES	3	3500
old IV	Pua	f	SHCHRIT	3	3500
old IV	Pua	f	FUT	3	2500
old IV	Pua	f	JOK	3	2500
old IV	Pua	f	SHUTS	3	2500
old IV	Pua	f	STIK	3	3500
old IV	Pua	f	LAT	3	2500
old IV	Pua	f	HAUS	3	2500
old IV	Pua	f	PRAIS	3	3000
old IV	Pua	f	STAF	3	2500
old IV	Pua	f	TAWK	3	2500
old IV	Pua	f	CHRAEP	3	3000
old IV	Kahea	f	BOIZ	3	3000
old IV	Kahea	f	JRES	3	3500
old IV	Kahea	f	FES	3	4000
old IV	Kahea	f	SHCHRIT	3	4500
old IV	Kahea	f	FUT	3	3000
old IV	Kahea	f	JOK	3	3000
old IV	Kahea	f	SHUTS	3	3000
old IV	Kahea	f	STIK	3	4500
old IV	Kahea	f	LAT	3	3000
old IV	Kahea	f	HAUS	3	3000
old IV	Kahea	f	PRAIS	3	3000
old IV	Kahea	f	STAF	3	3000
old IV	Kahea	f	TAWK	3	3000
old IV	Kahea	f	CHRAEP	3	3000
old IV	Keoni	m	BOIZ	3	3000
old IV	Keoni	m	JRES	3	3000
old IV	Keoni	m	FES	3	3500
old IV	Keoni	m	SHCHRIT	3	4000

old IV	Keoni	m	FUT	3	3000
old IV	Keoni	m	JOK	3	2500
old IV	Keoni	m	SHUTS	3	2500
old IV	Keoni	m	STIK	3	4000
old IV	Keoni	m	LAT	3	3000
old IV	Keoni	m	HAUS	3	3000
old IV	Keoni	m	PRAIS	3	3000
old IV	Keoni	m	STAF	3	2500
old IV	Keoni	m	TAWK	3	2500
old IV	Keoni	m	CHRAEP	3	3000
old IV	Palani	m	BOIZ	3	3000
old IV	Palani	m	JRES	3	3500
old IV	Palani	m	FES	3	3500
old IV	Palani	m	SHCHRIT	3	3500
old IV	Palani	m	FUT	3	2500
old IV	Palani	m	JOK	3	2500
old IV	Palani	m	SHUTS	3	2500
old IV	Palani	m	STIK	3	3500
old IV	Palani	m	LAT	3	2500
old IV	Palani	m	HAUS	3	2500
old IV	Palani	m	PRAIS	3	2500
old IV	Palani	m	STAF	3	2500
old IV	Palani	m	TAWK	3	2500
old IV	Palani	m	CHRAEP	3	4000
old IV	Carla	f	BOIZ	3	2500
old IV	Carla	f	JRES	3	3000
old IV	Carla	f	FES	3	3500
old IV	Carla	f	SHCHRIT	3	4000
old IV	Carla	f	FUT	3	2500
old IV	Carla	f	JOK	3	2500
old IV	Carla	f	SHUTS	3	2500
old IV	Carla	f	STIK	3	4000
old IV	Carla	f	LAT	3	2500
old IV	Carla	f	HAUS	3	2500
old IV	Carla	f	PRAIS	3	4000
old IV	Carla	f	STAF	3	2500
old IV	Carla	f	TAWK	3	2500
old IV	Carla	f	CHRAEP	3	4000
old IV	Lani	f	BOIZ	3	3000
old IV	Lani	f	JRES	3	4000
old IV	Lani	f	FES	3	4000
old IV	Lani	f	SHCHRIT	3	5000

old IV	Lani	f	FUT	3	3000
old IV	Lani	f	JOK	3	3000
old IV	Lani	f	SHUTS	3	3000
old IV	Lani	f	STIK	3	4500
old IV	Lani	f	LAT	3	3000
old IV	Lani	f	HAUS	3	3000
old IV	Lani	f	PRAIS	3	3000
old IV	Lani	f	STAF	3	3000
old IV	Lani	f	TAWK	3	3000
old IV	Lani	f	CHRAEP	3	3500
old IV	Kevin	m	BOIZ	3	2500
old IV	Kevin	m	JRES	3	3000
old IV	Kevin	m	FES	3	3000
old IV	Kevin	m	SHCHRIT	3	4000
old IV	Kevin	m	FUT	3	2500
old IV	Kevin	m	JOK	3	2500
old IV	Kevin	m	SHUTS	3	2500
old IV	Kevin	m	STIK	4	4000
old IV	Kevin	m	LAT	3	2500
old IV	Kevin	m	HAUS	3	2500
old IV	Kevin	m	PRAIS	3	3000
old IV	Kevin	m	STAF	3	2500
old IV	Kevin	m	TAWK	3	2500
old IV	Kevin	m	CHRAEP	3	3000
young IV	Myko	m	BOIZ	3	3000
young IV	Myko	m	JRES	3	3500
young IV	Myko	m	FES	3	3500
young IV	Myko	m	SHCHRIT	3	3500
young IV	Myko	m	FUT	3	2500
young IV	Myko	m	JOK	3	2500
young IV	Myko	m	SHUTS	3	2500
young IV	Myko	m	STIK	3	3500
young IV	Myko	m	LAT	3	2500
young IV	Myko	m	HAUS	3	2500
young IV	Myko	m	PRAIS	3	3000
young IV	Myko	m	STAF	3	2500
young IV	Myko	m	TAWK	3	2500
young IV	Myko	m	CHRAEP	3	3500
young IV	Kaleo	m	BOIZ	3	2500
young IV	Kaleo	m	JRES	3	3000
young IV	Kaleo	m	FES	3	3000
young IV	Kaleo	m	SHCHRIT	3	3000

young IV	Kaleo	m	FUT	3	2500
young IV	Kaleo	m	JOK	3	2500
young IV	Kaleo	m	SHUTS	3	2500
young IV	Kaleo	m	STIK	3	3000
young IV	Kaleo	m	LAT	3	2500
young IV	Kaleo	m	HAUS	3	2500
young IV	Kaleo	m	PRAIS	3	2500
young IV	Kaleo	m	STAF	3	2500
young IV	Kaleo	m	TAWK	3	2500
young IV	Kaleo	m	CHRAEP	3	3000
young IV	Lena	f	BOIZ	3	3000
young IV	Lena	f	JRES	3	3500
young IV	Lena	f	FES	3	4000
young IV	Lena	f	SHCHRIT	3	5000
young IV	Lena	f	FUT	3	3000
young IV	Lena	f	JOK	3	3000
young IV	Lena	f	SHUTS	3	3000
young IV	Lena	f	STIK	3	5000
young IV	Lena	f	LAT	3	3000
young IV	Lena	f	HAUS	3	3000
young IV	Lena	f	PRAIS	3	3500
young IV	Lena	f	STAF	3	3000
young IV	Lena	f	TAWK	3	3000
young IV	Lena	f	CHRAEP	3	3500
young IV	Alika	m	BOIZ	3	2500
young IV	Alika	m	JRES	3	3500
young IV	Alika	m	FES	3	3500
young IV	Alika	m	SHCHRIT	3	3000
young IV	Alika	m	FUT	3	2500
young IV	Alika	m	JOK	3	2500
young IV	Alika	m	SHUTS	3	2500
young IV	Alika	m	STIK	3	3000
young IV	Alika	m	LAT	3	2500
young IV	Alika	m	HAUS	3	2500
young IV	Alika	m	PRAIS	3	3000
young IV	Alika	m	STAF	3	2500
young IV	Alika	m	TAWK	3	2500
young IV	Alika	m	CHRAEP	3	3000
young IV	Mina	f	BOIZ	3	3500
young IV	Mina	f	JRES	3	3500
young IV	Mina	f	FES	3	5000
young IV	Mina	f	SHCHRIT	3	5000

young IV	Mina	f	FUT	3	3500
young IV	Mina	f	JOK	3	3500
young IV	Mina	f	SHUTS	3	3500
young IV	Mina	f	STIK	3	5000
young IV	Mina	f	LAT	3	3500
young IV	Mina	f	HAUS	3	3500
young IV	Mina	f	PRAIS	3	3500
young IV	Mina	f	STAF	3	3500
young IV	Mina	f	TAWK	3	3500
young IV	Mina	f	CHRAEP	3	3500
young IV	Starla	f	BOIZ	3	2500
young IV	Starla	f	JRES	3	3500
young IV	Starla	f	FES	3	4000
young IV	Starla	f	SHCHRIT	3	4500
young IV	Starla	f	FUT	3	2500
young IV	Starla	f	JOK	3	2500
young IV	Starla	f	SHUTS	3	2500
young IV	Starla	f	STIK	3	4500
young IV	Starla	f	LAT	3	2500
young IV	Starla	f	HAUS	3	2500
young IV	Starla	f	PRAIS	3	3000
young IV	Starla	f	STAF	3	2500
young IV	Starla	f	TAWK	3	2500
young IV	Starla	f	CHRAEP	3	3000
young IV	Sarah	f	BOIZ	3	3500
young IV	Sarah	f	JRES	3	3500
young IV	Sarah	f	FES	3	4000
young IV	Sarah	f	SHCHRIT	3	5000
young IV	Sarah	f	FUT	3	3500
young IV	Sarah	f	JOK	3	3000
young IV	Sarah	f	SHUTS	3	3000
young IV	Sarah	f	STIK	4	5000
young IV	Sarah	f	LAT	3	3500
young IV	Sarah	f	HAUS	3	3500
young IV	Sarah	f	PRAIS	3	3500
young IV	Sarah	f	STAF	3	3500
young IV	Sarah	f	TAWK	3	2500
young IV	Sarah	f	CHRAEP	3	3500
young IV	Eric	m	BOIZ	3	3000
young IV	Eric	m	JRES	3	3000
young IV	Eric	m	FES	3	3200
young IV	Eric	m	SHCHRIT	3	3500

young IV	Eric	m	FUT	3	3000
young IV	Eric	m	JOK	3	3000
young IV	Eric	m	SHUTS	3	3000
young IV	Eric	m	STIK	3	3500
young IV	Eric	m	LAT	3	3000
young IV	Eric	m	HAUS	3	3000
young IV	Eric	m	PRAIS	3	3000
young IV	Eric	m	STAF	3	3000
young IV	Eric	m	TAWK	3	3000
young IV	Eric	m	CHRAEP	3	3000

APPENDIX F

RAW FORMANT VALUES FROM 20% TO 80% ACROSS SPEAKER AND VOWEL IDENTITY

The information in this appendix is the raw F1 (table H.1) and F2 (table H.2) values in Hertz across speaker, sorted by age, vowel identity, and gender. These values represent the formant measurements before normalization. Mean formant measurements are listed for each point measured along the vowel (at 20, 30, 40, 50, 60, 70, and 80%). Outliers are not included in the means reported in this table. Because speakers exhibit differences in vocal tract length, these raw Hertz values are not used in this dissertation for interspeaker comparison. They are included here as a reference.

Table H.1. Raw F1 values (Hz) from the 20% to 80% measurement, split across speaker and vowel identity (age group and gender listed).

Speaker Pseudonym	Corpus & Age	Gender	Vowel identity	F1 (20%) raw	F1 (30%) raw	F1 (40%) raw	F1 (50%) raw	F1 (60%) raw	F1 (70%) raw	F1 (80%) raw
Joseph	old BC	m	SHCHRIT	422.9001	431.2554	430.0677	432.4425	456.1217	476.2221	505.8783
Joseph	old BC	m	STIK	438.1103	444.9094	455.1805	443.3378	467.8188	464.2673	464.8705
Joseph	old BC	m	FES	532.5619	531.861	531.8691	523.997	504.0904	528.7068	484.3567
Joseph	old BC	m	JRES	654.1923	693.1512	710.2105	723.9661	723.9847	721.3329	702.8615
Joseph	old BC	m	CHRAEP	676.7678	703.4302	726.0387	730.5012	716.4075	707.4087	688.6264
Joseph	old BC	m	SHUTS	414.7277	423.1759	430.0611	442.6082	435.9457	436.8288	424.5265
Joseph	old BC	m	FUT	414.8719	419.7766	422.9953	435.8704	437.3889	436.0715	432.4244
Joseph	old BC	m	JOK	576.8963	581.1961	577.7286	569.5656	567.9305	567.1074	545.2002
Joseph	old BC	m	TAWK	658.2308	671.3324	693.6756	683.9673	690.9358	681.3163	644.4063
Joseph	old BC	m	LAT	708.4356	742.5751	749.1587	751.0747	743.234	723.7227	724.5365
Joseph	old BC	m	STAF	716.0513	754.4676	770.7661	754.6803	751.1419	745.2722	718.4857
Joseph	old BC	m	PRAIS	724.3993	754.0807	758.0655	746.194	712.2894	661.9803	637.9634
Joseph	old BC	m	HAUS	772.7932	806.6723	785.2694	749.9895	720.2091	679.4446	618.5328
Joseph	old BC	m	BOIZ	618.6492	609.885	606.1273	584.2147	582.8766	586.3818	584.54
Kawika	old BC	m	SHCHRIT	387.9493	383.3371	380.9749	378.1656	374.4836	374.3744	373.7106
Kawika	old BC	m	STIK	380.0887	393.2241	396.9031	398.5381	398.0939	393.3717	387.3469
Kawika	old BC	m	FES	492.8708	503.0404	502.1775	491.7698	474.1444	465.8798	495.8103

Kawika	old BC	m	JRES	529.1072	546.7473	565.2287	577.041	585.0167	586.0573	581.871
Kawika	old BC	m	CHRAEP	591.737	623.1475	641.4152	652.3555	655.5129	655.0754	654.2802
Kawika	old BC	m	SHUTS	375.1759	369.4796	367.4663	368.7109	366.601	362.0784	366.7341
Kawika	old BC	m	FUT	373.8735	403.7956	420.042	421.9588	417.7284	409.7089	407.1152
Kawika	old BC	m	JOK	507.1737	512.8584	513.4881	505.0075	498.7308	494.2032	486.8038
Kawika	old BC	m	TAWK	576.1034	592.0121	601.406	610.4202	614.2604	613.8671	617.2854
Kawika	old BC	m	LAT	625.3048	650.8308	671.7968	684.1633	684.7757	688.3282	684.511
Kawika	old BC	m	STAF	601.3255	626.8411	641.9165	649.3223	650.7872	647.4216	634.0092
Kawika	old BC	m	PRAIS	686.6022	705.8703	708.8295	693.1995	663.3081	621.8293	587.7748
Kawika	old BC	m	HAUS	679.4179	700.4868	706.6268	695.2612	677.8784	643.9003	603.8623
Kawika	old BC	m	BOIZ	489.6448	516.2327	541.126	551.6029	548.7673	547.5204	530.9526
Kimo	old BC	m	SHCHRIT	377.4491	376.8376	373.701	373.8901	371.8901	376.4874	379.4881
Kimo	old BC	m	STIK	350.6491	352.7671	354.1855	352.1988	350.069	341.9621	345.0426
Kimo	old BC	m	FES	408.4925	410.6202	411.392	405.1658	399.7871	394.8366	389.072
Kimo	old BC	m	JRES	445.0247	456.0765	466.6464	469.4862	466.4441	464.431	457.873
Kimo	old BC	m	CHRAEP	481.9402	492.489	494.9167	497.212	494.3145	484.7346	470.2856
Kimo	old BC	m	SHUTS	383.9349	384.1253	375.9862	374.3906	376.9244	369.273	370.309
Kimo	old BC	m	FUT	399.7732	383.8416	385.4597	373.3209	371.0833	354.8989	347.7106
Kimo	old BC	m	JOK	454.8076	455.3147	449.5901	449.3103	442.3306	438.0184	429.4729
Kimo	old BC	m	TAWK	485.2256	500.2044	506.261	507.5996	496.3007	495.1782	472.2593
Kimo	old BC	m	LAT	522.5183	544.248	555.7097	561.4319	553.5637	543.629	527.7987
Kimo	old BC	m	STAF	532.8985	548.4096	554.9962	555.9689	554.9967	549.3507	539.4967
Kimo	old BC	m	PRAIS	528.0077	544.9272	539.1259	523.9591	504.8025	483.1484	470.1435
Kimo	old BC	m	HAUS	564.8175	564.6966	567.807	543.3154	506.0896	500.0586	482.8893
Kimo	old BC	m	BOIZ	447.6803	456.8874	456.665	456.9136	443.4799	433.5197	419.8492
Manny	old BC	m	SHCHRIT	404.0644	399.538	398.7865	400.3339	402.1349	408.3869	414.0208
Manny	old BC	m	STIK	402.3689	405.6429	408.1699	410.8868	412.7782	415.2681	419.9052
Manny	old BC	m	FES	450.1173	451.7683	444.2814	440.8122	437.377	431.218	428.03
Manny	old BC	m	JRES	503.0395	521.9775	538.4837	548.4046	554.8013	557.6627	551.0083
Manny	old BC	m	CHRAEP	599.2613	624.1819	634.3124	646.3865	647.0895	639.3366	620.3321
Manny	old BC	m	SHUTS	395.4014	400.0057	400.7108	398.3883	397.9116	398.9039	402.6994

Manny	old BC	m	FUT	390.7658	393.7185	394.2757	392.3336	386.3304	387.6974	396.1576
Manny	old BC	m	JOK	476.9481	476.8809	485.5967	484.3261	484.9382	480.8985	486.677
Manny	old BC	m	TAWK	500.6985	530.738	551.4039	574.132	578.0298	570.2497	550.8191
Manny	old BC	m	LAT	581.175	617.7528	638.4444	645.3223	640.3951	635.9288	620.972
Manny	old BC	m	STAF	628.2622	652.3157	666.0572	678.963	673.0664	653.3707	642.5249
Manny	old BC	m	PRAIS	682.2279	711.4121	721.7461	731.1216	708.0589	680.7427	632.2831
Manny	old BC	m	HAUS	612.4143	620.4688	639.417	613.5827	572.4944	538.3589	529.4877
Manny	old BC	m	BOIZ	481.9604	486.7673	494.5541	492.0642	490.9312	479.8505	484.4261
Kaimana	old BC	f	SHCHRIT	392.5216	395.2405	397.003	396.9117	398.5535	399.4368	398.4781
Kaimana	old BC	f	STIK	418.8195	427.3412	433.9878	439.5783	441.0699	448.7705	452.9199
Kaimana	old BC	f	FES	467.1356	462.4705	456.3025	450.7146	445.0049	445.4877	443.7314
Kaimana	old BC	f	JRES	521.0464	536.5237	546.7996	556.3482	558.4776	561.3351	556.0116
Kaimana	old BC	f	CHRAEP	650.5298	677.2482	695.1394	703.0898	703.2009	696.3452	684.9694
Kaimana	old BC	f	SHUTS	399.9352	407.8441	408.8694	404.4658	404.0121	408.4958	407.8792
Kaimana	old BC	f	FUT	413.4233	407.3719	406.3708	406.4349	402.6824	396.7424	389.6966
Kaimana	old BC	f	JOK	491.769	496.3921	497.4933	498.6766	496.3701	491.201	481.1813
Kaimana	old BC	f	TAWK	629.4921	647.3059	658.3277	665.1669	667.0087	665.6157	658.171
Kaimana	old BC	f	LAT	698.7799	709.8881	718.9475	719.5385	714.6772	715.855	711.0165
Kaimana	old BC	f	STAF	686.4319	702.7005	707.9435	705.6198	700.926	688.48	670.4107
Kaimana	old BC	f	PRAIS	723.9714	741.1734	729.965	701.3284	664.2555	619.9033	580.7493
Kaimana	old BC	f	HAUS	740.537	744.294	734.2478	714.501	693.7372	656.4123	615.851
Kaimana	old BC	f	BOIZ	547.2358	532.113	532.8939	537.7391	537.3978	538.3763	548.2705
Keiko	old BC	f	SHCHRIT	432.7115	436.6856	442.0934	446.4687	448.0801	443.3551	446.1171
Keiko	old BC	f	STIK	446.2377	451.6091	459.3902	464.4934	466.255	463.5005	458.4578
Keiko	old BC	f	FES	478.1205	479.4706	479.2291	474.8271	470.7713	462.6566	450.0682
Keiko	old BC	f	JRES	582.7745	603.7761	620.4333	629.5656	626.6553	619.6456	616.6501
Keiko	old BC	f	CHRAEP	614.0583	645.6637	658.0131	656.33	657.1837	648.2939	628.9524
Keiko	old BC	f	SHUTS	445.8756	432.6898	432.4494	430.8292	425.9873	421.5929	420.885
Keiko	old BC	f	FUT	468.3578	475.2285	475.1416	471.5312	464.6145	455.4095	441.1639
Keiko	old BC	f	JOK	513.7423	520.5163	519.3408	510.47	503.7313	496.2669	495.4684
Keiko	old BC	f	TAWK	649.8885	660.7338	653.5645	658.7204	679.2656	675.2183	662.0538

Keiko	old BC	f	LAT	776.0029	824.8259	837.7126	843.4095	846.9942	845.8991	813.3565
Keiko	old BC	f	STAF	736.0846	761.0971	768.2982	776.8796	762.3073	745.6386	718.2422
Keiko	old BC	f	PRAIS	779.724	816.9649	834.4438	785.0426	756.6458	681.6662	613.1827
Keiko	old BC	f	HAUS	783.0868	806.0456	795.7596	784.0134	769.6714	737.7065	690.4829
Keiko	old BC	f	BOIZ	543.7161	556.5257	548.1384	548.8913	567.1925	545.21	531.0195
Malia	old BC	f	SHCHRIT	419.5699	418.7919	416.1882	416.6275	419.9299	422.106	415.1624
Malia	old BC	f	STIK	438.6687	435.4143	437.2461	437.5528	439.0426	434.4706	429.6427
Malia	old BC	f	FES	505.8715	500.8067	492.1017	483.8354	473.5204	464.7177	452.62
Malia	old BC	f	JRES	568.9263	594.5472	610.8851	619.4847	624.1735	623.8545	611.9431
Malia	old BC	f	CHRAEP	690.0282	720.0976	728.4311	723.5798	725.81	717.5733	691.0256
Malia	old BC	f	SHUTS	453.5762	452.2122	455.9404	462.2373	465.2182	445.2715	456.4964
Malia	old BC	f	FUT	412.8034	417.3224	415.1111	418.7881	411.001	404.6076	386.6975
Malia	old BC	f	JOK	539.4802	540.6071	525.8042	525.0294	533.1117	516.4339	521.3144
Malia	old BC	f	TAWK	665.4618	700.5551	720.5708	730.1199	725.7921	714.9889	665.258
Malia	old BC	f	LAT	701.5097	755.2345	779.405	788.8603	789.4693	790.5792	772.5455
Malia	old BC	f	STAF	694.4298	735.5768	763.2294	772.5223	759.5205	763.6487	721.2239
Malia	old BC	f	PRAIS	736.0152	780.3283	780.5628	760.4803	722.9764	671.2227	615.56
Malia	old BC	f	HAUS	731.9047	770.4573	765.1201	750.7613	703.8271	653.0364	604.1545
Malia	old BC	f	BOIZ	499.1582	487.5591	489.0083	515.3909	561.6963	606.8444	594.0028
Miki	old BC	f	SHCHRIT	454.5396	453.7515	454.5771	454.1881	453.5675	454.3325	455.708
Miki	old BC	f	STIK	441.7401	451.5813	454.109	456.3028	456.9994	454.1449	444.9445
Miki	old BC	f	FES	498.0844	499.7918	497.7976	492.7981	488.6117	484.3725	475.0515
Miki	old BC	f	JRES	626.511	649.5704	663.5089	670.3629	676.1201	670.3229	653.3005
Miki	old BC	f	CHRAEP	634.0614	662.8885	680.2715	688.6505	689.2059	680.4737	662.6264
Miki	old BC	f	SHUTS	454.6219	465.5171	465.9669	470.4651	476.2515	474.384	474.9963
Miki	old BC	f	FUT	451.9003	459.3409	465.0158	469.5359	465.9639	455.4615	449.0223
Miki	old BC	f	JOK	553.5372	559.4637	559.9317	558.0274	555.3507	551.2803	549.257
Miki	old BC	f	TAWK	624.8488	641.9175	655.3034	663.4076	670.0447	666.8179	644.5225
Miki	old BC	f	LAT	728.6227	746.5926	753.8144	754.5792	743.2749	733.2373	714.6373
Miki	old BC	f	STAF	737.4491	761.4128	772.0638	768.5975	757.6221	748.2339	726.2236
Miki	old BC	f	PRAIS	748.6613	760.5433	748.4439	716.7238	665.5405	622.46	581.1599

Miki	old BC	f	HAUS	791.4101	813.351	792.732	749.8533	732.5877	744.0526	704.8421
Miki	old BC	f	BOIZ	617.1188	635.9648	634.9763	632.5979	624.495	603.3619	587.0815
Danny	young BC	m	SHCHRIT	351.337	344.5757	375.2963	351.1127	348.6035	353.7827	352.994
Danny	young BC	m	STIK	369.0193	369.5852	366.4444	362.1819	361.7093	359.2521	359.223
Danny	young BC	m	FES	411.1464	406.2025	402.2595	396.858	384.2348	377.1491	372.0988
Danny	young BC	m	JRES	500.5174	512.1426	516.7674	518.569	516.1518	512.5013	502.2258
Danny	young BC	m	CHRAEP	544.8542	577.7814	579.7703	575.7385	580.0112	583.2697	588.5899
Danny	young BC	m	SHUTS	358.691	358.4036	360.4869	361.1823	359.9417	361.3391	362.4662
Danny	young BC	m	FUT	385.836	371.6916	366.6145	365.8979	364.6223	368.1708	369.217
Danny	young BC	m	JOK	448.4876	447.7519	447.3044	439.5313	439.7247	441.5469	433.9925
Danny	young BC	m	TAWK	522.1975	530.3033	542.3105	533.6959	524.7672	514.137	524.1461
Danny	young BC	m	LAT	592.1439	608.8965	614.9011	627.608	622.9151	603.4048	590.6533
Danny	young BC	m	STAF	582.6421	604.8528	616.1675	616.1129	607.1574	585.1465	564.5781
Danny	young BC	m	PRAIS	565.179	564.0623	556.0719	535.0512	519.0097	490.7921	457.6672
Danny	young BC	m	HAUS	593.0862	559.4782	579.5482	537.8817	548.0427	567.7149	569.57
Danny	young BC	m	BOIZ	426.672	463.0863	488.1706	483.0333	479.2626	467.8515	451.8267
Eddie	young BC	m	SHCHRIT	619.6647	672.5771	533.1841	449.3419	521.7692	433.9825	427.1219
Eddie	young BC	m	STIK	458.1313	461.8011	466.1976	468.7505	471.6888	468.687	479.1288
Eddie	young BC	m	FES	504.1464	498.1804	495.4206	488.0633	479.6099	472.8508	463.2775
Eddie	young BC	m	JRES	590.3473	597.0366	608.234	610.3318	615.8928	613.1333	602.4172
Eddie	young BC	m	CHRAEP	653.7101	670.9892	678.5372	679.9673	675.5585	669.9917	649.9564
Eddie	young BC	m	SHUTS	413.3425	411.2969	411.6402	413.2738	409.691	412.4826	410.6788
Eddie	young BC	m	FUT	456.2351	442.1333	478.4072	489.2662	491.8883	484.3914	498.4486
Eddie	young BC	m	JOK	504.1073	506.4587	516.5317	523.0473	499.8381	489.7295	482.8613
Eddie	young BC	m	TAWK	650.2005	666.3461	690.3508	701.1684	704.5279	686.2826	692.5017
Eddie	young BC	m	LAT	701.423	683.6242	727.0534	746.5002	748.8044	749.5621	747.4714
Eddie	young BC	m	STAF	672.3387	684.596	697.9225	699.319	698.0514	688.8593	677.1302
Eddie	young BC	m	PRAIS	729.6517	727.72	724.08	701.998	670.9408	640.7228	598.2419
Eddie	young BC	m	HAUS	751.9259	777.6669	771.7726	787.2316	769.9204	761.2854	768.0137
Eddie	young BC	m	BOIZ	541.7493	555.9101	620.8556	656.2125	659.8986	650.8655	648.0087

Glen	young BC	m	SHCHRIT	377.3706	378.976	376.9267	378.3189	380.1014	376.4413	382.6301
Glen	young BC	m	STIK	369.8454	370.4546	372.1444	371.6229	369.227	366.6473	362.6499
Glen	young BC	m	FES	429.8102	429.0888	427.4241	425.699	420.5903	418.4751	421.7349
Glen	young BC	m	JRES	521.2871	526.4132	532.5403	537.5967	539.8043	536.8914	534.901
Glen	young BC	m	CHRAEP	528.4004	546.8321	563.7703	574.684	582.6577	577.4922	566.679
Glen	young BC	m	SHUTS	405.9871	407.2489	408.9822	410.704	409.3844	410.7179	405.9134
Glen	young BC	m	FUT	365.9238	368.9021	376.4287	378.3666	380.4762	377.8977	368.1165
Glen	young BC	m	JOK	455.3474	461.2494	461.6995	458.0923	457.4129	456.5004	459.9016
Glen	young BC	m	TAWK	510.7701	525.107	537.7928	554.8067	566.5303	550.3124	563.0067
Glen	young BC	m	LAT	614.7047	636.1326	643.1246	646.6536	638.1217	624.9975	614.398
Glen	young BC	m	STAF	614.4534	634.6146	651.2746	649.2734	626.2863	600.1215	549.8011
Glen	young BC	m	PRAIS	696.3207	700.5403	674.4399	638.7513	596.074	557.6338	521.9266
Glen	young BC	m	HAUS	593.688	630.4223	616.4013	611.4234	566.4539	541.072	512.8085
Glen	young BC	m	BOIZ	530.544	526.3193	519.2438	515.9822	497.8377	479.3702	490.4613
Victor	young BC	m	SHCHRIT	384.2993	385.8443	382.5714	380.1232	376.9857	378.9856	382.4685
Victor	young BC	m	STIK	372.5498	371.4484	372.3252	369.9745	368.3206	370.2308	374.1597
Victor	young BC	m	FES	443.0009	450.8543	452.6147	447.6173	440.6592	431.1359	430.2511
Victor	young BC	m	JRES	563.4088	586.9991	608.0761	621.4452	627.2084	629.8183	629.0691
Victor	young BC	m	CHRAEP	608.9214	628.6952	638.1075	647.1613	650.1133	641.1471	634.5493
Victor	young BC	m	SHUTS	448.4039	432.9539	427.1949	427.1981	427.9656	431.4476	432.349
Victor	young BC	m	FUT	368.2558	377.1361	393.9896	408.6273	403.5846	388.1446	376.9606
Victor	young BC	m	JOK	489.9375	491.6863	488.0367	487.2211	476.4302	470.0015	458.5345
Victor	young BC	m	TAWK	608.7804	620.542	634.3195	638.6337	642.6402	637.7848	634.4394
Victor	young BC	m	LAT	703.0846	734.1812	750.7753	757.7447	755.1049	751.7908	729.4804
Victor	young BC	m	STAF	710.3777	734.8217	746.0004	748.7658	758.4155	751.8873	731.0875
Victor	young BC	m	PRAIS	734.1977	759.0838	756.0015	740.3615	702.4818	660.723	612.2108
Victor	young BC	m	HAUS	718.9512	731.4426	710.705	668.4518	655.636	611.4965	567.1598
Victor	young BC	m	BOIZ	543.4387	536.1128	558.0112	567.2632	581.3427	559.3676	520.4168
Delia Jane	young BC	f	SHCHRIT	408.1341	406.1767	406.4569	408.8377	406.4452	400.6347	387.2663
Delia Jane	young BC	f	STIK	418.2149	432.6398	438.1314	440.9248	440.2424	435.5866	433.1828
Delia Jane	young BC	f	FES	471.5816	480.422	476.932	472.4771	466.1274	456.2948	445.9594

Delia Jane	young BC	f	JRES	642.6551	690.5668	719.4032	722.509	736.6339	730.2061	724.9158
Delia Jane	young BC	f	CHRAEP	700.0285	735.7549	768.4326	777.3267	790.9769	790.8849	776.2743
Delia Jane	young BC	f	SHUTS	405.0382	411.2964	396.7162	413.3842	428.6805	440.049	426.6365
Delia Jane	young BC	f	FUT	425.7074	444.4521	449.5959	449.9679	455.0378	479.1549	481.086
Delia Jane	young BC	f	JOK	539.321	518.252	542.1118	524.7053	497.2558	502.4645	500.4878
Delia Jane	young BC	f	TAWK	719.9004	747.5794	767.8274	783.02	778.5561	796.8557	789.798
Delia Jane	young BC	f	LAT	774.1328	805.8802	833.0614	850.0988	860.8679	860.0181	853.229
Delia Jane	young BC	f	STAF	774.3323	803.0002	805.9912	813.359	835.4974	838.8753	808.1148
Delia Jane	young BC	f	PRAIS	756.5634	790.8366	796.5145	790.8147	769.1336	727.9174	681.4745
Delia Jane	young BC	f	HAUS	826.0876	855.661	864.3348	846.1407	838.7317	796.4646	767.5135
Leilani	young BC	f	SHCHRIT	411.9821	407.9745	396.736	388.0055	387.171	386.7916	383.0754
Leilani	young BC	f	STIK	415.1457	421.8646	426.2603	432.2249	440.1697	440.4942	436.5314
Leilani	young BC	f	FES	449.5736	450.269	447.6769	438.9874	427.8764	416.6277	413.9304
Leilani	young BC	f	JRES	534.6234	556.4851	576.359	590.0509	593.693	592.0854	589.5032
Leilani	young BC	f	CHRAEP	611.6991	638.8763	659.8076	669.25	668.671	658.2739	649.7914
Leilani	young BC	f	SHUTS	416.5314	417.0862	406.5289	408.7539	403.1005	407.2114	414.347
Leilani	young BC	f	FUT	428.496	428.831	429.4549	423.5206	416.6542	409.9758	408.5785
Leilani	young BC	f	JOK	494.4147	493.9975	490.3851	484.0083	477.2497	467.5842	453.4351
Leilani	young BC	f	TAWK	623.2825	647.4202	661.7007	672.0819	673.0694	673.9233	656.327
Leilani	young BC	f	LAT	671.0052	697.1875	707.2645	707.5433	703.6197	693.5053	679.231
Leilani	young BC	f	STAF	656.6668	666.6737	676.2397	677.9912	674.2331	662.9567	638.4027
Leilani	young BC	f	PRAIS	697.178	706.5306	707.5642	688.0712	666.8929	632.6386	589.8113
Leilani	young BC	f	HAUS	719.6668	724.4773	717.3342	695.5467	675.6564	649.463	609.8683
Leilani	young BC	f	BOIZ	560.8432	586.7177	590.4513	580.7273	561.0414	537.8502	502.4651
Mona Lisa	young BC	f	SHCHRIT	482.5107	483.0837	479.0853	475.6301	472.2373	469.2724	468.3901
Mona Lisa	young BC	f	STIK	474.5587	483.2493	490.2781	492.8492	493.7255	492.9451	492.5587
Mona Lisa	young BC	f	FES	572.6698	574.2308	569.8063	563.9351	558.2636	549.429	544.1736
Mona Lisa	young BC	f	JRES	653.9483	690.9163	723.4304	749.9429	764.0781	770.2588	765.5736
Mona Lisa	young BC	f	CHRAEP	672.1887	706.5966	730.4859	746.2051	754.6448	759.5839	752.4036
Mona Lisa	young BC	f	SHUTS	448.003	452.5276	457.7687	462.1082	463.6141	463.8467	466.2547
Mona Lisa	young BC	f	FUT	454.114	463.7599	463.8233	467.8035	470.5889	469.7131	462.5817

Mona Lisa	young BC	f	JOK	572.8589	575.7539	574.15	570.4986	563.5771	556.3437	552.2611
Mona Lisa	young BC	f	TAWK	658.8587	694.4919	711.3976	736.9308	754.3042	750.7945	737.0589
Mona Lisa	young BC	f	LAT	824.4034	853.4132	873.7447	880.5064	882.7091	877.2079	859.9104
Mona Lisa	young BC	f	STAF	754.5595	805.0021	816.3097	828.4725	837.3065	812.0618	810.6881
Mona Lisa	young BC	f	PRAIS	843.5047	891.5884	890.9829	871.9623	818.09	745.6594	677.0333
Mona Lisa	young BC	f	HAUS	935.7407	944.7559	938.2773	923.8159	863.4123	801.3558	751.6507
Mona Lisa	young BC	f	BOIZ	575.4791	606.7385	639.6683	651.1616	655.7264	671.7784	661.6348
Teresa	young BC	f	SHCHRIT	470.5539	475.3986	477.2959	478.5445	478.5238	476.8729	474.0999
Teresa	young BC	f	STIK	496.1184	496.0335	498.2862	499.1368	496.8868	491.9795	482.1678
Teresa	young BC	f	FES	495.3024	501.1444	505.0495	504.5045	501.8816	493.3263	481.4762
Teresa	young BC	f	JRES	571.8623	584.1525	595.1924	604.8249	609.1093	611.6987	606.7111
Teresa	young BC	f	CHRAEP	583.8448	612.744	636.4881	649.1164	657.9736	661.0904	656.5207
Teresa	young BC	f	SHUTS	434.8211	438.1399	438.6869	438.7285	438.0067	436.936	437.5559
Teresa	young BC	f	FUT	451.7036	456.9041	462.0386	463.8453	466.9588	470.8532	474.7269
Teresa	young BC	f	JOK	518.9508	520.061	519.5173	518.5444	515.1728	511.4347	500.772
Teresa	young BC	f	TAWK	632.5355	656.9552	671.2164	675.8057	679.0949	678.1313	666.3594
Teresa	young BC	f	LAT	690.9039	701.7685	703.4967	705.4641	706.9901	676.0331	688.6208
Teresa	young BC	f	STAF	641.5254	671.8817	692.776	705.6305	696.7505	691.1516	678.533
Teresa	young BC	f	PRAIS	687.3267	708.7656	723.0532	725.4936	712.7373	692.1666	653.4457
Teresa	young BC	f	HAUS	699.9174	717.0755	699.7706	670.6108	645.6172	606.9191	583.3518
Teresa	young BC	f	BOIZ	509.606	517.6874	542.2044	612.7229	524.5597	562.7566	550.6947
Grant	old IV	m	SHCHRIT	330.722	328.9491	328.3514	330.1596	332.9191	344.7971	368.083
Grant	old IV	m	STIK	381.4458	386.1043	391.319	396.3618	398.5071	396.8855	394.2386
Grant	old IV	m	FES	437.7672	426.9011	415.0873	403.0043	392.1556	384.3166	378.9996
Grant	old IV	m	JRES	499.8672	506.1099	516.8206	527.0701	530.6023	530.2957	526.3755
Grant	old IV	m	CHRAEP	572.3108	600.0264	607.0628	619.4598	622.7411	623.9004	613.4711
Grant	old IV	m	SHUTS	363.2265	369.1718	370.1034	367.3943	370.0498	371.5966	371.086
Grant	old IV	m	FUT	400.8329	414.5532	422.371	424.2792	425.9008	430.7161	445.1935
Grant	old IV	m	JOK	467.3141	469.1496	469.6539	471.4045	465.4531	461.0325	452.4668
Grant	old IV	m	TAWK	548.5708	574.9455	590.2101	594.7538	595.7891	609.7721	612.3179

Grant	old IV	m	LAT	590.2604	616.4004	630.709	632.827	638.8301	636.4527	616.8442
Grant	old IV	m	STAF	556.1462	569.3673	574.1763	578.8654	578.3085	565.7057	558.9078
Grant	old IV	m	PRAIS	578.7428	594.3951	598.0453	582.4795	560.8585	525.2979	486.0168
Grant	old IV	m	HAUS	634.514	659.18	660.8434	636.3247	598.9736	564.0507	516.7546
Grant	old IV	m	BOIZ	484.5007	501.3195	492.5512	486.1871	480.661	488.9794	473.5881
Keoni	old IV	m	SHCHRIT	402.6483	395.9756	394.8543	347.5629	360.5771	387.7727	361.4428
Keoni	old IV	m	STIK	401.1216	379.3308	381.7114	382.7667	384.9177	379.0247	381.7139
Keoni	old IV	m	FES	421.9115	416.6361	414.1204	410.0541	405.7307	395.0453	390.5819
Keoni	old IV	m	JRES	465.9062	477.3336	482.9279	487.9652	489.5077	487.1769	485.174
Keoni	old IV	m	CHRAEP	549.5045	579.9414	598.4713	605.8825	615.8703	603.0396	569.3058
Keoni	old IV	m	SHUTS	362.7151	361.8332	366.7632	366.9535	369.1122	377.0962	381.3856
Keoni	old IV	m	FUT	389.3161	391.6516	393.1084	394.2413	393.65	396.8987	391.9249
Keoni	old IV	m	JOK	449.5433	457.1898	462.1831	460.4694	457.5326	454.4214	441.1003
Keoni	old IV	m	TAWK	508.8503	542.9057	555.7367	563.5432	570.3428	565.3847	545.3035
Keoni	old IV	m	LAT	569.962	624.5002	636.6309	648.4304	657.3041	643.7458	633.6831
Keoni	old IV	m	STAF	571.6061	606.4158	613.8982	607.2902	584.1904	553.319	532.93
Keoni	old IV	m	PRAIS	653.803	655.2074	656.6304	611.0548	563.2238	515.9836	473.8459
Keoni	old IV	m	HAUS	599.8513	637.8448	637.3168	597.5156	619.8128	613.0272	565.6547
Keoni	old IV	m	BOIZ	445.7725	450.1328	459.1717	469.0796	455.4938	452.8506	442.3687
Kevin	old IV	m	SHCHRIT	411.2058	373.2391	366.8261	363.6788	361.495	426.5046	410.9628
Kevin	old IV	m	STIK	373.0654	375.6909	375.3792	379.8751	376.3806	369.7487	369.474
Kevin	old IV	m	FES	434.43	427.0548	415.3769	402.5641	392.7061	385.2261	379.5007
Kevin	old IV	m	JRES	518.0999	554.6556	581.9013	600.1153	606.9174	599.19	584.593
Kevin	old IV	m	CHRAEP	497.192	532.1625	568.6085	598.8975	617.1445	626.5983	622.2525
Kevin	old IV	m	SHUTS	385.7166	394.0103	395.0245	395.7691	390.9252	390.8384	392.7066
Kevin	old IV	m	FUT	396.6622	400.6022	403.7773	405.4204	400.408	393.6032	457.9378
Kevin	old IV	m	JOK	468.6339	488.8803	478.6473	471.9556	467.5739	459.1753	445.9598
Kevin	old IV	m	TAWK	557.5408	593.5267	621.6962	626.1309	626.3453	624.7603	608.7318
Kevin	old IV	m	LAT	559.1443	600.9595	634.4745	649.3579	656.5266	654.6166	637.191
Kevin	old IV	m	STAF	560.849	591.7385	622.3403	643.1196	646.4387	627.3626	597.4373
Kevin	old IV	m	PRAIS	626.1303	654.1787	656.2469	637.8543	599.5191	559.1952	524.191

Kevin	old IV	m	HAUS	631.0472	668.8004	629.1421	602.6001	570.3435	529.8173	501.0768
Kevin	old IV	m	BOIZ	545.5528	512.1302	483.0898	464.297	450.9349	434.6537	426.81
Palani	old IV	m	SHCHRIT	370.7547	373.4789	375.7469	375.5572	369.8364	369.4947	375.8749
Palani	old IV	m	STIK	392.7022	395.7965	398.0281	400.2074	398.7667	396.7717	405.1066
Palani	old IV	m	FES	434.3585	429.9751	427.6984	422.8952	418.2537	413.7256	409.7047
Palani	old IV	m	JRES	496.4319	513.7076	524.9112	537.5075	546.2605	544.2264	544.5515
Palani	old IV	m	CHRAEP	613.8661	634.569	646.4146	646.5329	706.5142	695.7407	684.3447
Palani	old IV	m	SHUTS	400.2239	400.5621	404.0493	399.8527	397.852	388.5739	387.1204
Palani	old IV	m	FUT	401.406	399.1705	397.3399	396.1368	394.3867	394.0009	387.0439
Palani	old IV	m	JOK	463.9888	469.4365	471.855	474.8224	475.6261	473.3771	478.2949
Palani	old IV	m	TAWK	548.1633	568.9748	586.1419	595.8062	601.259	603.4999	594.3307
Palani	old IV	m	LAT	598.0459	620.5369	638.3137	642.178	642.7749	642.8493	633.5658
Palani	old IV	m	STAF	558.2893	578.4547	590.6113	594.9837	600.0514	602.2634	593.5551
Palani	old IV	m	PRAIS	581.7298	603.7352	604.5506	595.6145	571.8501	545.8525	521.5613
Palani	old IV	m	HAUS	617.0689	619.5288	612.2721	601.6178	580.6005	555.2923	532.7275
Palani	old IV	m	BOIZ	469.2514	469.9494	472.112	466.9452	467.5503	463.6725	447.6853
Carla	old IV	f	SHCHRIT	437.2474	393.4248	384.0867	376.4476	379.0181	396.0027	424.8594
Carla	old IV	f	STIK	401.9712	452.4051	435.5906	428.0368	436.8991	437.0705	437.4812
Carla	old IV	f	FES	466.1906	465.384	470.341	475.6895	472.5283	467.6781	458.5093
Carla	old IV	f	JRES	530.1671	553.9124	575.8187	595.8758	605.6419	603.266	599.1956
Carla	old IV	f	CHRAEP	661.7898	738.0761	798.7025	825.4468	835.111	837.4918	828.4173
Carla	old IV	f	SHUTS	422.0961	394.0473	405.9413	421.7075	424.0357	427.0351	424.7703
Carla	old IV	f	FUT	410.3674	419.8056	424.3994	439.8953	442.6359	430.1611	406.6778
Carla	old IV	f	JOK	468.2735	455.6468	465.557	464.294	460.6092	467.6022	454.8317
Carla	old IV	f	TAWK	572.8745	611.4466	621.8102	632.2633	632.9766	632.3134	641.7297
Carla	old IV	f	LAT	670.7081	703.9336	726.2011	744.77	754.626	737.7106	718.8988
Carla	old IV	f	STAF	638.7332	671.8482	706.2711	740.9353	732.628	717.7219	684.5784
Carla	old IV	f	PRAIS	783.7592	841.2649	819.9484	774.362	697.7963	625.9689	550.1976
Carla	old IV	f	HAUS	684.9377	736.3242	741.8139	739.8705	743.7866	708.83	652.6367
Carla	old IV	f	BOIZ	477.1346	507.2821	524.0456	527.0842	510.0037	490.9824	478.5038

Kahea	old IV	f	SHCHRIT	491.4921	504.915	498.072	502.6317	500.4669	560.8424	492.2872
Kahea	old IV	f	STIK	474.1586	483.5099	475.2089	474.1059	477.106	475.0473	471.5587
Kahea	old IV	f	FES	520.0869	519.5	522.5863	515.0733	502.0259	494.2947	486.3918
Kahea	old IV	f	JRES	649.4153	696.2007	723.6223	738.1867	746.0241	741.6218	740.0456
Kahea	old IV	f	CHRAEP	707.5107	738.4377	767.838	780.5075	809.4032	819.3462	822.9286
Kahea	old IV	f	SHUTS	443.9345	440.6463	443.0866	440.9064	440.4081	433.135	438.9401
Kahea	old IV	f	FUT	450.4532	440.1635	447.4304	449.7966	449.6916	451.7214	452.9718
Kahea	old IV	f	JOK	560.5011	563.3058	579.96	585.184	588.6209	605.4294	594.7367
Kahea	old IV	f	TAWK	690.5212	733.9399	764.0622	772.6529	786.5768	777.5775	765.6813
Kahea	old IV	f	LAT	769.122	813.2887	835.9063	863.6027	875.6646	876.281	859.4972
Kahea	old IV	f	STAF	830.0239	850.9349	850.5657	863.2964	873.9931	848.9512	816.6667
Kahea	old IV	f	PRAIS	844.2837	872.9966	865.4603	838.765	783.6343	708.233	636.7499
Kahea	old IV	f	HAUS	873.9109	852.0917	792.3024	742.0646	670.9613	619.9633	568.2474
Kahea	old IV	f	BOIZ	561.4599	552.2435	561.9331	566.762	580.7074	564.6864	526.4761
Lani	old IV	f	SHCHRIT	425.3862	426.4736	426.0754	426.7559	419.5342	411.6562	405.0595
Lani	old IV	f	STIK	436.0449	444.3957	449.5042	452.7226	455.9083	461.2362	459.8312
Lani	old IV	f	FES	504.9468	504.3309	501.1724	499.6267	492.0912	491.5863	480.1696
Lani	old IV	f	JRES	578.6123	596.0128	610.3879	614.934	615.3807	613.7802	609.9498
Lani	old IV	f	CHRAEP	679.7272	710.6179	733.2388	747.0848	757.4556	752.1298	746.1359
Lani	old IV	f	SHUTS	450.4192	445.6587	438.2499	435.2193	434.8675	430.3602	440.0975
Lani	old IV	f	FUT	422.1396	433.234	439.0753	441.9906	445.6792	448.2859	453.6218
Lani	old IV	f	JOK	518.0561	519.4449	521.1021	519.5035	516.9717	505.7661	505.8657
Lani	old IV	f	TAWK	645.2744	671.3121	692.5818	714.3708	721.7363	715.0685	718.9842
Lani	old IV	f	LAT	677.473	706.437	730.3006	743.9219	751.4461	745.2846	728.2097
Lani	old IV	f	STAF	676.021	704.6122	725.4628	734.1934	727.7765	721.2859	711.0916
Lani	old IV	f	PRAIS	714.655	748.4606	761.2967	752.6581	730.808	692.6493	641.8551
Lani	old IV	f	HAUS	692.8261	733.0672	741.3821	724.5884	703.5391	664.4985	624.4146
Lani	old IV	f	BOIZ	548.2342	558.9764	583.3111	588.5561	584.6534	583.7325	558.0766
Pua	old IV	f	SHCHRIT	419.4333	392.266	389.9737	387.1232	386.7265	393.7396	384.9514
Pua	old IV	f	STIK	450.3304	449.3318	445.7055	445.2801	441.0584	437.9259	434.1118
Pua	old IV	f	FES	480.4844	471.9133	461.6118	455.5318	444.2302	435.4645	435.3485

Pua	old IV	f	JRES	541.8184	563.803	579.0152	588.2665	591.3924	591.3925	585.4917
Pua	old IV	f	CHRAEP	703.8569	739.5132	753.5414	762.5796	764.3116	759.6488	737.1797
Pua	old IV	f	SHUTS	447.6215	436.5389	438.9275	434.6164	439.0923	443.6308	448.3484
Pua	old IV	f	FUT	442.1486	441.5404	435.0102	437.0572	442.1064	443.5511	449.1172
Pua	old IV	f	JOK	566.6543	551.7031	537.4405	530.4691	522.2074	503.148	485.7863
Pua	old IV	f	TAWK	672.4628	694.787	699.6519	696.0783	694.8289	662.8175	631.1576
Pua	old IV	f	LAT	712.9312	732.9839	745.5569	737.7144	736.0129	733.6393	729.5362
Pua	old IV	f	STAF	702.0631	721.5776	718.7229	725.7617	718.0277	694.9479	660.5831
Pua	old IV	f	PRAIS	760.1421	785.2595	778.4208	753.243	712.9161	667.4714	626.2909
Pua	old IV	f	HAUS	758.9538	760.353	767.4763	742.4893	720.6326	668.1533	631.4936
Pua	old IV	f	BOIZ	529.0649	526.6495	532.8768	524.9004	529.9231	528.3795	506.1427
Eric	young IV	m	SHCHRIT	425.6895	406.6658	405.9047	403.1992	423.9062	433.6287	412.6624
Eric	young IV	m	STIK	434.5826	437.5212	441.2182	450.6259	454.1644	455.2793	455.1937
Eric	young IV	m	FES	472.9637	467.9099	465.7725	463.9005	461.6891	462.857	456.4707
Eric	young IV	m	JRES	525.8685	547.3323	563.1091	572.7099	578.883	578.3698	573.1795
Eric	young IV	m	CHRAEP	608.9947	637.641	651.5967	661.1935	663.8251	659.2206	650.8478
Eric	young IV	m	SHUTS	408.0771	424.7423	424.3088	422.4457	412.5287	410.3965	416.516
Eric	young IV	m	FUT	443.5679	447.6304	448.6837	446.4324	446.7711	446.5741	441.4381
Eric	young IV	m	JOK	490.9568	500.6902	512.7804	520.6603	518.3757	518.4011	517.4377
Eric	young IV	m	TAWK	616.1628	628.1896	632.4979	626.243	622.6154	619.7088	610.6764
Eric	young IV	m	LAT	619.1837	644.3172	655.0294	655.6658	660.5458	651.698	649.307
Eric	young IV	m	STAF	578.4057	590.1687	598.2826	601.0106	602.594	601.3281	596.2624
Eric	young IV	m	PRAIS	622.622	623.6636	614.7357	606.2922	596.4071	573.4653	548.6276
Eric	young IV	m	HAUS	645.3682	660.0353	645.9246	632.3369	607.2233	587.249	562.8531
Eric	young IV	m	BOIZ	482.1576	493.8875	512.1073	513.7775	492.6577	471.2274	457.6902
Kaleo	young IV	m	SHCHRIT	362.5721	360.091	358.5335	355.642	348.6709	349.9903	354.3629
Kaleo	young IV	m	STIK	416.6253	411.326	416.2523	415.1201	415.1217	411.0885	405.1771
Kaleo	young IV	m	FES	419.1154	413.5815	411.0568	411.4373	408.7951	404.4011	401.1274
Kaleo	young IV	m	JRES	489.4277	491.8658	500.1554	507.8123	509.24	511.6965	505.5869
Kaleo	young IV	m	CHRAEP	541.4107	564.7777	580.8374	583.8643	588.4519	585.5927	575.8315

Kaleo	young IV	m	SHUTS	372.477	373.6587	375.0578	374.7015	377.3093	374.8983	372.9405
Kaleo	young IV	m	FUT	397.7855	395.8831	400.5415	402.7055	401.3077	397.9176	392.8843
Kaleo	young IV	m	JOK	446.5448	452.0317	454.717	451.6882	454.8047	454.3607	448.3684
Kaleo	young IV	m	TAWK	520.1342	534.8429	548.7073	548.8832	545.5385	544.0419	535.9896
Kaleo	young IV	m	LAT	565.8623	589.9248	601.43	607.7667	608.7951	597.5729	586.4375
Kaleo	young IV	m	STAF	504.2326	526.3608	537.8139	546.5607	545.4954	542.3351	535.5058
Kaleo	young IV	m	PRAIS	568.47	575.0125	578.1176	566.3545	557.2209	536.4602	512.5424
Kaleo	young IV	m	HAUS	605.1334	607.9576	607.3459	589.9984	576.0517	556.0622	542.542
Kaleo	young IV	m	BOIZ	514.0828	495.3838	503.6731	486.6008	475.8843	453.2447	443.964
Alika	young IV	m	SHCHRIT	383.9117	391.7433	392.5294	406.7468	391.3698	395.974	391.3016
Alika	young IV	m	STIK	441.3582	433.3644	433.7784	428.5212	428.1697	430.7848	430.201
Alika	young IV	m	FES	472.226	516.8567	472.8708	467.4436	461.3536	443.3443	501.7754
Alika	young IV	m	JRES	588.9008	636.6148	646.8761	646.7015	645.38	653.0312	650.6734
Alika	young IV	m	CHRAEP	665.288	702.9104	725.2526	736.5903	740.0421	731.2209	717.4842
Alika	young IV	m	SHUTS	404.4813	400.018	395.8025	396.6257	404.0754	398.2396	396.2858
Alika	young IV	m	FUT	438.9997	438.2103	437.8815	432.8195	436.4107	437.4554	431.3997
Alika	young IV	m	JOK	512.2333	513.4037	523.1346	518.2642	513.5528	513.2899	509.685
Alika	young IV	m	TAWK	579.5209	616.4561	630.9111	642.6466	643.5491	645.1073	637.1294
Alika	young IV	m	LAT	627.0369	656.4665	665.6762	673.7361	681.2415	678.8346	671.7338
Alika	young IV	m	STAF	609.8696	631.8141	639.6154	649.7289	665.6128	668.3794	664.9638
Alika	young IV	m	PRAIS	687.9861	701.8417	691.8858	674.758	663.4554	639.6753	613.6511
Alika	young IV	m	HAUS	674.4111	681.5289	670.2624	660.3595	623.1643	593.7659	580.3587
Alika	young IV	m	BOIZ	519.2167	522.9048	540.4339	531.1956	530.5529	531.7049	525.2067
Myko	young IV	m	SHCHRIT	385.389	378.7931	374.8035	377.241	378.6604	378.8228	376.7854
Myko	young IV	m	STIK	444.3101	442.1735	448.4022	449.2661	451.8494	454.1538	456.111
Myko	young IV	m	FES	463.8553	465.7919	461.7253	453.0458	441.2897	434.439	433.2649
Myko	young IV	m	JRES	566.7326	592.7822	616.6541	626.3071	632.1775	627.8742	620.0931
Myko	young IV	m	CHRAEP	642.3487	675.2336	687.6137	693.3115	704.6464	696.5842	684.4255
Myko	young IV	m	SHUTS	402.0992	412.6562	415.8632	413.2945	409.7368	414.9268	415.1062
Myko	young IV	m	FUT	439.8645	440.8397	446.8145	453.8629	457.8011	460.0582	457.3015
Myko	young IV	m	JOK	496.8281	503.0793	505.576	508.1966	499.1921	495.6661	493.8781

Myko	young IV	m	TAWK	586.7734	614.4229	626.7816	637.3515	638.3331	641.0838	640.2995
Myko	young IV	m	LAT	668.2723	697.3122	724.9229	744.5106	748.7738	743.9545	736.9192
Myko	young IV	m	STAF	641.0002	674.3316	685.5827	695.3882	706.7867	679.8487	671.3883
Myko	young IV	m	PRAIS	672.126	697.1227	700.6458	684.5678	658.9164	610.0992	567.1019
Myko	young IV	m	HAUS	693.2662	705.4052	700.8297	689.0439	650.1528	629.1385	595.6765
Myko	young IV	m	BOIZ	537.3892	575.5151	592.2098	601.3758	578.1808	551.6612	519.7034
Lena	young IV	f	SHCHRIT	562.0783	553.5751	543.8853	542.8894	558.8612	564.5591	635.3545
Lena	young IV	f	STIK	648.1292	675.6729	647.2742	649.6205	666.2701	677.6638	692.5959
Lena	young IV	f	FES	562.7044	567.119	582.3115	574.3429	575.6578	567.4019	556.8176
Lena	young IV	f	JRES	705.734	753.9092	771.1247	767.2176	777.8761	772.3017	756.7637
Lena	young IV	f	CHRAEP	847.5338	901.3473	940.4128	961.9254	953.3755	944.5359	925.6329
Lena	young IV	f	SHUTS	506.2514	502.9815	505.0203	515.0122	523.7211	532.155	541.3791
Lena	young IV	f	FUT	609.8899	635.6271	646.2587	655.1634	659.8662	650.7502	629.6588
Lena	young IV	f	JOK	649.3669	657.9377	658.1349	659.629	658.9977	653.4097	649.6126
Lena	young IV	f	TAWK	848.4422	871.2034	862.9737	873.5502	844.2608	855.3397	822.3059
Lena	young IV	f	LAT	862.4462	890.1701	878.6323	893.3297	897.3531	891.5329	853.2038
Lena	young IV	f	STAF	795.6185	823.4734	838.8459	844.2934	837.6087	821.4879	788.9952
Lena	young IV	f	PRAIS	821.0889	852.7644	866.7372	854.3443	823.5916	774.0534	723.0483
Lena	young IV	f	HAUS	865.5441	880.1575	876.9043	854.5467	838.3258	774.0588	724.3568
Lena	young IV	f	BOIZ	674.5742	642.0503	669.5886	692.9571	699.4465	685.3082	620.9521
Mina	young IV	f	SHCHRIT	473.9098	465.0237	457.3314	468.4576	467.183	478.6298	494.2475
Mina	young IV	f	STIK	523.77	531.7634	548.7888	534.6081	530.7174	533.1497	552.6274
Mina	young IV	f	FES	554.5044	550.2058	556.0344	545.5637	535.811	532.8659	531.0092
Mina	young IV	f	JRES	663.1786	701.8942	705.8192	705.9939	713.8766	712.1426	705.1575
Mina	young IV	f	CHRAEP	832.5704	876.9657	872.0603	876.4028	845.37	811.8555	795.0708
Mina	young IV	f	SHUTS	486.4441	494.8002	501.6762	505.3704	495.2596	492.917	488.937
Mina	young IV	f	FUT	528.3311	528.4914	532.6059	536.1961	533.4182	528.719	525.1709
Mina	young IV	f	JOK	598.028	621.7894	627.734	632.0774	633.8381	623.0197	616.0373
Mina	young IV	f	TAWK	755.8576	781.3538	809.9136	816.3923	818.099	801.1365	802.4502
Mina	young IV	f	LAT	824.4742	861.9836	877.9817	900.552	909.7791	870.2108	820.4832
Mina	young IV	f	STAF	818.6328	849.5882	852.1111	857.7805	835.901	789.2382	745.9391

Mina	young IV	f	PRAIS	828.7359	862.198	850.6242	832.0941	803.8238	744.4009	689.5864
Mina	young IV	f	HAUS	819.0269	837.9487	836.8404	796.349	769.5056	750.8099	698.942
Mina	young IV	f	BOIZ	607.7848	621.2183	644.4949	638.4704	632.4086	611.4368	573.4522
Sarah	young IV	f	SHCHRIT	518.0366	538.4897	439.2376	429.6226	525.468	551.4376	643.2959
Sarah	young IV	f	STIK	500.7039	516.1594	535.3548	537.2939	540.6772	539.9344	541.3971
Sarah	young IV	f	FES	479.6448	472.8931	470.1987	473.4169	472.2619	456.9555	470.5018
Sarah	young IV	f	JRES	655.8393	682.4527	704.5976	715.7765	721.9688	720.5462	710.438
Sarah	young IV	f	CHRAEP	850.5959	897.56	915.5005	921.7111	910.2739	896.1317	878.2358
Sarah	young IV	f	SHUTS	441.3522	451.6855	459.9177	464.0455	467.945	462.858	462.892
Sarah	young IV	f	FUT	527.034	547.326	552.4387	554.9135	557.4201	546.6081	549.2626
Sarah	young IV	f	JOK	575.2722	579.3689	578.3053	572.1292	558.9757	550.3766	555.588
Sarah	young IV	f	TAWK	744.4152	762.5855	785.7405	812.976	819.9405	816.519	826.0397
Sarah	young IV	f	LAT	875.7488	889.7062	906.7426	900.102	899.9848	878.461	860.524
Sarah	young IV	f	STAF	690.5939	734.5167	751.0465	750.3811	744.6357	735.1227	711.1201
Sarah	young IV	f	PRAIS	808.1688	829.4712	804.2445	770.9919	720.5111	690.5067	644.079
Sarah	young IV	f	HAUS	891.4604	898.2684	906.648	866.7734	865.3025	868.3078	802.2191
Sarah	young IV	f	BOIZ	681.6726	694.7443	704.6362	697.0097	636.7069	622.2406	594.1561
Starla	young IV	f	SHCHRIT	432.0708	420.0241	433.5995	439.3307	443.5361	428.146	420.349
Starla	young IV	f	STIK	462.9449	462.198	467.4146	466.9421	461.1514	471.5008	520.8498
Starla	young IV	f	FES	512.021	516.9352	522.7963	521.5852	516.582	517.3379	500.2236
Starla	young IV	f	JRES	610.0096	626.344	641.7798	647.522	645.4753	641.5566	622.3862
Starla	young IV	f	CHRAEP	733.6086	771.5731	789.0681	798.1918	794.3002	791.22	789.5436
Starla	young IV	f	SHUTS	391.022	396.8792	395.0553	388.0015	371.646	373.1366	360.8774
Starla	young IV	f	FUT	392.1326	393.393	394.1767	386.9762	377.3859	372.6234	357.5077
Starla	young IV	f	JOK	520.9182	532.7335	546.7882	528.9032	522.7318	518.6533	481.49
Starla	young IV	f	TAWK	657.6169	689.0768	705.6418	693.4789	697.7443	661.2865	632.6448
Starla	young IV	f	LAT	648.455	733.6166	729.9508	754.7995	733.2928	745.1995	715.4577
Starla	young IV	f	STAF	687.4375	708.2846	719.5117	714.8431	704.202	679.2823	667.6738
Starla	young IV	f	PRAIS	715.0669	753.4946	763.0834	743.8641	713.781	679.0621	644.146
Starla	young IV	f	HAUS	660.5054	688.5747	557.5709	562.8608	541.64	532.5684	485.7786
Starla	young IV	f	BOIZ	564.5702	653.2527	679.197	676.7615	670.1346	658.7949	647.6367

Table H.2. Raw F2 values (Hz) from the 20% to 80% measurement, split across speaker and vowel identity (age group and gender listed).

Speaker Pseudonym	Corpus & Age	Gender	Vowel identity	F2 (20%) raw	F2 (30%) raw	F2 (40%) raw	F2 (50%) raw	F2 (60%) raw	F2 (70%) raw	F2 (80%) raw
Joseph	old BC	m	SHCHRIT	2270.727	2291.749	2299.245	2321.082	2337.271	2314.661	2309.699
Joseph	old BC	m	STIK	2153.025	2166.672	2195.469	2234.416	2242.991	2272.908	2259.121
Joseph	old BC	m	FES	2032.961	2093.183	2147.005	2184.502	2184.801	2207.673	2220.042
Joseph	old BC	m	JRES	1890.247	1947.967	1964.137	1972.865	1981.688	1952.458	1897.259
Joseph	old BC	m	CHRAEP	1794.281	1839.314	1823.802	1841.648	1803.965	1775.755	1735.2
Joseph	old BC	m	SHUTS	1122.444	1093.003	1078.659	1068.829	1083.038	1086.402	1070.562
Joseph	old BC	m	FUT	904.0985	927.6522	923.8857	950.5082	963.4523	959.5933	992.6233
Joseph	old BC	m	JOK	1000.686	946.1764	928.5725	917.1521	918.1339	919.2979	892.1416
Joseph	old BC	m	TAWK	945.5938	964.4115	966.2623	974.9329	977.594	995.8656	996.1969
Joseph	old BC	m	LAT	1287.007	1257.14	1247.223	1251.913	1265.193	1239.008	1251.725
Joseph	old BC	m	STAF	1191.407	1209.006	1245.729	1249.645	1297.082	1262.485	1247.23
Joseph	old BC	m	PRAIS	1294.842	1328.377	1386.987	1451.514	1547.043	1594.61	1723.231
Joseph	old BC	m	HAUS	1235.356	1229.537	1213.932	1183.456	1131.092	1111.439	1018.901
Joseph	old BC	m	BOIZ	847.1795	1128.717	957.9769	1218.425	1227.977	1409.427	1700.025
Kawika	old BC	m	SHCHRIT	2048.771	2069.386	2110.119	2142.965	2159.505	2158.401	2158.765
Kawika	old BC	m	STIK	1939.797	1936.097	1941.093	1961.148	1978.479	1987.376	1993.593
Kawika	old BC	m	FES	1880.715	1920.691	1967.164	2002.965	2024.8	2044.816	2074.507
Kawika	old BC	m	JRES	1824.508	1820.5	1810.356	1802.095	1796.828	1795.06	1785.449
Kawika	old BC	m	CHRAEP	1688.84	1711.518	1741.277	1748.358	1751.743	1759.013	1775.37
Kawika	old BC	m	SHUTS	1133.344	1049.168	1011.111	991.3475	984.8885	1007.909	1055.982
Kawika	old BC	m	FUT	1371.294	1346.701	1294.517	1218.526	1153.711	1096.46	1040.519
Kawika	old BC	m	JOK	993.6013	969.152	946.9958	924.6444	917.6656	912.3849	952.9646
Kawika	old BC	m	TAWK	1093.037	1067.609	1062.084	1063.951	1067.242	1071.895	1092.736
Kawika	old BC	m	LAT	1228.513	1221.139	1208.62	1209.357	1209.684	1212.504	1218.075
Kawika	old BC	m	STAF	1224.639	1259.517	1290.287	1315.33	1334.769	1353.6	1374.836
Kawika	old BC	m	PRAIS	1431.491	1492.948	1561.895	1643.723	1731.31	1814.512	1890.319

Kawika	old BC	m	HAUS	1330.544	1300.194	1273.947	1238.478	1210.069	1180.707	1150.347
Kawika	old BC	m	BOIZ	897.0991	946.4599	994.1806	1047.492	1113.972	1177.759	1286.189
Kimo	old BC	m	SHCHRIT	2147.834	2175.822	2178.553	2182.295	2171.954	2175.857	2150.118
Kimo	old BC	m	STIK	2134.928	2147.39	2167.43	2172.904	2187.172	2177.453	2185.691
Kimo	old BC	m	FES	2063.553	2108.53	2137.299	2154.076	2177.051	2183.475	2179.024
Kimo	old BC	m	JRES	1857.357	1887.859	1915.369	1917.768	1876.095	1872.768	1846.092
Kimo	old BC	m	CHRAEP	1652.316	1680.287	1689.516	1718.006	1711.25	1715.686	1712.886
Kimo	old BC	m	SHUTS	1095.915	1091.528	1028.78	1049.648	1056.662	1094.416	1110.378
Kimo	old BC	m	FUT	928.1106	967.4095	980.4293	1011.261	1066.48	977.3966	932.1001
Kimo	old BC	m	JOK	1013.955	990.1675	990.4228	1004.217	970.8215	977.1271	994.5947
Kimo	old BC	m	TAWK	959.1436	967.6062	966.9714	968.3067	954.3647	973.149	977.0803
Kimo	old BC	m	LAT	1210.69	1208.193	1198.681	1189.929	1183.438	1167.534	1160.392
Kimo	old BC	m	STAF	1201.681	1216.829	1220.435	1233.457	1239.88	1244.971	1243.076
Kimo	old BC	m	PRAIS	1579.548	1625.684	1685.089	1742.354	1802.924	1861.11	1894.044
Kimo	old BC	m	HAUS	1200.767	1191.693	1119.096	1063.652	1035.915	1020.089	1029.473
Kimo	old BC	m	BOIZ	1024.377	1062.636	1104.63	1177.041	1246.261	1433.444	1400.505
Manny	old BC	m	SHCHRIT	2289.726	2286.559	2298.45	2289.576	2276.188	2265.443	2256.367
Manny	old BC	m	STIK	2154.075	2182.114	2205.542	2211.293	2217.108	2220.255	2218.011
Manny	old BC	m	FES	2135.98	2165.859	2159.932	2167.83	2176.349	2150.023	2124.047
Manny	old BC	m	JRES	1802.35	1772.63	1771.681	1765.7	1789.471	1743.041	1695.73
Manny	old BC	m	CHRAEP	1852.125	1875.742	1857.84	1866.743	1861.894	1861.002	1834.001
Manny	old BC	m	SHUTS	1227.153	1231.56	1161.105	1158.942	1163.088	1137.251	1091.761
Manny	old BC	m	FUT	1046.751	1057.497	1061.122	1076.493	1063.584	1057.447	1096.089
Manny	old BC	m	JOK	958.2141	904.2908	917.997	909.058	913.9323	927.7719	982.9119
Manny	old BC	m	TAWK	914.1444	911.556	892.5011	931.9609	938.7073	949.4357	914.6643
Manny	old BC	m	LAT	1081.135	1088.516	1086.045	1093.105	1098.341	1105.092	1101.73
Manny	old BC	m	STAF	1232.514	1239.599	1220.406	1206.636	1204.717	1229.339	1247.173
Manny	old BC	m	PRAIS	1499.393	1487.864	1503.861	1526.693	1620.762	1710.06	1738.368
Manny	old BC	m	HAUS	912.868	927.8636	951.4247	947.1276	939.2872	922.2883	943.5894
Manny	old BC	m	BOIZ	984.6355	1022.072	1058.603	1100.823	1143.244	1206.302	1303.721

Kaimana	old BC	f	SHCHRIT	2456.33	2482.723	2501.2	2514.949	2499.435	2498.865	2507.042
Kaimana	old BC	f	STIK	2386.588	2423.431	2446.33	2444.128	2440.51	2452.907	2449.738
Kaimana	old BC	f	FES	2324.517	2371.913	2377.779	2433.178	2449.71	2451.27	2437.534
Kaimana	old BC	f	JRES	2067.211	2076.99	2079.783	2072.856	2061.366	2050.695	2031.462
Kaimana	old BC	f	CHRAEP	1852.438	1854.845	1875.075	1878.79	1881.02	1871.2	1860.621
Kaimana	old BC	f	SHUTS	1084.334	1030.762	1002.392	985.9991	1003.43	993.7088	1010.545
Kaimana	old BC	f	FUT	1294.433	1259.702	1270.053	1275.519	1288.699	1311.764	1321.754
Kaimana	old BC	f	JOK	1052.8	1015.8	998.8575	990.7449	994.4563	1006.445	1020.898
Kaimana	old BC	f	TAWK	1159.614	1162.729	1164.783	1174.497	1186.149	1187.016	1196.25
Kaimana	old BC	f	LAT	1344.01	1354.38	1358.681	1368.241	1380.34	1376.628	1387.288
Kaimana	old BC	f	STAF	1455.556	1452.912	1455.163	1454.048	1457.526	1455.442	1436.955
Kaimana	old BC	f	PRAIS	1674.959	1718.402	1774.389	1843.948	1937.375	2017.249	2059.771
Kaimana	old BC	f	HAUS	1321.427	1290.452	1247.821	1192.088	1130.516	1090.206	1064.236
Kaimana	old BC	f	BOIZ	1098.019	1246.509	1439.564	1653.225	1794.282	1860.582	1956.929
Keiko	old BC	f	SHCHRIT	2597.308	2640.566	2667.313	2657.969	2667.592	2636.685	2607.409
Keiko	old BC	f	STIK	2441.913	2420.827	2418.24	2432.64	2441.188	2420.01	2408.97
Keiko	old BC	f	FES	2346.051	2461.397	2514.689	2529.892	2557.481	2520.488	2497.591
Keiko	old BC	f	JRES	2020.476	2023.39	2035.022	2003.437	1984.557	1962.817	1964.103
Keiko	old BC	f	CHRAEP	2096.824	2114.075	2107.987	2103.555	2107.848	2100.725	2097.677
Keiko	old BC	f	SHUTS	1701.878	1622.248	1558.37	1507.161	1444.998	1451.838	1441.543
Keiko	old BC	f	FUT	1297.145	1244.38	1252.862	1288.333	1310.053	1328.136	1351.224
Keiko	old BC	f	JOK	1115.379	1092.233	1069.743	1066.816	1059.195	1068.712	1139.113
Keiko	old BC	f	TAWK	1123.002	1095.126	1070.591	1051.131	1058.196	1083.018	1132.159
Keiko	old BC	f	LAT	1430.522	1397.682	1398.519	1384.996	1375.736	1368.666	1364.341
Keiko	old BC	f	STAF	1305.493	1308.698	1312.373	1328.231	1343.24	1338.168	1379.336
Keiko	old BC	f	PRAIS	1430.698	1491.68	1603.825	1648.351	1765.734	1843.984	1999.972
Keiko	old BC	f	HAUS	1400.983	1289.462	1225.98	1182.431	1205.302	1179.945	1206.998
Keiko	old BC	f	BOIZ	1047.199	1055.496	1108.462	1177.703	1361.63	1609.142	1930.885
Malia	old BC	f	SHCHRIT	2504.345	2544.387	2598.036	2585.433	2573.419	2565.259	2545.154
Malia	old BC	f	STIK	2373.713	2399.082	2434.709	2463.702	2491.996	2514.761	2479.123
Malia	old BC	f	FES	2404.203	2469.251	2494.667	2529.306	2548.677	2581.024	2587.233

Malia	old BC	f	JRES	2199.821	2166.936	2172.746	2199.308	2210.101	2209.148	2215.51
Malia	old BC	f	CHRAEP	1978.758	2027.55	2083.951	2107.884	2124.604	2158.664	2136.782
Malia	old BC	f	SHUTS	1233.842	1084.51	1094.946	1050.828	1020.057	998.262	960.9929
Malia	old BC	f	FUT	1207.065	1160.889	1117.081	1084.03	1052.26	1098.425	1231.744
Malia	old BC	f	JOK	1077.175	996.8814	997.4285	960.9185	1046.567	924.0616	1032.833
Malia	old BC	f	TAWK	1002.577	992.8778	1007.585	1005.94	1014.236	1028.522	1037.595
Malia	old BC	f	LAT	1347.624	1292.838	1262.038	1268.143	1298.044	1317.294	1336.011
Malia	old BC	f	STAF	1471.687	1474.362	1483.922	1470.725	1446.538	1445.614	1460.603
Malia	old BC	f	PRAIS	1500.448	1536.653	1617.78	1834.105	1953.318	2094.171	2163.819
Malia	old BC	f	HAUS	1335.669	1329.234	1255.085	1219.347	1157.912	1108.871	1071.956
Malia	old BC	f	BOIZ	720.4574	681.2665	653.086	836.2439	1067.975	1627.902	1817.244
Miki	old BC	f	SHCHRIT	2420.131	2498.476	2524.51	2542.523	2521	2524.095	2499.007
Miki	old BC	f	STIK	2537.127	2587.21	2632.034	2634.282	2627.935	2620.44	2598.804
Miki	old BC	f	FES	2379.529	2441.636	2458.491	2488.366	2461.98	2433.197	2450.286
Miki	old BC	f	JRES	2060.184	2088.96	2148.367	2108.96	2122.813	2101.656	2096.997
Miki	old BC	f	CHRAEP	2193.819	2257.273	2295.788	2314.97	2336.638	2337.723	2346.203
Miki	old BC	f	SHUTS	1291.053	1216.875	1177.933	1183.262	1177.673	1178.112	1216.835
Miki	old BC	f	FUT	1471.564	1319.354	1283.879	1245.974	1265.699	1264.541	1323.799
Miki	old BC	f	JOK	1129.927	1116.13	1111.931	1090.368	1081.322	1105.175	1058.185
Miki	old BC	f	TAWK	1229.649	1211.232	1203.953	1178.17	1181.845	1177.904	1171.734
Miki	old BC	f	LAT	1399.9	1418.601	1412.273	1406.667	1384.675	1356.394	1323.265
Miki	old BC	f	STAF	1439.749	1463.953	1469.439	1480.048	1500.795	1509.87	1496.996
Miki	old BC	f	PRAIS	1770.88	1840.814	1930.171	2057.872	2201.624	2262.847	2382.059
Miki	old BC	f	HAUS	1757.1	1561.487	1500.837	1446.953	1397.18	1313.751	1268.358
Miki	old BC	f	BOIZ	1889.77	1841.482	1818.359	1841.027	1865.559	1925.713	2043.003
Danny	young BC	m	SHCHRIT	2094.455	2115.786	2142.072	2141.388	2137.003	2143.584	2137.134
Danny	young BC	m	STIK	2001.949	2037.076	2046.869	2050.811	2070.484	2038.694	2059.349
Danny	young BC	m	FES	1996.389	2029.834	2058.247	2082.568	2095.851	2109.826	2111.003
Danny	young BC	m	JRES	1738.778	1740.964	1747.363	1743.451	1738.698	1715.296	1710.695
Danny	young BC	m	CHRAEP	1807.324	1810.951	1823.587	1842.291	1851.056	1853.171	1872.105

Danny	young BC	m	SHUTS	1150.128	1133.497	1110.688	1075.22	1073.531	1073.55	1088.802
Danny	young BC	m	FUT	1119.746	1102.974	1082.958	1134.628	1156.984	1170.167	1201.614
Danny	young BC	m	JOK	951.4325	927.7075	913.2315	909.747	911.2806	926.8543	971.9301
Danny	young BC	m	TAWK	944.6958	924.4938	930.299	924.6546	941.3404	956.2341	1002.389
Danny	young BC	m	LAT	1080.032	1063.814	1090.953	1095.921	1102.222	1108.219	1117.782
Danny	young BC	m	STAF	1177.59	1213.082	1209.167	1177.972	1186.9	1218.35	1207.606
Danny	young BC	m	PRAIS	1464.341	1533.597	1594.543	1628.224	1705.573	1707.111	1702.371
Danny	young BC	m	HAUS	1023.289	957.9251	926.627	969.627	1049.7	1112.389	1062.465
Danny	young BC	m	BOIZ	969.4421	1055.391	1169.856	1229.304	1285.158	1370.426	1405.895
Eddie	young BC	m	SHCHRIT	2394.445	2432.44	2455.673	2418.849	2446.546	2402.399	2407.458
Eddie	young BC	m	STIK	2015.228	2034.756	2048.137	2041.602	2035.193	2001.418	1980.953
Eddie	young BC	m	FES	1968.098	2010.171	2058.063	2096.821	2130.551	2147.863	2141.134
Eddie	young BC	m	JRES	1749.018	1751.155	1770.866	1771.799	1758.297	1739.776	1728.949
Eddie	young BC	m	CHRAEP	1714.323	1759.521	1762.05	1767.132	1770.997	1778.537	1783.449
Eddie	young BC	m	SHUTS	933.9465	900.5856	888.2559	918.4077	919.5349	927.385	910.3207
Eddie	young BC	m	FUT	1249.71	1128.242	1174.419	1182.064	1191.51	1238.797	1270.48
Eddie	young BC	m	JOK	881.8792	870.5227	868.932	866.4017	864.2995	866.5919	867.4044
Eddie	young BC	m	TAWK	1089.919	1090.038	1090.021	1086.017	1083.637	1070.765	1062.264
Eddie	young BC	m	LAT	1346.75	1333.266	1358.125	1345.643	1347.053	1338.283	1373.53
Eddie	young BC	m	STAF	1404.749	1379.731	1379.978	1392.646	1398.183	1397.696	1397.195
Eddie	young BC	m	PRAIS	1568.658	1578.566	1636.39	1672.429	1738.929	1809.648	1844.103
Eddie	young BC	m	HAUS	1326.686	1308.1	1302.44	1262.345	1254.51	1171.897	1138.175
Eddie	young BC	m	BOIZ	1519.824	1529.541	1524.486	1562.262	1590.622	1607.194	1602.834
Glen	young BC	m	SHCHRIT	2030.102	2023.084	2035.387	2041.041	2030.819	2049.801	2068.723
Glen	young BC	m	STIK	1979.715	2022.172	2012.312	2032.535	2026.931	2089.24	2088.93
Glen	young BC	m	FES	2027.477	2038.251	2053.935	2065.422	2072.311	2072.951	2106.459
Glen	young BC	m	JRES	1875.006	1838.602	1793.48	1763.301	1790.157	1761.39	1734.883
Glen	young BC	m	CHRAEP	1786.916	1797.429	1807.507	1797.936	1787.045	1767.906	1752.754
Glen	young BC	m	SHUTS	1019.386	1068.979	1009.737	1082.211	1035.874	1069.386	1019.402
Glen	young BC	m	FUT	822.2355	842.3316	852.5753	855.4535	853.967	873.2689	902.7484
Glen	young BC	m	JOK	911.965	914.4288	873.2065	877.9111	894.3037	881.7728	918.7904

Glen	young BC	m	TAWK	918.0346	903.3249	906.8812	914.6536	909.833	920.629	927.0445
Glen	young BC	m	LAT	1143.537	1166.263	1154.832	1175.01	1194.792	1214.181	1238.246
Glen	young BC	m	STAF	1067.196	1063.774	1099.845	1133.67	1128.862	1147.154	1156.703
Glen	young BC	m	PRAIS	1458.818	1536.255	1608.808	1690.864	1766.167	1822.793	1859.05
Glen	young BC	m	HAUS	1095.855	1072.891	1033.425	999.5619	965.0976	966.4816	953.6613
Glen	young BC	m	BOIZ	998.9151	1086.398	1109.717	1279.668	1286.878	1351.788	1448.247
Victor	young BC	m	SHCHRIT	2300.785	2367.63	2387.686	2422.462	2400.63	2407.413	2387.821
Victor	young BC	m	STIK	2294.509	2339.375	2375.977	2380.411	2385.279	2346.35	2349.903
Victor	young BC	m	FES	2163.927	2257.212	2287.775	2305.545	2273.83	2339.637	2311.496
Victor	young BC	m	JRES	1877.63	1930.886	1941.095	1948.761	1950.394	1956.759	1962.577
Victor	young BC	m	CHRAEP	1619.654	1568.439	1598.841	1630.093	1610.301	1608.313	1608.294
Victor	young BC	m	SHUTS	1309.708	1221.683	1150.239	1106.248	1095.003	1083.611	1115.878
Victor	young BC	m	FUT	866.6224	865.021	899.6941	937.5127	984.8696	1027.281	1018.473
Victor	young BC	m	JOK	934.1576	910.2447	887.7749	855.944	832.1579	830.4816	840.5935
Victor	young BC	m	TAWK	1033.454	1023.157	1003.932	1008.14	1025.99	1026.689	1045.271
Victor	young BC	m	LAT	1207.92	1202.638	1209.294	1210.768	1197.628	1222.932	1224.479
Victor	young BC	m	STAF	1247.133	1253.66	1242.392	1234.798	1241.159	1246.433	1264.783
Victor	young BC	m	PRAIS	1353.92	1430.097	1491.671	1563.076	1655.725	1654.129	1576.996
Victor	young BC	m	HAUS	1127.825	1119.834	1098.379	1064.128	1018.212	967.2707	961.3609
Victor	young BC	m	BOIZ	929.1832	975.914	1044.902	1138.721	1287.569	1429.526	1593.973
Delia Jane	young BC	f	SHCHRIT	2464.854	2511.951	2488.679	2515.536	2457.829	2497.048	2431.874
Delia Jane	young BC	f	STIK	2248.744	2269.836	2305.189	2365.424	2385.029	2393.809	2388.838
Delia Jane	young BC	f	FES	2328.694	2457	2487.7	2537.703	2570.199	2561.263	2540.191
Delia Jane	young BC	f	JRES	1996.956	1938.988	1991.624	1996	1991.497	1957.326	2002.113
Delia Jane	young BC	f	CHRAEP	2114.814	2116.734	2112.747	2140.685	2114.295	2089.2	2089.63
Delia Jane	young BC	f	SHUTS	1595.789	1520.969	1427.055	1390.205	1450.923	1500.995	1477.931
Delia Jane	young BC	f	FUT	1468.303	1370.114	1355.539	1358.3	1364.06	1371.222	1469.515
Delia Jane	young BC	f	JOK	1080.187	954.5831	1002.78	933.0574	937.8577	1037.533	1198.37
Delia Jane	young BC	f	TAWK	1283.159	1245.543	1309.469	1235.351	1160.176	1272.42	1301.743
Delia Jane	young BC	f	LAT	1233.919	1199.709	1260.152	1308.585	1330.806	1357.845	1335.975
Delia Jane	young BC	f	STAF	1534.506	1526.27	1564.179	1583.278	1652.352	1697.026	1655.049

Delia Jane	young BC	f	PRAIS	1713.538	1744.514	1789.079	1802.252	1980.579	2054.119	2131.418
Delia Jane	young BC	f	HAUS	1521.136	1441.246	1420.016	1397.926	1327.375	1250.244	1203.598
Leilani	young BC	f	SHCHRIT	2341.365	2378.051	2420.235	2452.885	2449.735	2459.784	2447.691
Leilani	young BC	f	STIK	2016.403	2042.261	2073.304	2078.271	2062.422	2038.226	2003.389
Leilani	young BC	f	FES	2172.206	2215.702	2266.472	2288.816	2289.357	2281.797	2318.035
Leilani	young BC	f	JRES	1877.3	1909.344	1899.865	1900.307	1897.756	1887.394	1868.722
Leilani	young BC	f	CHRAEP	1741.393	1756.098	1751.766	1757.942	1754.335	1752.073	1742.397
Leilani	young BC	f	SHUTS	1187.806	1150.197	1096.548	1062.017	1058.01	1034.182	1108.394
Leilani	young BC	f	FUT	1094.685	1125.292	1138.044	1198.994	1236.916	1321.913	1339.868
Leilani	young BC	f	JOK	963.3195	917.9181	888.9306	886.4719	883.4791	882.8329	912.2283
Leilani	young BC	f	TAWK	1035.092	1042.35	1047.452	1048.735	1045.339	1050.135	1075.117
Leilani	young BC	f	LAT	1222.186	1210.731	1216.635	1212.176	1228.832	1234.682	1251.07
Leilani	young BC	f	STAF	1334.382	1317.146	1324.851	1336.791	1338.104	1341.753	1344.79
Leilani	young BC	f	PRAIS	1367.296	1432.964	1523.623	1590.073	1653.302	1705.19	1733.897
Leilani	young BC	f	HAUS	1287.702	1240.868	1210.528	1129.41	1110.652	1060.266	1006.61
Leilani	young BC	f	BOIZ	972.8213	1009.998	1096.29	1188.5	1299.617	1520.291	1585.574
Mona Lisa	young BC	f	SHCHRIT	2591.507	2616.607	2620.792	2631.554	2643.393	2633.877	2595.082
Mona Lisa	young BC	f	STIK	2396.901	2445.2	2458.562	2464.634	2469.711	2470.684	2472.016
Mona Lisa	young BC	f	FES	2442.06	2492.399	2507.743	2527.095	2559.138	2543.23	2519.017
Mona Lisa	young BC	f	JRES	2211.838	2232.749	2246.758	2235.126	2201.29	2200.446	2183.972
Mona Lisa	young BC	f	CHRAEP	2370.797	2425.581	2401.137	2401.31	2391.597	2392.826	2397.449
Mona Lisa	young BC	f	SHUTS	1166.513	1166.76	1169.596	1112.544	1082.182	1071.428	1076.145
Mona Lisa	young BC	f	FUT	1048.682	1093.591	1052.939	1062.406	1086.623	1132.94	1175.786
Mona Lisa	young BC	f	JOK	1046.755	1028.506	1004.667	992.7148	975.0972	976.8308	985.6822
Mona Lisa	young BC	f	TAWK	1042.33	1075.406	1073.506	1078.676	1095.403	1123.399	1113.334
Mona Lisa	young BC	f	LAT	1499.85	1516.698	1525.047	1511.81	1520.042	1502.473	1462.724
Mona Lisa	young BC	f	STAF	1206.999	1231.255	1226.692	1222.449	1243.935	1270.939	1292.773
Mona Lisa	young BC	f	PRAIS	1794.675	1843.174	1903.097	1967.993	2044.349	2128.045	2202.659
Mona Lisa	young BC	f	HAUS	1519.124	1508.073	1474.77	1429.466	1374.27	1257.509	1207.18
Mona Lisa	young BC	f	BOIZ	1095.123	1074.922	1087.782	1120.843	1228.085	1333.412	1535.106

Teresa	young BC	f	SHCHRIT	2672.216	2681.165	2700.901	2753.499	2743.891	2744.626	2722.136
Teresa	young BC	f	STIK	2489.115	2482.229	2514.517	2530.761	2547.759	2552.31	2529.704
Teresa	young BC	f	FES	2321.837	2395.643	2418.365	2462.667	2489.456	2563.46	2467.088
Teresa	young BC	f	JRES	1992.481	2023.696	1977.436	1970.785	1926.785	1860.417	1822.637
Teresa	young BC	f	CHRAEP	2036.044	1962.138	1962.702	1929.431	1898.566	1877.44	1871.435
Teresa	young BC	f	SHUTS	967.7998	948.4068	902.5699	887.7371	954.5448	882.4452	873.1574
Teresa	young BC	f	FUT	916.8029	935.0151	956.2009	960.5001	966.1772	997.6188	1027.767
Teresa	young BC	f	JOK	1027.149	995.387	962.1078	937.2555	924.953	917.4652	913.436
Teresa	young BC	f	TAWK	1072.294	1070.495	1094.877	1097.033	1110.317	1105.559	1092.452
Teresa	young BC	f	LAT	1179.277	1189.587	1190.622	1191.772	1187.29	1174.571	1190.274
Teresa	young BC	f	STAF	1180.883	1183.666	1204.679	1233.565	1259.511	1290.964	1291.263
Teresa	young BC	f	PRAIS	1321.328	1326.899	1445.04	1545.605	1634.08	1636.286	1696.238
Teresa	young BC	f	HAUS	1201.761	1191.807	1147.375	1098.085	1064.525	1030.418	1034.97
Teresa	young BC	f	BOIZ	970.7859	873.8398	861.4913	1415.825	1372.757	1425.634	1511.379
Grant	old IV	m	SHCHRIT	1980.997	1997.198	2005.787	1990.819	1996.579	1988.839	1995.39
Grant	old IV	m	STIK	1643.457	1687.772	1752.97	1740.972	1742.491	1717.608	1707.157
Grant	old IV	m	FES	1953.997	1999.223	2005.883	2013.437	2012.354	2034.808	2022.626
Grant	old IV	m	JRES	1789.993	1832.744	1879.436	1854.39	1840.909	1820.344	1791.65
Grant	old IV	m	CHRAEP	1517.745	1524.67	1534.552	1528.152	1511.951	1502.682	1493.686
Grant	old IV	m	SHUTS	1253.874	1224.925	1260.956	1216.517	1188.896	1192.821	1164.383
Grant	old IV	m	FUT	1213.262	1229.95	1252.631	1260.692	1275.644	1274.065	1284.569
Grant	old IV	m	JOK	1009.48	955.5037	922.4809	949.6782	918.5076	967.5801	962.295
Grant	old IV	m	TAWK	1100.579	1083.527	1075.539	1081.813	1093.038	1120.826	1141.023
Grant	old IV	m	LAT	1201.559	1208.665	1200.117	1207.008	1219.11	1217.235	1218.236
Grant	old IV	m	STAF	1200.13	1200.899	1212.813	1223.861	1234.424	1243.144	1242.166
Grant	old IV	m	PRAIS	1304.275	1341.305	1399.206	1443.436	1548.18	1614.449	1726.793
Grant	old IV	m	HAUS	1264.536	1259.258	1216.429	1162.182	1098.024	1023.578	996.3813
Grant	old IV	m	BOIZ	1436.546	1444.071	1396.091	1358.073	1389.279	1410.535	1316.259
Keoni	old IV	m	SHCHRIT	2322.057	2369.171	2376.318	2383.984	2393.858	2351.468	2352.276
Keoni	old IV	m	STIK	2170.633	2220.312	2258.122	2283.585	2295.257	2285.973	2286.377

Keoni	old IV	m	FES	1908.772	1977.132	2032.323	2081.5	2107.004	2115.598	2109.586
Keoni	old IV	m	JRES	1678.605	1724.918	1734.318	1736.767	1745.577	1740.899	1730.05
Keoni	old IV	m	CHRAEP	1595.789	1596.767	1588.154	1593.419	1593.884	1589.497	1578.962
Keoni	old IV	m	SHUTS	1196.173	1177.749	1145.664	1153.393	1155.755	1208.574	1191.333
Keoni	old IV	m	FUT	1376.858	1297.147	1299.921	1307.719	1337.469	1302.308	1346.408
Keoni	old IV	m	JOK	1116.019	1071.595	1056.129	1012.352	1010.728	1024.778	1036.874
Keoni	old IV	m	TAWK	1094.508	1046.967	1031.7	1009.973	1008.622	976.6179	997.1476
Keoni	old IV	m	LAT	1203.12	1170.732	1162.359	1163.935	1179.605	1247.97	1227.041
Keoni	old IV	m	STAF	1175.809	1185.408	1167.525	1147.245	1147.759	1155.336	1154.431
Keoni	old IV	m	PRAIS	1339.263	1359.8	1435.921	1517.739	1582.254	1701.278	1696.454
Keoni	old IV	m	HAUS	1192.683	1125.699	1104.755	1085.056	1117.35	1143.054	1151.39
Keoni	old IV	m	BOIZ	1205.297	1087.042	1242.072	1102.134	1156.634	1254.588	1373.861
Kevin	old IV	m	SHCHRIT	2061.367	2093.576	2128.219	2156.835	2177.72	2220.937	2216.032
Kevin	old IV	m	STIK	1787.899	1844.179	1903.9	1952.819	1970.954	1951.478	1881.276
Kevin	old IV	m	FES	1883.985	1969.918	2029.315	2065.217	2056.95	2014.001	2010.378
Kevin	old IV	m	JRES	1651.858	1685.538	1681.609	1639.407	1626.93	1628.898	1637.26
Kevin	old IV	m	CHRAEP	1641.797	1645.849	1627.891	1584.77	1547.128	1526.087	1518.191
Kevin	old IV	m	SHUTS	1131.408	1111.431	1084.449	1063.873	1046.565	1056.054	1027.239
Kevin	old IV	m	FUT	1079.86	1039.409	998.3453	985.2613	976.2681	987.3126	1170.683
Kevin	old IV	m	JOK	944.7377	912.598	890.137	893.8776	891.6699	903.0929	952.6639
Kevin	old IV	m	TAWK	1032.803	1023.236	1019.424	1011.766	1020.449	1043.08	1053.666
Kevin	old IV	m	LAT	1128.034	1086.466	1078.826	1072.23	1070.298	1057.04	1067.07
Kevin	old IV	m	STAF	1157.379	1131.404	1121.735	1117.453	1115.082	1118.778	1119.826
Kevin	old IV	m	PRAIS	1308.775	1348.452	1404.492	1481.913	1570.402	1655.138	1733.567
Kevin	old IV	m	HAUS	1122.658	1065.561	1021.861	980.8251	949.4858	905.6349	953.1998
Kevin	old IV	m	BOIZ	1618.711	1718.097	1779.428	1689.294	1955.486	2080.816	1996.716
Palani	old IV	m	SHCHRIT	2038.892	2092.683	2134.686	2145.096	2144.036	2135.929	2077.027
Palani	old IV	m	STIK	1948.417	1961.398	1994.317	2011.546	2011.047	2002.263	2005.077
Palani	old IV	m	FES	1957.815	1999.455	2038.054	2054.901	2074.337	2089.325	2061.062
Palani	old IV	m	JRES	1765.285	1734.435	1726.565	1710.669	1733.008	1723.444	1699.291
Palani	old IV	m	CHRAEP	1861.737	1863.577	1867.095	1870.135	1895.453	1874.557	1882.269

Palani	old IV	m	SHUTS	1197.449	1173.919	1146.782	1077.305	1084.364	1104.249	1078.192
Palani	old IV	m	FUT	1062.989	1046.01	1066.425	1082.528	1079.488	1121.446	1148.058
Palani	old IV	m	JOK	1037.353	962.6632	941.5489	944.2123	933.013	868.9643	884.5456
Palani	old IV	m	TAWK	1164.373	1081.133	1063.029	1027.574	1028.683	1012.173	997.6877
Palani	old IV	m	LAT	1109.623	1102.998	1125.565	1123.654	1139.687	1147.705	1155.725
Palani	old IV	m	STAF	1223.456	1221.181	1223.98	1237.084	1255.239	1281.131	1297.955
Palani	old IV	m	PRAIS	1451.833	1486.849	1523.161	1577.104	1649.441	1706.935	1733.165
Palani	old IV	m	HAUS	1080.287	1077.443	1060.856	1029.074	991.6341	959.9207	987.8411
Palani	old IV	m	BOIZ	1319.182	1382.375	1450.963	1414.568	1421.981	1401.677	1420.721
Carla	old IV	f	SHCHRIT	2386.604	2508.238	2537.432	2468.188	2519.205	2475.555	2493.151
Carla	old IV	f	STIK	2268.832	2300.038	2332.882	2367.388	2365.273	2347.566	2337.289
Carla	old IV	f	FES	2105.57	2190.205	2251.169	2277.274	2341.959	2301.378	2213.968
Carla	old IV	f	JRES	1982.561	1997.701	2070.891	2050.462	2053.228	2032.579	2016.044
Carla	old IV	f	CHRAEP	1962.819	1956.874	1918.388	1873.311	1847.13	1828.841	1836.347
Carla	old IV	f	SHUTS	992.745	941.0687	977.8033	1005.085	1033.634	1070.353	1071.036
Carla	old IV	f	FUT	1029.028	1033.07	982.8094	998.715	995.1996	1019.975	1023.878
Carla	old IV	f	JOK	1070.136	1009.634	1007.428	1009.273	939.5243	933.8137	942.3349
Carla	old IV	f	TAWK	1364.655	1284.996	1172.124	1161.477	1142.594	1141.927	1150.025
Carla	old IV	f	LAT	1251.988	1234.269	1212.539	1229.73	1220.796	1256.51	1260.774
Carla	old IV	f	STAF	1285.931	1317.704	1299.21	1290.743	1294.976	1328.557	1268.62
Carla	old IV	f	PRAIS	1567.563	1574.455	1748.468	1876.21	1975.042	2108.975	2177.2
Carla	old IV	f	HAUS	1279.002	1345.447	1281.587	1212.635	1177.139	1153.88	1210.831
Carla	old IV	f	BOIZ	1088.871	1117.085	1171.61	1166.857	1181.691	1256.759	1256.655
Kahea	old IV	f	SHCHRIT	2570.855	2676.832	2670.498	2703.839	2709.19	2693.277	2695.491
Kahea	old IV	f	STIK	2481.987	2597.198	2516.79	2498.184	2440.57	2478.16	2498.072
Kahea	old IV	f	FES	2219.944	2314.777	2418.13	2486.165	2475.968	2511.309	2477.161
Kahea	old IV	f	JRES	1854.299	1884.723	1897.271	1874.083	1879.233	1885.429	1918.717
Kahea	old IV	f	CHRAEP	1876.992	1884.441	1890.214	1830.987	1909.842	1929.96	1881.598
Kahea	old IV	f	SHUTS	1188.109	1092.39	1075.484	1027.1	1040.571	1018.745	1080.666
Kahea	old IV	f	FUT	1189.888	1127.446	1098.563	1078.081	1091.999	1132.472	1207.662
Kahea	old IV	f	JOK	1029.574	965.1923	966.1451	979.7515	991.9163	1014.682	984.2005

Kahea	old IV	f	TAWK	1075.513	1089.681	1085.622	1099.792	1093.222	1113.597	1128.419
Kahea	old IV	f	LAT	1286.154	1301.264	1278.344	1284.187	1309.252	1301.958	1316.778
Kahea	old IV	f	STAF	1342.678	1323.863	1305.703	1337.037	1340.543	1397.858	1390.016
Kahea	old IV	f	PRAIS	1486.313	1534.07	1651.009	1761.201	1798.238	1815.92	1696.291
Kahea	old IV	f	HAUS	1144.988	1127.732	1057.556	1063.687	1044.675	1030.003	988.1527
Kahea	old IV	f	BOIZ	1181.116	1174.09	1365.138	1535.692	1718.237	1881.949	1923.989
Lani	old IV	f	SHCHRIT	2586.827	2621.354	2646.123	2658.784	2676.756	2686.705	2681.494
Lani	old IV	f	STIK	2352.25	2392.694	2417.609	2436.611	2439.816	2423.042	2401.579
Lani	old IV	f	FES	2155.727	2253.538	2343.561	2367.609	2416.059	2400.808	2373.008
Lani	old IV	f	JRES	1803.56	1850.751	1882.019	1901.337	1895.841	1889.27	1883.389
Lani	old IV	f	CHRAEP	1860.099	1861.382	1906.766	1862.438	1827.144	1811.217	1754.536
Lani	old IV	f	SHUTS	1056.239	1027.937	962.3132	936.0493	904.0607	905.3349	928.3788
Lani	old IV	f	FUT	1045.202	1071.115	1110.901	1162.679	1209.819	1262.469	1329.394
Lani	old IV	f	JOK	987.3072	949.9368	929.5027	909.7423	898.2347	878.358	894.5686
Lani	old IV	f	TAWK	1148.758	1127.107	1109.89	1115.24	1139.746	1160.9	1180.999
Lani	old IV	f	LAT	1206.653	1251.45	1243.532	1264.47	1337.327	1374.557	1415.941
Lani	old IV	f	STAF	1235.383	1241.825	1280.802	1330.141	1350.787	1373.196	1419.428
Lani	old IV	f	PRAIS	1465.067	1563.414	1626.735	1684.85	1770.746	1900.399	2000.456
Lani	old IV	f	HAUS	1232.286	1219.818	1199.579	1192.707	1141.31	1108.558	1076.15
Lani	old IV	f	BOIZ	928.5496	966.8471	1043.327	1196.953	1380.804	1598.088	1739.856
Pua	old IV	f	SHCHRIT	2245.586	2281.425	2342.281	2349.71	2309.994	2316.567	2242.504
Pua	old IV	f	STIK	2002.289	2056.393	2088.028	2065.326	2089.645	2075.417	2084.821
Pua	old IV	f	FES	2133.565	2229.061	2303.817	2352.628	2390.051	2378.889	2308.518
Pua	old IV	f	JRES	1897.681	1942.004	1944.453	1928.731	1902.87	1888.134	1865.463
Pua	old IV	f	CHRAEP	1695.067	1689.131	1680.55	1676.103	1665.917	1652.728	1658.623
Pua	old IV	f	SHUTS	1157.036	1070.443	1031.934	1013.477	997.5121	986.7257	992.894
Pua	old IV	f	FUT	1012.385	1002.199	1000.695	1025.103	1067.932	1097.227	1150.705
Pua	old IV	f	JOK	1068.448	1015.938	974.0854	961.4781	914.1343	902.5927	932.2073
Pua	old IV	f	TAWK	1137.955	1087.888	1049.523	1055.466	1028.994	964.9198	992.1741
Pua	old IV	f	LAT	1210.434	1201.314	1201.202	1196.225	1205.013	1218.412	1200.115
Pua	old IV	f	STAF	1341.242	1294.063	1316.65	1335.039	1356.955	1354.936	1402.279

Pua	old IV	f	PRAIS	1487.801	1552.943	1617.19	1719.303	1767.249	1868.315	1923.681
Pua	old IV	f	HAUS	1227.015	1165.63	1121.159	1053.046	1183.506	1161.539	1105.604
Pua	old IV	f	BOIZ	1025.673	1048.045	1084.708	1144.623	1233.91	1381.36	1371.743
Eric	young IV	m	SHCHRIT	2132.966	2148.258	2165.833	2171.781	2161.67	2175.926	2159.459
Eric	young IV	m	STIK	1959.609	2016.382	2030.316	2049.622	2032.988	2009.511	1986.75
Eric	young IV	m	FES	1846.805	1884.451	1943.803	1937.174	1984.28	1972.064	1942.596
Eric	young IV	m	JRES	1535.548	1542.761	1561.157	1568.547	1575.204	1568.735	1566.204
Eric	young IV	m	CHRAEP	1510.807	1515.372	1506.065	1494.098	1485.069	1483.639	1480.847
Eric	young IV	m	SHUTS	1357.78	1353.043	1377.429	1369.838	1351.257	1346.352	1339.168
Eric	young IV	m	FUT	1292.891	1261.003	1227.683	1249.135	1316.363	1320.564	1285.2
Eric	young IV	m	JOK	1286.281	1258.349	1201.628	1152.162	1158.235	1162.586	1166.695
Eric	young IV	m	TAWK	1229.058	1182.6	1180.55	1166.704	1161.681	1173.695	1188.863
Eric	young IV	m	LAT	1226.377	1203.412	1219.558	1213.717	1216.122	1230.065	1253.342
Eric	young IV	m	STAF	1206.439	1213.895	1204.199	1188.314	1217.194	1229.766	1267.722
Eric	young IV	m	PRAIS	1372.273	1419.496	1474.35	1518.115	1581.233	1634.149	1651.187
Eric	young IV	m	HAUS	1162.887	1149.342	1167.652	1163.967	1152.495	1159.06	1207.448
Eric	young IV	m	BOIZ	1231.483	1244.727	1276.123	1359.352	1440.167	1486.93	1659.178
Kaleo	young IV	m	SHCHRIT	1816.762	1831.86	1853.8	1853.998	1846.742	1857.131	1853.136
Kaleo	young IV	m	STIK	1718.006	1717.254	1727.117	1727.244	1720.173	1705.542	1690.046
Kaleo	young IV	m	FES	1739.584	1760.807	1778.225	1800.821	1804.129	1798.326	1778.775
Kaleo	young IV	m	JRES	1648.964	1642.15	1661.456	1652.777	1638.616	1639.056	1620.458
Kaleo	young IV	m	CHRAEP	1497.79	1514.642	1522.384	1513.823	1491.74	1474.202	1484.816
Kaleo	young IV	m	SHUTS	1171.597	1162.183	1162.7	1151.376	1114.2	1114.826	1120.042
Kaleo	young IV	m	FUT	1272.348	1258.952	1254.483	1268.809	1283.914	1317.422	1356.666
Kaleo	young IV	m	JOK	1067.055	1047.383	1015.887	1012.118	994.328	984.3964	991.7696
Kaleo	young IV	m	TAWK	990.8608	987.8517	999.3926	972.9696	969.5796	984.5597	1001.868
Kaleo	young IV	m	LAT	1094.888	1080.74	1063.761	1062.451	1056.462	1059.624	1070.064
Kaleo	young IV	m	STAF	1143.357	1127.132	1116.931	1131.193	1142.213	1161.212	1170.846
Kaleo	young IV	m	PRAIS	1212.802	1256.261	1293.725	1352.049	1400.379	1450.588	1485.942
Kaleo	young IV	m	HAUS	1070.867	1054.553	1037.401	1022.187	1016.573	1007.716	1040.758

Kaleo	young IV	m	BOIZ	970.413	1023.863	1129.688	1237.844	1324.04	1351.493	1376.739
Alika	young IV	m	SHCHRIT	1996.084	2038.127	2040.355	2033.342	2012.843	1992.854	1957.358
Alika	young IV	m	STIK	1766.626	1792.804	1826.094	1849.23	1859.471	1872.282	1866.905
Alika	young IV	m	FES	2068.49	2135.501	2126.792	2145.507	2165.728	2176.889	2194.691
Alika	young IV	m	JRES	1879.427	1930.292	1904.143	1883.929	1891.24	1857.033	1842.708
Alika	young IV	m	CHRAEP	1504.359	1480.16	1457.596	1433.919	1415.213	1403.732	1420.25
Alika	young IV	m	SHUTS	1231.969	1210.895	1173.917	1169.768	1153.158	1148.364	1152.977
Alika	young IV	m	FUT	1100.541	1105.363	1064.365	1064.367	1114.577	1079.311	1111.319
Alika	young IV	m	JOK	945.3481	902.8068	871.9668	850.9551	861.8131	889.1017	935.2612
Alika	young IV	m	TAWK	951.6376	944.4883	950.2969	962.4316	982.9293	996.1183	1029.744
Alika	young IV	m	LAT	1044.025	1037.749	1040.896	1051.168	1058.826	1077.246	1114.016
Alika	young IV	m	STAF	1023.531	1030.039	1025.323	1035.134	1056.31	1082.52	1113.853
Alika	young IV	m	PRAIS	1224.787	1275.092	1339.748	1399.74	1480.495	1559.025	1622.601
Alika	young IV	m	HAUS	1052.068	1016.797	992.6628	978.3551	955.6603	959.1846	1009.442
Alika	young IV	m	BOIZ	985.1566	1036.781	1098.11	1207.265	1272.017	1384.732	1480.397
Myko	young IV	m	SHCHRIT	2191.957	2259.032	2292.536	2335.804	2332.131	2289.241	2270.822
Myko	young IV	m	STIK	2014.592	2045.498	2052.954	2058.006	2072.035	2070.694	2048.607
Myko	young IV	m	FES	2042.892	2077.069	2105.092	2128.833	2149.212	2157.325	2149.523
Myko	young IV	m	JRES	1835.04	1847.954	1853.538	1844.871	1846.343	1840.609	1820.924
Myko	young IV	m	CHRAEP	1765.878	1767.224	1754.91	1745.519	1744.439	1734.284	1737.983
Myko	young IV	m	SHUTS	1358.244	1354.12	1318.848	1295.075	1300.828	1291.91	1303.588
Myko	young IV	m	FUT	1098.492	1096.455	1111.168	1138.587	1157.189	1175.123	1199.558
Myko	young IV	m	JOK	1099.095	1068.904	1032.662	1011.138	1014.918	1022.113	1033.769
Myko	young IV	m	TAWK	1094.922	1103.671	1110.455	1134.525	1138.972	1155.295	1159.7
Myko	young IV	m	LAT	1291.972	1304.002	1304.265	1311.925	1321.019	1320.525	1311.872
Myko	young IV	m	STAF	1387.851	1398.251	1384.804	1384.189	1395.632	1333.435	1396.671
Myko	young IV	m	PRAIS	1501.941	1547.314	1618.585	1688.199	1745.287	1834.723	1890.603
Myko	young IV	m	HAUS	1319.116	1324.596	1288.19	1248.359	1240.883	1225.498	1181.11
Myko	young IV	m	BOIZ	1218.96	1320.777	1379.286	1464.271	1574.976	1690.178	1791.06
Lena	young IV	f	SHCHRIT	2775.136	2807.954	2867.353	2869.03	2888.642	2814.616	2806.305
Lena	young IV	f	STIK	2335.958	2389.716	2407.702	2421.45	2433.167	2425.839	2433.941

Lena	young IV	f	FES	2240.278	2306.108	2404.142	2448.827	2495.702	2476.597	2459.054
Lena	young IV	f	JRES	2043.849	2057.933	2078.951	2046.769	2087.054	2081.743	2084.97
Lena	young IV	f	CHRAEP	1818.656	1814.127	1778.287	1767.011	1759.144	1762.393	1771.629
Lena	young IV	f	SHUTS	1484.558	1511.031	1482.277	1448.853	1385.063	1441.786	1461.058
Lena	young IV	f	FUT	1540.394	1589.177	1621.944	1671.613	1720.203	1760.965	1719.365
Lena	young IV	f	JOK	1274.067	1276.458	1255.56	1244.546	1254.071	1280.234	1310.463
Lena	young IV	f	TAWK	1411.76	1397.979	1330.235	1309.714	1323.803	1356.301	1387.724
Lena	young IV	f	LAT	1371.206	1366.934	1366.357	1433.559	1467.456	1498.366	1517.481
Lena	young IV	f	STAF	1518.687	1540.287	1533.435	1582.756	1610.643	1632.178	1675.066
Lena	young IV	f	PRAIS	1694.454	1754.069	1817.879	1900.308	1986.425	2052.238	2139.926
Lena	young IV	f	HAUS	1543.985	1438.314	1422.539	1374.335	1316.677	1301.595	1329.944
Lena	young IV	f	BOIZ	1147.115	1236.176	1260.493	1524.916	1759.344	2089.014	1869.051
Mina	young IV	f	SHCHRIT	2889.268	2933.019	2944.632	2945.016	2935.574	2881.627	2820.915
Mina	young IV	f	STIK	2536.488	2537.975	2577.12	2567.059	2576.601	2571.953	2610.42
Mina	young IV	f	FES	2697.166	2740.212	2778.58	2799.463	2828.285	2820.685	2822.354
Mina	young IV	f	JRES	2076.696	2080.009	2095.96	2137.41	2128.279	2088.075	2153.239
Mina	young IV	f	CHRAEP	1908.008	1843.463	1839.452	1887.471	1844.708	1868.788	1891.929
Mina	young IV	f	SHUTS	1455.079	1424.462	1476.534	1477.155	1382.005	1393.656	1360.554
Mina	young IV	f	FUT	1357.173	1385.827	1406.612	1451.758	1496.015	1543.019	1598.663
Mina	young IV	f	JOK	1398.292	1326.839	1290.735	1290.971	1290.467	1293.389	1322.17
Mina	young IV	f	TAWK	1427.626	1431.053	1448.071	1447.421	1428.602	1437.241	1557.688
Mina	young IV	f	LAT	1535.275	1514.92	1478.873	1466.952	1475.505	1478.119	1484.866
Mina	young IV	f	STAF	1567.374	1560.749	1562.188	1587.245	1623.114	1617.887	1623.949
Mina	young IV	f	PRAIS	1674.728	1773.792	1832.834	1970.935	2054.573	2143.508	2175.465
Mina	young IV	f	HAUS	1313.101	1284.752	1268.567	1249.15	1239.889	1243.902	1224.224
Mina	young IV	f	BOIZ	1331.842	1362.097	1569.38	1583.886	1763.58	1968.422	2046.788
Sarah	young IV	f	SHCHRIT	2796.633	2833.736	2810.982	2837.431	2862.261	2864.916	2877.251
Sarah	young IV	f	STIK	2077.941	2113.655	2133.338	2128.389	2132.737	2115.58	2091.506
Sarah	young IV	f	FES	2567.484	2603	2615.153	2586.125	2625.342	2631.254	2631.173
Sarah	young IV	f	JRES	1852.81	1854.953	1853.146	1856.132	1874.089	1872.069	1875.059
Sarah	young IV	f	CHRAEP	1736.091	1729.438	1708.479	1710.334	1700.987	1692.784	1678.508

Sarah	young IV	f	SHUTS	1355.857	1348.619	1339.803	1342.298	1365.994	1306.983	1304.206
Sarah	young IV	f	FUT	1358.62	1329.76	1319.234	1348.707	1375.151	1401.942	1425.591
Sarah	young IV	f	JOK	1238.397	1185.707	1113.094	1096.372	1096.016	1093.701	1103.606
Sarah	young IV	f	TAWK	1212.747	1203.102	1195.676	1208.133	1214.758	1217.01	1227.927
Sarah	young IV	f	LAT	1404.784	1389.593	1413.429	1421.584	1447.103	1481.077	1508.275
Sarah	young IV	f	STAF	1443.743	1456.038	1479.39	1481.302	1487.164	1490.388	1503.111
Sarah	young IV	f	PRAIS	1593.469	1667.783	1773.065	1897.504	1997.873	2085.832	2094.682
Sarah	young IV	f	HAUS	1415.316	1383.629	1374.068	1327.066	1300.74	1259.869	1227.134
Sarah	young IV	f	BOIZ	1152.102	1330.163	1455.972	1622.688	1774.224	1942.993	2025.516
Starla	young IV	f	SHCHRIT	2358.517	2374.094	2408.465	2419.915	2411.062	2401.37	2344.667
Starla	young IV	f	STIK	2194.539	2229.8	2237.809	2233.272	2217.56	2239.878	2209.089
Starla	young IV	f	FES	1949.613	2018.568	2056.352	2078.949	2100.221	2102.377	2045.056
Starla	young IV	f	JRES	1700.895	1713.621	1711.134	1696.325	1686.215	1666.931	1656.795
Starla	young IV	f	CHRAEP	1615.405	1613.825	1594.195	1585.504	1565.48	1574.159	1567.675
Starla	young IV	f	SHUTS	1142.375	1133.305	1095.533	1098.727	1065.035	1072.034	1069.131
Starla	young IV	f	FUT	985.8406	983.3185	977.2274	985.3447	1035.69	1026.202	1052.085
Starla	young IV	f	JOK	970.4272	957.4831	929.0995	890.9082	954.0175	966.3139	949.2334
Starla	young IV	f	TAWK	1141.58	1144.384	1128.617	1078.189	1080.349	1082.527	1110.264
Starla	young IV	f	LAT	1103.503	1189.34	1201.296	1248.732	1207.153	1206.396	1151.815
Starla	young IV	f	STAF	1252.941	1249.387	1216.028	1230.317	1233.924	1175.218	1202.373
Starla	young IV	f	PRAIS	1420.152	1495.637	1592.566	1670.3	1746.094	1792.014	1797.076
Starla	young IV	f	HAUS	1060	1110.332	974.792	1017.995	1018.875	1012.991	976.4271
Starla	young IV	f	BOIZ	911.7932	884.3781	972.0884	1004.999	1209.102	1303.573	1297.731

APPENDIX G

LOBANOV NORMALIZED FORMANT VALUES FROM 20% TO 80% ACROSS AGE GROUP, VOWEL IDENTITY, AND GENDER

The information in this appendix is the Lobanov normalized F1 (table G.1) and F2 (table G.2) values across corpus, age, vowel identity, and gender used for analysis in this dissertation. Mean formant measurements are listed for each point measured along the vowel (at 20, 30, 40, 50, 60, 70, and 80%). Outliers are not included in these tables.

Table G.1. Lobanov normalized F1 values from the 20% to 80% measurement, split across age group, vowel identity, and gender.

Corpus & Age	Vowel	Gender	F1 (20%) Lobanov	F1 (30%) Lobanov	F1 (40%) Lobanov	F1 (50%) Lobanov	F1 (60%) Lobanov	F1 (70%) Lobanov	F1 (80%) Lobanov
old BC	SHCHRIT	m	-0.98443	-1.11746	-1.13424	-1.15185	-1.09922	-0.98327	-0.81811
old BC	SHCHRIT	f	-0.97581	-1.07318	-1.07071	-1.0621	-1.03623	-0.99521	-0.9297
old BC	STIK	m	-1.03204	-1.11597	-1.08593	-1.12593	-1.05735	-1.02596	-0.92135
old BC	STIK	f	-0.91093	-0.97164	-0.94957	-0.9242	-0.8965	-0.85583	-0.80836
old BC	FES	m	-0.44269	-0.5134	-0.56008	-0.62672	-0.68746	-0.61723	-0.60054
old BC	FES	f	-0.55972	-0.66381	-0.70819	-0.74342	-0.76455	-0.75066	-0.73359
old BC	JRES	m	0.05532	0.149288	0.217512	0.287481	0.36	0.411177	0.398389
old BC	JRES	f	0.009307	0.07371	0.138027	0.203867	0.254773	0.313127	0.366405
old BC	CHRAEP	m	0.544685	0.655837	0.670548	0.732494	0.769508	0.775872	0.713255
old BC	CHRAEP	f	0.514227	0.662259	0.717925	0.752814	0.80747	0.834485	0.832231
old BC	SHUTS	m	-1.03849	-1.15617	-1.16153	-1.16655	-1.16129	-1.12573	-1.02109
old BC	SHUTS	f	-0.89186	-0.98316	-0.98519	-0.97953	-0.95677	-0.94559	-0.85842
old BC	FUT	m	-1.02162	-1.11336	-1.09223	-1.11026	-1.10932	-1.09181	-1.01941
old BC	FUT	f	-0.89892	-0.9861	-0.99041	-0.97963	-0.99983	-1.0097	-1.01963
old BC	JOK	m	-0.18333	-0.25527	-0.28554	-0.32822	-0.31875	-0.29409	-0.26277
old BC	JOK	f	-0.34187	-0.39302	-0.4359	-0.44798	-0.43032	-0.43038	-0.35944
old BC	TAWK	m	0.2385	0.334688	0.380857	0.424629	0.484115	0.509572	0.409672
old BC	TAWK	f	0.465948	0.55849	0.597891	0.65872	0.73272	0.771444	0.701605
old BC	LAT	m	0.662878	0.862429	0.896369	0.949903	0.969278	0.96474	0.93453

old BC	LAT	f	1.000589	1.157421	1.191191	1.238817	1.267483	1.341109	1.351915
old BC	STAF	m	0.757334	0.912152	0.928152	0.940524	0.979949	0.960598	0.894881
old BC	STAF	f	0.908123	1.041044	1.071406	1.112112	1.089293	1.119096	1.062519
old BC	PRAIS	m	0.986471	1.151203	1.067427	1.001303	0.849982	0.614588	0.451381
old BC	PRAIS	f	1.133875	1.283041	1.21757	1.023436	0.817801	0.538971	0.298271
old BC	HAUS	m	1.0109	1.103129	1.04461	0.867803	0.671829	0.498608	0.310383
old BC	HAUS	f	1.171457	1.274002	1.158583	1.068552	0.948536	0.807769	0.623538
old BC	BOIZ	m	-0.10809	-0.12088	-0.11476	-0.13893	-0.14861	-0.13394	-0.14197
old BC	BOIZ	f	-0.12398	-0.1986	-0.23673	-0.18941	-0.0818	-0.0366	0.021345
young BC	SHCHRIT	m	-0.8713	-0.9172	-0.89827	-1.03411	-0.98183	-1.00106	-0.90567
young BC	SHCHRIT	f	-0.98782	-1.0585	-1.12621	-1.15252	-1.14657	-1.12035	-1.09586
young BC	STIK	m	-0.9522	-0.95208	-0.9471	-0.97713	-0.95823	-0.9607	-0.8823
young BC	STIK	f	-0.91429	-0.9435	-0.95417	-0.94343	-0.91879	-0.89054	-0.86279
young BC	FES	m	-0.53145	-0.56565	-0.5952	-0.62835	-0.65507	-0.67844	-0.62113
young BC	FES	f	-0.61447	-0.66921	-0.72362	-0.76847	-0.79779	-0.82114	-0.81119
young BC	JRES	m	0.166613	0.185079	0.196193	0.250567	0.302318	0.380424	0.39191
young BC	JRES	f	0.100476	0.192582	0.286899	0.364963	0.432696	0.492259	0.550705
young BC	CHRAEP	m	0.4049	0.492585	0.498335	0.55814	0.637886	0.734894	0.730552
young BC	CHRAEP	f	0.401512	0.511164	0.61972	0.681081	0.738155	0.790149	0.82037
young BC	SHUTS	m	-0.85275	-0.86696	-0.85904	-0.8538	-0.82498	-0.82329	-0.74639
young BC	SHUTS	f	-1.11601	-1.15804	-1.22394	-1.19371	-1.16672	-1.10402	-1.05139
young BC	FUT	m	-0.91663	-0.95263	-0.88667	-0.86347	-0.84301	-0.85337	-0.80272
young BC	FUT	f	-1.0184	-1.03621	-1.06158	-1.07085	-1.05644	-1.00036	-0.95267
young BC	JOK	m	-0.32438	-0.34714	-0.37127	-0.38823	-0.38176	-0.35435	-0.31726
young BC	JOK	f	-0.36655	-0.47845	-0.5095	-0.56508	-0.61841	-0.60389	-0.59754
young BC	TAWK	m	0.385287	0.385527	0.420761	0.446947	0.473771	0.499546	0.587299
young BC	TAWK	f	0.567257	0.637426	0.687261	0.751387	0.790625	0.867876	0.84305
young BC	LAT	m	0.964886	0.986177	0.996843	1.102497	1.120416	1.182355	1.125952
young BC	LAT	f	1.09274	1.126854	1.1491	1.160669	1.183776	1.157068	1.210506
young BC	STAF	m	0.912895	0.961243	0.977405	1.016314	1.004896	1.002984	0.832559
young BC	STAF	f	0.866772	0.957734	0.970486	1.005767	1.030595	1.017697	0.994279

young BC	PRAIS	m	1.220069	1.1495	0.991038	0.828188	0.64657	0.485372	0.261498
young BC	PRAIS	f	1.165293	1.203451	1.162996	1.0636	0.896586	0.682709	0.431775
young BC	HAUS	m	0.893966	0.949262	0.835144	0.713811	0.567368	0.524943	0.39486
young BC	HAUS	f	1.445138	1.392364	1.254912	1.066294	0.895695	0.683665	0.524889
young BC	BOIZ	m	-0.12839	-0.0435	0.058913	0.085676	0.096427	0.053728	0.017436
young BC	BOIZ	f	-0.14272	-0.06467	0.014945	0.07756	-0.05404	0.014265	-0.06733
old IV	SHCHRIT	m	-0.90898	-1.09035	-1.06785	-1.2391	-1.17525	-0.93676	-0.94029
old IV	SHCHRIT	f	-0.94022	-1.0753	-1.12183	-1.1261	-1.12461	-1.00065	-1.01621
old IV	STIK	m	-0.80935	-0.94591	-0.90283	-0.95551	-0.90349	-0.87795	-0.84966
old IV	STIK	f	-0.92338	-0.88863	-0.94168	-0.94623	-0.91221	-0.86434	-0.82852
old IV	FES	m	-0.47023	-0.63659	-0.68708	-0.81516	-0.81789	-0.82186	-0.84418
old IV	FES	f	-0.58568	-0.67185	-0.71198	-0.7306	-0.76157	-0.74757	-0.73685
old IV	JRES	m	-0.00639	0.053665	0.090348	0.204198	0.24197	0.268661	0.337502
old IV	JRES	f	-0.06109	0.016833	0.100193	0.155443	0.215733	0.257752	0.333611
old IV	CHRAEP	m	0.512676	0.630234	0.712029	0.823756	0.998245	1.028846	1.027425
old IV	CHRAEP	f	0.682634	0.815718	0.950623	1.014095	1.13685	1.211623	1.291954
old IV	SHUTS	m	-0.88757	-0.97383	-0.94098	-1.02225	-0.98881	-0.92864	-0.90145
old IV	SHUTS	f	-0.95093	-1.0669	-1.08545	-1.07782	-1.04917	-1.00454	-0.93258
old IV	FUT	m	-0.71491	-0.81639	-0.7864	-0.85416	-0.81557	-0.75401	-0.63271
old IV	FUT	f	-0.9794	-1.00943	-1.01756	-0.98004	-0.94249	-0.90846	-0.88565
old IV	JOK	m	-0.24815	-0.27684	-0.3083	-0.33437	-0.32552	-0.30929	-0.31162
old IV	JOK	f	-0.33869	-0.44928	-0.47173	-0.48685	-0.48353	-0.46741	-0.4576
old IV	TAWK	m	0.344385	0.505417	0.539548	0.642792	0.655561	0.715172	0.772064
old IV	TAWK	f	0.440879	0.551037	0.611268	0.644258	0.702205	0.672555	0.721536
old IV	LAT	m	0.56368	0.792775	0.819168	0.971634	0.973878	0.98317	1.045376
old IV	LAT	f	0.801699	0.881813	0.96116	1.015721	1.089013	1.111818	1.165463
old IV	STAF	m	0.456921	0.593733	0.600225	0.713145	0.689139	0.615211	0.623932
old IV	STAF	f	0.845084	0.880698	0.909569	0.970172	0.986293	0.939963	0.907101
old IV	PRAIS	m	0.773231	0.88542	0.788531	0.729098	0.488954	0.259082	0.082774
old IV	PRAIS	f	1.20604	1.287727	1.22001	1.039811	0.799621	0.518028	0.244389
old IV	HAUS	m	0.891651	1.058353	0.841628	0.737957	0.600254	0.438227	0.266606

old IV	HAUS	f	1.100951	1.060912	0.910598	0.716273	0.545339	0.345706	0.144819
old IV	BOIZ	m	-0.16269	-0.21423	-0.25068	-0.26841	-0.30852	-0.26549	-0.29814
old IV	BOIZ	f	-0.32458	-0.35982	-0.30517	-0.3193	-0.29192	-0.28111	-0.35652
young IV	SHCHRIT	m	-1.18175	-1.28369	-1.33449	-1.33128	-1.29519	-1.24597	-1.2415
young IV	SHCHRIT	f	-0.84692	-0.95948	-1.04016	-0.98503	-0.87319	-0.83187	-0.59587
young IV	STIK	m	-0.77841	-0.86954	-0.88027	-0.88107	-0.84571	-0.82026	-0.77038
young IV	STIK	f	-0.60415	-0.63205	-0.64308	-0.64204	-0.60128	-0.53478	-0.35435
young IV	FES	m	-0.58847	-0.60515	-0.74395	-0.78183	-0.80578	-0.83523	-0.7049
young IV	FES	f	-0.63463	-0.71733	-0.70713	-0.70329	-0.70758	-0.71494	-0.66869
young IV	JRES	m	0.145425	0.22187	0.29628	0.34999	0.380675	0.454101	0.457184
young IV	JRES	f	0.060116	0.097325	0.147478	0.12873	0.200718	0.240772	0.207744
young IV	CHRAEP	m	0.790823	0.926336	1.011956	1.061344	1.095038	1.130142	1.088662
young IV	CHRAEP	f	0.865492	0.935698	0.987759	0.945062	0.965143	0.982434	0.917871
young IV	SHUTS	m	-1.10455	-1.11035	-1.15416	-1.17342	-1.14977	-1.1461	-1.07334
young IV	SHUTS	f	-1.06454	-1.10326	-1.10301	-1.04103	-1.05275	-1.02617	-0.94239
young IV	FUT	m	-0.82267	-0.8832	-0.89514	-0.89109	-0.85536	-0.83033	-0.80907
young IV	FUT	f	-0.74861	-0.77726	-0.75291	-0.73273	-0.71112	-0.71496	-0.69356
young IV	JOK	m	-0.33071	-0.35831	-0.3499	-0.35428	-0.36101	-0.32947	-0.30063
young IV	JOK	f	-0.34045	-0.37405	-0.37881	-0.39794	-0.3879	-0.38392	-0.3566
young IV	TAWK	m	0.491141	0.555962	0.59549	0.604117	0.591432	0.658204	0.679721
young IV	TAWK	f	0.583664	0.561798	0.587712	0.538181	0.576853	0.612089	0.575575
young IV	LAT	m	0.837721	0.953673	1.021408	1.082206	1.107586	1.139281	1.136415
young IV	LAT	f	0.772885	0.862921	0.817136	0.811001	0.89092	0.922704	0.79335
young IV	STAF	m	0.503524	0.58139	0.616649	0.670773	0.714135	0.73349	0.726902
young IV	STAF	f	0.524631	0.542672	0.548244	0.493184	0.504405	0.458547	0.364699
young IV	PRAIS	m	1.004988	0.966003	0.89126	0.766118	0.650617	0.479766	0.275476
young IV	PRAIS	f	0.73474	0.744849	0.692944	0.52564	0.426069	0.280125	0.0963
young IV	HAUS	m	1.167318	1.10399	0.981767	0.854699	0.615007	0.495086	0.370089
young IV	HAUS	f	0.784715	0.735505	0.472012	0.304739	0.285127	0.232538	0.036595
young IV	BOIZ	m	-0.15311	-0.18608	-0.09844	-0.14753	-0.25201	-0.34394	-0.41742
young IV	BOIZ	f	-0.1611	-0.23583	-0.14608	-0.14907	-0.17272	-0.20672	-0.36625

Table G.2. Lobanov normalized F2 values from the 20% to 80% measurement, split across age group, vowel identity, and gender.

Corpus & Age	Vowel	Gender	F2 (20%) Lobanov	F2 (30%) Lobanov	F2 (40%) Lobanov	F2 (50%) Lobanov	F2 (60%) Lobanov	F2 (70%) Lobanov	F2 (80%) Lobanov
old BC	SHCHRIT	m	1.304996	1.305808	1.308671	1.295087	1.278163	1.252629	1.22685
old BC	SHCHRIT	f	1.19149	1.225481	1.221966	1.194556	1.150729	1.11956	1.084082
old BC	STIK	m	1.102192	1.09937	1.109822	1.111668	1.113412	1.126242	1.112517
old BC	STIK	f	1.093545	1.088711	1.079799	1.064661	1.047841	1.031173	0.990964
old BC	FES	m	0.961489	1.023911	1.060442	1.073922	1.077213	1.081544	1.078294
old BC	FES	f	0.967032	1.052551	1.044348	1.068818	1.058237	1.029239	1.012135
old BC	JRES	m	0.589169	0.590732	0.578132	0.543902	0.531268	0.478319	0.396943
old BC	JRES	f	0.488988	0.466019	0.459768	0.418677	0.39133	0.356765	0.334057
old BC	CHRAEP	m	0.430411	0.470608	0.452958	0.452525	0.414677	0.400816	0.364213
old BC	CHRAEP	f	0.364357	0.394732	0.407447	0.402278	0.399319	0.392688	0.367865
old BC	SHUTS	m	-0.81485	-0.88934	-0.97948	-1.00238	-1.00194	-0.98866	-0.99726
old BC	SHUTS	f	-0.82973	-0.9615	-1.01595	-1.05952	-1.10089	-1.10162	-1.12274
old BC	FUT	m	-1.03593	-1.01601	-1.03316	-1.03705	-1.05072	-1.1012	-1.08827
old BC	FUT	f	-0.85509	-0.95909	-0.98071	-0.99194	-0.99328	-0.95271	-0.89571
old BC	JOK	m	-1.13909	-1.22596	-1.23537	-1.26299	-1.28235	-1.27384	-1.22786
old BC	JOK	f	-1.21265	-1.25645	-1.27056	-1.29147	-1.27641	-1.29861	-1.25898
old BC	TAWK	m	-1.14308	-1.15906	-1.16723	-1.15917	-1.16596	-1.1427	-1.14532
old BC	TAWK	f	-1.16196	-1.16494	-1.17151	-1.18473	-1.18478	-1.17	-1.17913
old BC	LAT	m	-0.70858	-0.73342	-0.75288	-0.76762	-0.76997	-0.7754	-0.78235
old BC	LAT	f	-0.78497	-0.79089	-0.81355	-0.8201	-0.83462	-0.83017	-0.8606
old BC	STAF	m	-0.68101	-0.65537	-0.63819	-0.63854	-0.60919	-0.60598	-0.5952
old BC	STAF	f	-0.66899	-0.65275	-0.64992	-0.65381	-0.66582	-0.66672	-0.68113
old BC	PRAIS	m	-0.25774	-0.20203	-0.10897	-0.01584	0.138536	0.264057	0.404416
old BC	PRAIS	f	-0.35888	-0.27592	-0.15583	0.003561	0.170289	0.302648	0.433894
old BC	HAUS	m	-0.7729	-0.79762	-0.8412	-0.91426	-0.97532	-1.02447	-1.0686
old BC	HAUS	f	-0.68083	-0.78101	-0.88102	-0.95985	-1.02033	-1.08493	-1.13741
old BC	BOIZ	m	-1.26528	-1.04964	-1.08561	-0.86657	-0.77996	-0.51698	-0.29831
old BC	BOIZ	f	-1.10051	-1.02025	-0.89159	-0.68188	-0.4509	-0.13302	0.152521

young BC	SHCHRIT	m	1.221016	1.228668	1.221638	1.198672	1.166471	1.174293	1.161942
young BC	SHCHRIT	f	1.360407	1.382546	1.36984	1.386076	1.346465	1.339154	1.290676
young BC	STIK	m	0.998771	1.026613	1.001422	0.984889	0.973357	0.962847	0.957478
young BC	STIK	f	0.943413	0.960631	0.980349	0.986386	0.979222	0.952478	0.933923
young BC	FES	m	0.937137	0.975741	0.992102	1.007986	1.006903	1.052156	1.045597
young BC	FES	f	1.01474	1.110639	1.134074	1.158331	1.178413	1.171233	1.142659
young BC	JRES	m	0.495002	0.462601	0.423114	0.382696	0.373071	0.33393	0.302027
young BC	JRES	f	0.515771	0.511404	0.495645	0.470831	0.425773	0.371713	0.358268
young BC	CHRAEP	m	0.383877	0.364238	0.362272	0.35369	0.330156	0.316724	0.306901
young BC	CHRAEP	f	0.549825	0.533114	0.500702	0.482697	0.437974	0.402768	0.398585
young BC	SHUTS	m	-1.00905	-1.04665	-1.11204	-1.10243	-1.13111	-1.13204	-1.16022
young BC	SHUTS	f	-0.81229	-0.86945	-0.95122	-1.01332	-0.99895	-1.01856	-1.01219
young BC	FUT	m	-1.07149	-1.13789	-1.10668	-1.06056	-1.02663	-0.97914	-0.94726
young BC	FUT	f	-1.02303	-1.01083	-1.02339	-0.98094	-0.95951	-0.8862	-0.82381
young BC	JOK	m	-1.28502	-1.31716	-1.35486	-1.37447	-1.37246	-1.38937	-1.34618
young BC	JOK	f	-1.20765	-1.28679	-1.29973	-1.33615	-1.36487	-1.32944	-1.26238
young BC	TAWK	m	-1.1166	-1.14637	-1.15115	-1.16116	-1.13934	-1.14528	-1.11379
young BC	TAWK	f	-1.06242	-1.05329	-1.01756	-1.03783	-1.07374	-1.02831	-1.02235
young BC	LAT	m	-0.73817	-0.76171	-0.74117	-0.74251	-0.74311	-0.73163	-0.71359
young BC	LAT	f	-0.72467	-0.73703	-0.71478	-0.70799	-0.70788	-0.7188	-0.73742
young BC	STAF	m	-0.70771	-0.71122	-0.70189	-0.71023	-0.7102	-0.68963	-0.69416
young BC	STAF	f	-0.68696	-0.68702	-0.66432	-0.66012	-0.63358	-0.58783	-0.59445
young BC	PRAIS	m	-0.18896	-0.08369	0.027557	0.123171	0.260212	0.318469	0.315306
young BC	PRAIS	f	-0.30796	-0.23685	-0.11708	-0.03248	0.121647	0.198425	0.289527
young BC	HAUS	m	-0.79535	-0.84686	-0.89892	-0.97624	-1.02808	-1.09485	-1.13231
young BC	HAUS	f	-0.60968	-0.67745	-0.73746	-0.83462	-0.91731	-1.02302	-1.09607
young BC	BOIZ	m	-1.07839	-0.94309	-0.8052	-0.63992	-0.53519	-0.38174	-0.26096
young BC	BOIZ	f	-1.1721	-1.18302	-1.09445	-0.88915	-0.74352	-0.48719	-0.28696
old IV	SHCHRIT	m	1.439027	1.4314	1.401722	1.398657	1.387275	1.368044	1.342706
old IV	SHCHRIT	f	1.459632	1.487666	1.481529	1.454089	1.424387	1.392666	1.365728
old IV	STIK	m	0.898481	0.929271	0.978	1.003326	0.993326	0.949354	0.911571

old IV	STIK	f	1.133121	1.1561	1.117053	1.101758	1.054811	1.035436	1.03719
old IV	FES	m	1.044199	1.117177	1.129968	1.178708	1.164246	1.151472	1.124449
old IV	FES	f	0.94612	1.032432	1.123238	1.174849	1.199546	1.167263	1.078505
old IV	JRES	m	0.549416	0.560783	0.538338	0.487475	0.465929	0.434824	0.398055
old IV	JRES	f	0.463055	0.471285	0.483741	0.451873	0.415069	0.386851	0.381389
old IV	CHRAEP	m	0.36733	0.342095	0.288198	0.260145	0.223474	0.189678	0.164259
old IV	CHRAEP	f	0.372607	0.325579	0.301301	0.224772	0.210232	0.187012	0.146732
old IV	SHUTS	m	-0.72981	-0.76223	-0.78304	-0.85319	-0.88437	-0.85312	-0.91682
old IV	SHUTS	f	-0.94568	-1.04908	-1.08749	-1.12859	-1.12825	-1.14012	-1.09706
old IV	FUT	m	-0.77535	-0.82575	-0.81688	-0.80284	-0.79663	-0.79644	-0.66772
old IV	FUT	f	-1.0399	-1.03854	-1.05867	-1.03422	-0.99157	-0.94593	-0.87408
old IV	JOK	m	-1.15793	-1.23432	-1.26869	-1.26362	-1.29485	-1.29647	-1.27196
old IV	JOK	f	-1.0749	-1.14743	-1.17695	-1.1956	-1.23987	-1.25784	-1.25047
old IV	TAWK	m	-0.97863	-1.02593	-1.04971	-1.06597	-1.05624	-1.05709	-1.05251
old IV	TAWK	f	-0.84636	-0.88778	-0.94253	-0.94733	-0.96342	-0.98823	-0.96532
old IV	LAT	m	-0.8325	-0.84803	-0.83422	-0.83288	-0.82034	-0.80982	-0.81792
old IV	LAT	f	-0.69574	-0.67924	-0.70704	-0.70444	-0.67194	-0.65777	-0.64486
old IV	STAF	m	-0.74657	-0.73494	-0.74361	-0.74158	-0.7389	-0.72946	-0.73077
old IV	STAF	f	-0.59174	-0.60954	-0.61078	-0.58261	-0.57013	-0.53598	-0.52615
old IV	PRAIS	m	-0.35727	-0.28476	-0.17905	-0.04082	0.127495	0.288092	0.412572
old IV	PRAIS	f	-0.24135	-0.16409	-0.01191	0.139602	0.229235	0.371088	0.414516
old IV	HAUS	m	-0.81312	-0.85968	-0.92422	-1.00348	-1.07427	-1.16182	-1.14193
old IV	HAUS	f	-0.74447	-0.75369	-0.84531	-0.89064	-0.91438	-0.96485	-0.99629
old IV	BOIZ	m	-0.42868	-0.46649	-0.32967	-0.50767	-0.39734	-0.30427	-0.26406
old IV	BOIZ	f	-1.11045	-1.03925	-0.91647	-0.79261	-0.62372	-0.38383	-0.35001
young IV	SHCHRIT	m	1.448438	1.474176	1.479895	1.477451	1.435581	1.416836	1.394595
young IV	SHCHRIT	f	1.749733	1.744054	1.71803	1.679056	1.677119	1.631593	1.570413
young IV	STIK	m	1.009735	1.030359	1.03557	1.040636	1.021546	0.998424	0.965647
young IV	STIK	f	0.987047	1.001493	0.992178	0.947529	0.937099	0.939638	0.928136
young IV	FES	m	1.154899	1.198706	1.224648	1.239639	1.272661	1.270697	1.257781
young IV	FES	f	1.143613	1.18443	1.220179	1.193887	1.240954	1.241756	1.203362

young IV	JRES	m	0.611818	0.603876	0.599703	0.56712	0.549124	0.519124	0.479707
young IV	JRES	f	0.288612	0.269321	0.261417	0.220663	0.225116	0.195551	0.206713
young IV	CHRAEP	m	0.241989	0.220262	0.183253	0.138317	0.092116	0.053714	0.055073
young IV	CHRAEP	f	0.013081	-0.0458	-0.09295	-0.11033	-0.15781	-0.15905	-0.16431
young IV	SHUTS	m	-0.50355	-0.54028	-0.57673	-0.61194	-0.66259	-0.68964	-0.7138
young IV	SHUTS	f	-0.74671	-0.76436	-0.76992	-0.804	-0.89381	-0.90312	-0.9199
young IV	FUT	m	-0.76601	-0.79439	-0.81696	-0.77989	-0.71293	-0.70393	-0.6802
young IV	FUT	f	-0.84446	-0.83062	-0.80225	-0.76624	-0.70606	-0.67191	-0.65586
young IV	JOK	m	-0.9709	-1.04406	-1.13526	-1.19091	-1.20129	-1.20807	-1.2133
young IV	JOK	f	-0.98907	-1.05817	-1.11968	-1.16026	-1.15436	-1.16464	-1.15072
young IV	TAWK	m	-1.04522	-1.07382	-1.05426	-1.05854	-1.06394	-1.04522	-1.04622
young IV	TAWK	f	-0.84268	-0.86025	-0.88573	-0.93374	-0.94867	-0.95065	-0.88578
young IV	LAT	m	-0.80719	-0.82628	-0.82003	-0.8136	-0.81466	-0.80628	-0.80427
young IV	LAT	f	-0.76589	-0.75351	-0.75036	-0.72999	-0.73187	-0.72726	-0.73175
young IV	STAF	m	-0.75265	-0.75877	-0.77312	-0.76682	-0.73356	-0.74664	-0.70075
young IV	STAF	f	-0.58994	-0.59231	-0.59229	-0.5775	-0.56181	-0.59371	-0.56568
young IV	PRAIS	m	-0.39589	-0.28949	-0.15734	-0.0234	0.115038	0.269536	0.36642
young IV	PRAIS	f	-0.30901	-0.18928	-0.05049	0.104938	0.243635	0.365872	0.414925
young IV	HAUS	m	-0.82153	-0.8572	-0.89324	-0.94458	-0.98206	-1.01058	-1.00803
young IV	HAUS	f	-0.82314	-0.8818	-0.9535	-0.99571	-1.04622	-1.09193	-1.13157
young IV	BOIZ	m	-0.95502	-0.83387	-0.68637	-0.45343	-0.26683	-0.10323	0.15228
young IV	BOIZ	f	-1.12786	-0.98498	-0.75517	-0.57024	-0.26206	0.105132	0.066818

APPENDIX H

MORPHO-SYNTACTIC EXAMPLES USED TO CALCULATE PDM SCORE WITH EXAMPLES

This appendix provides a list of the morpho-syntactic items that were used to calculate the Pidgin Density Measure score. For each feature, a description of the morpho-syntactic item precedes the examples. Each example is written in Odo orthography (see Appendix A). Each feature is attested in the literature describing Pidgin, and the original source of the example is cited.

C.1. Zero copula

Pidgin does not always explicitly express a copula in present tense constructions involving noun phrases, predicate adjectives, locatives or progressives (compare (1) with past tense *wen mai faDa waz smal* ‘when my father was small’) (Day 1972: 32). There is also evidence that null-copula constructions imply that the event in question is unsurprising, but that surprise is conveyed when *ste* (see §B.2) is used (Drager 2012: 69).

(1) mai bed **Ø** bai da doa (Day 1972: 31)
My bed is by the door.
(2) de **Ø** faking drti (Day 1972: 23)
They are fucking dirty.
(3) dei **Ø** hanting pig (Odo 1970: 234)
They are hunting pig.

C.2 Copula/progressive/auxiliary *ste*

Generally, *ste* acts as a copula when it occurs with adjectives, and it marks nonpunctual aspect when it is used with non-stative verbs (Siegel 2000). Though Bickerton (1981: 27-28) claims that Pidgin uses *ste* to mark habitual aspect as well, it is mostly used to describe continuous or progressive aspect (Siegel 2000: 228). The functions associated with *ste* have also been shown to parallel the functions of Portuguese *estar* (the verb from which *ste* is also purportedly derived), which is cited as a source of substrate influence in Pidgin (Sakoda & Siegel 2008: 214-215; Siegel 2000: 225).

(4) da buk **ste** awn tap da tebo (Sakoda & Siegel 2008: 215)
The book is on the table.
(5) da waDa **ste** kol (Sakoda & Siegel 2008: 215)
The water is cold.
(6) Jan **ste** raiDing wan leDa (Sakoda & Siegel 2008: 215)
John is writing a letter.
(7) da haus **ste** pau awreDi (Sakoda & Siegel 2008: 215)
The house is already finished.

C.3. Past tense/deliberative *wen, bin, haed*

These forms mark anterior aspect; *bin* (derived from English 'been') is the older form, more common on Kauaʻi (Drager 2012: 69), which is now being replaced by more recent *wen* (derived from English 'went') as a result of decreolization (Bickerton 1981: 58; Siegel 2000: 216). *Haed* (derived from English 'had') is much less frequent and is associated with Kauaʻi speakers, though it was once much more widely distributed across the islands (Siegel 2000: 222). As a general rule, *wen* cannot co-occur with adjectives (e.g., **hi wen sik* 'he was sick') without an accompanying verb (Siegel 2000: 227); *wen* may also have a deliberative meaning when it co-occurs with *go*, as long as *go* is not the main verb, as in *de wen go chap daun wan mango chri* ('they went to chop down a mango tree') (Drager 2012: 69).

(8) aen hi **bin** bulshit me (Sato 1993: 128)
And he bullshitted me.
(9) so wen da wahinez **wen** kam intavyu mi (Sato 1993: 128)
So when the women came to interview me.
(10) e mai sista **haed** krai yu no (Sato 1993: 128)
Hey, my sister cried, you know.

C.4. Future/irrealis *go, gon, goin*

The forms *go*, *gon*, and *goin* (pronounced without a velar nasal) are used to mark non-past, and irrealis events (that is, events that have not occurred).

(11) bat nobadi **gon** get jab (Bickerton 1981: 24)
But nobody will get a job.
(12) ai no **go** maeri yu den (Reinecke 1969: 214)
I won't marry you then.
(13) wi **goin** ste agyu antiw da rod gud fo nating (Roberts 1998: 24)
We'll be arguing until the road's good for nothing (translation from Siegel 2000: 218)

C.5. Existential *get, haed, nomo*

Existential and possessive constructions like those below are expressed with a single word, *get*, similar to what is found in Cantonese (Sakoda & Siegel 2008: 213-214). *Haed* functions as the past tense of this existential verb, and *nomo* functions as the negative present tense existential.

(14) **get** wan student hi very brait (Sakoda & Siegel 2008: 214)
There's a student who's very bright.
(15) **get** wan wahine shi **get** wan data (Siegel 2000: 212)
There's a woman who has a daughter.
(16) **haed** dis ol grin haus (Siegel 2000: 215)
There was this old green house.
(17) wi **nomo** mane fo bai wan TV (Sakoda & Siegel 2008: 232)
We don't have any money to buy a TV.

C.6. Negative *no, nat, neva*

Negation is marked by *no* in the present tense in null-copula constructions, as well as with *ste*. *Nat* occurs in equative, attributive, and locative sentences (Roberts 2011: 562). Negation of verbs in the past tense is marked by obligatory *neva* (Drager 2012: 69).

(18) pepa **no** ste autsaid (Siegel 2000: 212)
The paper isn't outside.
(19) mai sista **nat** skini (Sakoda & Siegel 2003: 84)
My sister isn't skinny.
(20) hi **neva** go (Odo 1970: 234)
He didn't go.

C.7. Clause final forms and general extenders

Discourse markers (e.g., *ae*, *bambai*, *no*, clause-final *bat*) and general extenders (*laiDat*, *aeswai*) are common in Pidgin, and serve a variety of purposes. General extenders is a class of pragmatic words which generally complete (or extend) otherwise complete utterances (compare *and stuff* and *or whatever* in English) (Overstreet 2005). Clause-final *ae*, for example, is often used as a confirmation check in Pidgin (compare English 'right/you know?'). *Yae* is also a confirmation check in Pidgin, though anecdotally, *yae* is also a part of Hawai'i English, and so is not included in the calculation of the PDM. Much more research is necessary to analyze how these markers are employed by speakers (Da Pidgin Coup 1999).

(21) yae bikawz ai chro frt **aeh**? (Sato 1993: 130)
Yeah, because I throw fertilizer [i.e., fertilize sugar cane], you know?
(22) so shi wen go hag him **laiDat** (Labov 1971[1990]: 68)
So she went and hugged him that/in that manner.
(23) ai no laik yu braDa. ai no kaen tel yu hau kam **bat**. (Sakoda & Siegel 2003: 98)
I don't like you, brother, but I can't tell you why.
(24) shi no laik kam klos. shi ste wail **aeswai.** (Sakoda & Siegel 2003: 107)
She doesn't like to come close because she's wild.
(25) ai ges naudez kaenat tael fram laes nem **no**? (Tonouchi 1998: 252)
I guess nowadays you can't tell from the last names, can you?
(26) da haus ste pau **awredi** (Sakoda & Siegel 2008: 215)
The house is finished.

C.8. Quantifiers *dakain* and *kain*

The quantifier *dakain* may be used as a referent to a previously established or contextually known lexeme or topic. Wong (1999) also suggests that *dakain* can be used to add vagueness to an interaction and force interlocutors to rely on shared knowledge to interpret intended meaning. The quantifier *kain* may be used as a postmodifier to mean "kind of" or "other examples of"; it may also be used alongside adjectives or other quantifiers.

(27) ai gon **dakain** em (Sakoda & Siegel 2008: 50)
I'm gonna do something to him [you know what I mean].
(28) wat **kain** glav dis? (Chock 1998: 28)
What kind of glove is this?
(29) ai no yu awredi dan pleni **kain** fo haewp mi aut leitlii. (Kearns 2000: 34)
I know you've already done plenty to help me out lately.

C.9. Possessive *get*

In addition to having an existential meaning, *get* in Pidgin may be used to indicate possession (Sakoda & Siegel 2003).

(30) mai boifren **get** mumps (Odo 1970: 234)
My boyfriend has the mumps.

C.10. Complement *fo*

The introduction of infinitival clauses is marked by *fo* (derived from English 'for') in Pidgin, in contrast with English 'to'. This use of *fo* parallels the use of *para* in Portuguese (Sakoda & Siegel 2008: 214).

(31) aesk him **fo** aian mai shrt (Odo 1970: 234)
Ask him to iron my shirt.

C.11. Indefinite *wan*

Pidgin uses *wan* to mark non-specific (indefinite) NPs (Siegel 2000: 215).

(32) ai get **wan** dog (Odo 1970: 234)
I have a dog.

C.12. Desiderative *laik*

Desire expressed in English as 'want (to)' is takes the form of *laik* in Pidgin.

(33) yu **laik** go Maui o wat? (Sakoda & Siegel 2008: 232)
Do you want to go to Maui, or what?

C.13. Zero-preposition in *kam/go* constructions

When using directional verbs *kam* or *go*, Pidgin may not exhibit a preposition following the verb.

(34) gaDa go **Ø** bich. gaDa go get taero (Day 1972: 63)
Gotta go to the beach. Gotta go get taro.
(35) wi kam **Ø** Hilo (Sakoda & Siegel 2003: 44)
We come to Hilo.

C.14. Stative *kam*

The stative verb *kam* is used in Pidgin instead of the English ‘become’.

(36) aen den evri ting **kam** qwaiyit (Lum 1999: 19)
And then everything became quiet.

C.15. Hortative *chrai*

In Pidgin, *chrai* may be used to soften commands as a sort of politeness marker (Sakoda & Siegel 2003: 86).

(37) Faye, **chrai** weit!
Faye, wait a minute!

C.16. Object *em*

In object position, any third person referent may be referred to as *em* (Sakoda & Siegel 2003).

(38) Chalz iz da maen fo du **em** (Sakoda & Siegel 2008: 214)
Charles is the man to do it.

C.17. Modal *pau*

The word *pau* in Pidgin indicates completion either as an adjective or a verb (Sakoda & Siegel 2003).

(39) bring em baek wen yu **pau** ae? (Sakoda & Siegel 2003: 86)
Bring it back when you(’re) finish(ed), OK?

C.18. Adverbial *bambai*

Pidgin sometimes uses *bambai* (‘by and by’) to mean ‘later/eventually’ (Bickerton & Odo 1976).

(40) **bambai** wen de go menlaen nobaDi goin andastaen dem wen dey tawk (Romaine 1999: 291)
Later, when they go to the mainland, nobody will understand them when they talk.

C.19. Inclusive *dem/gaiz/foks*

In Pidgin, using *dem*, *gaiz*, or *foks* after a noun phrase can mark the plural or be used as inclusive plural markers.

(41) Leinani **dem** waz plaening wan chrip to da zu aeh? (Wong 1999: 210)
Leinani and some of the other teachers that Leinani tends to associate with were planning a trip to the zoo.

(42) as **gaiz** bifo, ae, wi no it California rais (Sakoda & Siegel 2003: 93)
Previously, we didn't eat California rice.

(43) laes wiken ai waz supos to go wit Vernalani **foks** to da Pure Heart kansrt (Sakoda & Siegel 2003: 46)
Last weekend, I was supposed to go with Vernalani and the people associated with Vernalani to the Pure Heart concert.