Department of Linguistics
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Presentation Date: 1/16/2015

Submission date: 3/15/2015

Final Word Count in main body (excluding foot notes, acknowledgements, and reference list): 9524

1st 2nd Comprehensive Paper

Committee Chair: Scott Kiesling Approved: ___________________________

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UNIVERSITY OF PITTSBURGH
DEPARTMENT OF LINGUISTICS

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Variation and Change in Four Contrastive Vowels in Toronto Heritage Cantonese[1]

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Abstract
This paper addresses variation and change in four contrastive vowels (/iː/, /uː/, /ɛː/, and /ɔː/) in Heritage Cantonese among both male and female speakers across two generations. The data comes from the HerLD (Heritage Language Documentation) Corpus, a product of the Heritage Language Variation and Change (HLVC) in Toronto Project (Nagy et al 2009). The mean F1 and F2 of 75 vowel tokens were measured across two phonetic contexts (pre-velar and open-syllable) from each of 17 speakers for a grand total of 1275 vowel tokens. Specific research questions include: 1) Is variation in these four vowel categories conditioned by linguistic factors (preceding consonant and velar coda)? 2) Is variation in these four vowel categories conditioned by external factors (generational background, sex, and age)? 3) Is there change influenced by the vowel system of Toronto English? Results show a consistent lowering effect of the high vowels /iː/ and /uː/ in pre-velar context across the speech community. This is consistent with observed allophonic variation in Hong Kong Cantonese. The results also show a notable sex-based split among second generation (GEN 2) speakers that is absent among first generation (GEN 1) speakers. While GEN 2 male speakers pattern one way (ex: increasing acoustic differentiation based on phonetic context), GEN 2 female speakers pattern another way (ex: following the Canadian Vowel Shift). Yet, while the specific patterns differ, both male and female GEN 2 speakers show patterns that could be attributed to influence from Toronto English. Overall, the results show that both phonological categorization and low-level phonetic differences in a dominant language can influence low-level phonetic change in a heritage language. Social factors also need to be taken into consideration

1. Introduction

As Di Paolo et al have said, "variation and change in vowel systems is considered critical in sociolinguistics because research has shown that vowel variation generally occurs below the level of conscious awareness, and it provides evidence of both linguistic and socio-psychological influences on sound change" (2011:87). The fact that vowels are a continuous phonetic feature and the fact that variation in production is often below the level of conscious awareness has

[1] **Acknowledgements:** In addition to my committee members (Scott Kiesling, Shelome Gooden, and Naomi Magy), I would also like to thank Naomi Cui, Vina Law, Minyi Zhu, Radu Craioveanu, Andrew Peters, and audiences at Canada Variation and Change 8, the CRC Workshop in Phonetics and Phonology at the University of Toronto, and the University of Pittsburgh for their contributions and ideas to earlier versions of this project.

made them an intriguing variable to investigate in terms of social conditioning. Yet, an overwhelming majority of research in variationist sociolinguistics has focused on English and on monolingual speech communities (cf. Stanford and Preston 2009; Meyerhoff and Nagy 2008). This is especially true for the study of vowel variation. Without more research on a greater variety of languages spoken in a greater variety of communities, the importance of vowels as features that provide evidence for both linguistic and socio-psychological factors in driving sound change appears to be limited to the few languages that have been researched within this framework.

This paper makes two contributions to the variationist literature on vowel systems. The first is descriptive in its investigation of the vowel system of Toronto Heritage Cantonese (HCAN), a non-Indo-European language traditionally spoken as a lingua franca in Guangdong (Canton) Province, China and the surrounding region (including Hong Kong and Macao). Although sociolinguistic variation in Cantonese consonants and tone has been described (see Matthews and Yip 2011 for a summary of research), variation in vowel production has largely been ignored. The second major contribution is in examining a heritage language (henceforth abbreviated as HL) within a variationist framework. For the purpose of this paper, HLs are broadly defined as minority languages spoken in a society in which another language is the dominant and official language. In this case, the dominant language is Toronto English (TOENG). Only a few studies have examined vowel production in HLs and among these few studies (cf. Godson 2003; Chang et al. 2011; Ronquest 2013), none have used sociolinguistic interview data leaving open a huge research gap. The study of vowel production among heritage speakers has much to contribute to scholarship on the interface between structural and social factors in language change since HL speech involves both issues of identity and contact.

Using data from the HerLD (Heritage Language Documentation) Corpus, a product of the Heritage Language Variation and Change (HLVC) in Toronto Project (Nagy et al. 2009), this paper examines variation in four contrastive vowels in Cantonese: /iː/, /uː/, /ɔː/, and /ɛː/. This is a part of the vowel inventory that shares acoustic similarities with six contrastive vowels in TOENG and that has also been subject to sound change in the history of Cantonese. The analysis considers two linguistic variables known to condition allophonic variation (preceding consonant and velar coda) and three external factors (generational group, sex, and age). By addressing potential transfer effects on allophonic variants, this paper also investigates the question of phonetic vs. phonological considerations in contact. The specific research questions addressed are as follows:

1) Is variation in these four vowel categories conditioned by linguistic factors (preceding consonant and velar coda)?

2) Is variation in these four vowel categories conditioned by external factors (generational background, sex, and age)?

3) Is there change influenced by the vowel system of TOENG?

In the next section I provide relevant background on the sociolinguistic context of HCAN and on Cantonese vowels. I then present two sets of predictions about how the vowel system of HCAN speakers may be changing based on the historical development of Cantonese vowels and on points of similarity with the vowel system of TOENG (Section 3). Since heritage speakers have knowledge of more than one phonological system, change could potentially be motivated by multiple factors. After describing the data (Section 4) and explaining the methodology (Section 5), I present results addressing the three research questions (Section 6) and discuss the broader implications of this study (Section 7). The overall results show pre-velar context to have a lowering effect on /iː/ and /uː/ across the speech community. Generational background and sex also condition variation, but these factors have a more notable effect when considered together with pre-velar context as a factor group. While all GEN 2 speakers show evidence of interference from Canadian English, the effect of interference is different for male and female speakers. I will argue that these findings present evidence showing that both phonological categorization and low-level phonetic differences in a dominant language can influence low-level phonetic change in a HL. The fact that both phonological categories and phonetic features of the dominant language can influence change in a HL makes it possible for quite different patterns to emerge within a community of HL speakers.

2. Background on Heritage Cantonese and Cantonese Vowels

2.1. Socio-Historical Background and Context of Heritage Cantonese

The perspective of HCAN taken in this paper is a variationist one and one that contrasts with the approach taken in much of the literature on HLs. Illustrating a widely-held view is Polinsky (2011), which defines HLs as languages "spoken by early bilinguals, simultaneous or sequential, whose home language (L1) is severely restricted because of insufficient input." Much of the literature assumes attrition as a key characteristic. Some have even used the term "incomplete acquisition" to describe the linguistic competence of HL speakers (cf. Montrul 2008). On the other hand, researchers have also described HL speech as quite variable and as falling along a continuum in terms of proficiency levels with some closer to the "native speaker baseline" defined by their immigrant parents than others (Polinsky and Kagan 2007).

In contrast to the focus on low proficiency speakers found in much of the literature of this emerging field, this paper examines only the speech of those fluent enough to carry on a one-hour long conversation in Cantonese. This was the level of fluency required for participation in the HLVC Project (Nagy et al. 2009). This paper also focuses on HL phonology, which has not been as well researched as HL morphosyntax but has been impressionistically described as “native-like” (Polinsky and Kagan 2007). Thus, in focusing on HL phonology and on speakers on the higher end of the proficiency continuum, this study does not assume “incomplete acquisition” to be a characteristic of the speech examined.

Also in contrast to much of the literature is the social and ecological context in which Toronto HCAN is spoken. Polinsky’s (2010) definition suggests that HL speakers have few opportunities outside of home to receive sufficient “input”. Although the social pressure to shift to dominant languages in the US and in many places around the world is a reality, it is not universal. Toronto, Canada, for example, has widely been described as a city with a social environment that supports sustained multilingualism. Part of this can be attributed to the Canadian government’s adoption of a multiculturalism policy in 1971 (Siemiatycki et al. 2003). In the past few decades, this policy has had an especially profound impact on life in Toronto and on how residents perceive the city. A *Toronto Star* article, for example, describes the GTA (Greater Toronto Area) as “unofficially but inexorably … approaching omni-lingualism” even though Canada is officially bilingual in English and French (Taylor 2007). This article highlighted how one can hear residents speaking many different languages “by choice” suggesting that societal pressures to shift to exclusive use of English, the lingua franca, are minimal. Furthermore, this article also describes how different parts of the GTA are “a conurbation of neighbourhoods [sic], rather than ghettos” suggesting the lack of social stigma attached to ethnic minority identity. Toronto is both a city with a large concentration of speakers of non-official languages and a city with social conditions supportive of HL maintenance. Even politicians and city planners have boasted about how Toronto has one of the highest percentages of foreign born and multilingual residents in North America (cf. Berridge 1995).

Yet, Toronto is not only “the most multilingual city in the world.”[2] It is also one in which Cantonese is one of the top three most widely spoken languages. With over 177,000 speakers, Cantonese is almost tied with Italian (178,000 speakers) for second place in the GTA trailing behind only English (Statistics Canada 2012). Siemiatycki et al. have also noted that “Toronto’s Chinese community is sufficiently large and affluent, in sections, to promote an impressive commercial, media, and marketing presence” (2003:408). This includes having five “Chinatowns”, three Chinese language daily newspapers, two Chinese-language television stations, Chinese editions of several English-language magazines, and a large number of businesses that advertise in Cantonese. In short, the opportunities for use and exposure to Cantonese outside of home are quite the opposite of “severely restricted” as suggested by Polinsky (2010). Sociolinguistic research in the Toronto Chinese community has also observed that many second generation Chinese-Canadians are bilingual in both English and Cantonese (Hoffman and Walker 2010). Although cases of attrition exist, they appear to be less common than observed in other HL research contexts especially in the US.

Varieties of Cantonese have also had a long history of presence in Canada. While Chinese immigration to Canada as well as to the rest of North America dates back to the 19th Century, most of the early immigrants came from the “Four Counties” (Taishan, Kaiping, Enping, Xinhui) area of Guangdong Province (Hsu 2000; Thompson 1989). This is a region in which a continuum of dialects are spoken, all of which belong to what Yue-Hashimoto (1991)

[2] I’ve been unable to identify the original source of this claim. Taylor (2007) mentions that the UN has called Toronto “the most multicultural city in the world”, but this is about multiculturalism rather than about multilingualism. Yet, the fact that this quote has floated around without an attribution to its original source reflects the widely-held view among Torontonians that multilingualism is linked to multiculturalism and both multilingualism and multiculturalism have become defining characteristics of the city.

has classified as the Siyi-Liangnang sub-group of the Yue[3] Family, a larger sub-group of Chinese. Those from Hong Kong, who were speakers of another Yue dialect, began arriving in large numbers after the easing of immigration laws in the 1960's (Thompson 1989). Subsequent waves of immigration came in the 1980's and 1990's and were largely motivated by the political uncertainty of Hong Kong's future (Li 2005). For instance, there was the 1989 Tiananmen Square massacre, which created fear among many Hong Kongers and the 1997 handover of Hong Kong from a British colony to the government of the People's Republic of China.

The result of the most recent waves of immigration is that Canada is now home to one of the largest communities of Hong Kong Cantonese speakers outside of Asia. The most recent census (Statistics Canada 2012) also shows Cantonese (388,930) as the most widely reported Chinese mother tongue followed by Mandarin[4] (255,160), which was also ranked second in the GTA[5]. What is clear from these statistics is that Cantonese is a strong and vibrant language in Canada and especially in the GTA. The time of presence in Canada is also sufficiently long enough for the presence of three generations of speakers for the Hong Kong variety and more for other varieties of Cantonese. The shift in immigration patterns after the 1960's also led to increasing class-based stratification within the Chinese community in Toronto (Thompson 1989). This raises the possibility of sociolinguistic differentiation based on class much as such stratification has been observed in many monolingual English speaking communities.

While it should be clear that the social and ecological conditions supportive of maintenance of Cantonese are more strongly present in Toronto than in many other places in

[3] Much of the literature treats "Yue" and "Cantonese" as synonymous. Some, such as (Yue-Hashimoto 1972), however, prefer to use "Cantonese" to refer exclusivey to the lingua franca variety associated with the commercial centers of the region (Guangzhou, Macao, and Hong Kong) and "Yue" to refer a larger grouping of dialects.

[4] Although some HCAN speakers also speak Mandarin, knowledge of Mandarin is far from universal. Thus, it seems much more likely for there to be influence from English than from Mandarin.

[5] The actual number of speakers of both Cantonese and Mandarin may actually be higher due to the ambiguous definition of "Chinese", which was also included as a census choice. Nevertheless, Cantonese is clearly one of the most widely spoken languages in the GTA.

North America, the extent to which such conditions could have an effect on the vowel system of a HL on a community-level, especially one in which the HL is far from stigmatized, is uncharted territory. Research on HL phonology is also very poorly studied. Polinsky and Kagan (2007) suggest that this could be due to the impression that heritage speakers sound so "native-like" in their pronunciation that few researchers have thought to investigate differences. Yet, as is well known, acoustic observations do not always match impressionistic observations. The one and only study on vowels that Polinsky and Kagan (2007) cite is one that shows heritage Western Armenian speakers in Southern California differing from both monolingual Western Armenian and Armenian-dominant bilingual speakers (Godson 2003).

Since Polinsky and Kagan (2007), only two other known studies of HL vowel production have been published. Both of these studies show HL vowel space to be distinct as is the case for heritage Western Armenian. Ronquest (2013), for example, shows a centralization effect for vowels in unstressed syllables among heritage Spanish speakers in Chicago. The direction of centralization, however, does not match the production of unstressed schwa found in English nor is it a phenomenon observed in standard varieties of Spanish. Chang et al. (2011) shows that one difference between heritage speakers of Mandarin and other bilingual speakers of Mandarin and English is in their ability to produce phonological distinctions within each language and between both languages. For example, while all groups of speakers examined produced an F2 distinction for back vowels in both Mandarin and English, heritage speakers produced the greatest acoustic difference between these similar vowel categories. Native Mandarin speakers produced vowels like /u/ in both English and Mandarin further back than the other speakers reflecting the relatively low F2 of Mandarin /u/ while late learners of Mandarin produced /u/ with higher F2 in both languages reflecting the higher F2 of English /u/. At the same time, none of the groups failed to distinguish vowel categories within each language such as the /y/ vs. /u/ contrast in Mandarin even though English /u/ is acoustically more similar to Mandarin /y/.

Put together, all of these previous studies show that heritage speaker vowels may be influenced by multiple factors resulting in vowel spaces that are different from that of other bilingual speakers of the same languages as well as that of monolingual speakers of the baseline language. With early exposure to two languages, HL speakers also have a better ability of producing cross-linguistic distinctions than other bilinguals. While Chang et al. (2011) show that this means phonological considerations can override low-level phonetic considerations in transfer from the dominant language to the HL, this paper addresses whether this knowledge of the phonological contrasts in two languages can lead to low-level allophonic changes in a HL. If this is possible, can we see social differentiation in how change occurs across a HL speech community?

2.2 Overview of Cantonese Vowels

The typologically large vowel inventory of Cantonese and the social importance of the language in Toronto makes HCAN especially well-suited to address broader questions about the role of phonetics vs. phonology in language contact and more generally about the interface between structure and social factors in language change. While the vowel inventory of Cantonese is large, it is also different from TOENG especially in its phonetic conditioning of allophonic variants.

The inherent ambiguity in the set of contrasts found in Cantonese makes several different possible groupings of phones to phoneme categories (see Bauer and Benedict 1997 for a summary). Some descriptions present as few as seven contrastive vowels while others argue for eight. The Jyutping Romanization system, which has become the most widely used transcription system in the past decade, distinguishes between nine monophthongs. Others such as Zee (1999) avoid the question of phonological categorization by simply listing all non-contrastive vowels. Zee's (1999) description is shown in Figures 1 (monophthongs) and 2 (diphthongs) below. It includes 11 monophthongs and 11 diphthongs.

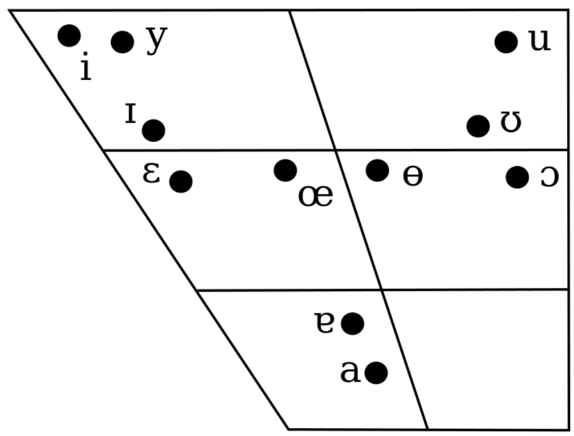
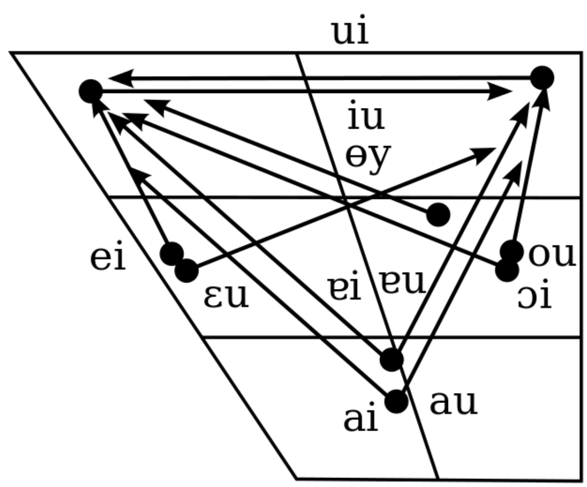


Figure 1 (above): Cantonese Monophthongs (based on the vowel chart from Zee 1999: 59)
Figure 2 (below): Cantonese Diphthongs (based on the vowel chart from Zee 1999: 59)



One of the most controversial issues in the description of Cantonese vowels involves the high vowels [ɪ] and [ʊ]. Although, Cantonese linguists are in universal agreement that these vowels are allophonic variants that occur only preceding velar consonants, there is disagreement about both their phonetic description and phonological categorization. Some sources, for example, describe these vowels as [e] and [o] respectively and as hence lower vowels. Bauer & Benedict (1997) have described these vowels as short diphthongs, [e^{j}] and [o^{w}]. Cantonese linguists have also debated about whether these two vowels are allophones of /iː/ and /uː/ or allophones of lower vowels like /ɛː/ and /ɔː/ or /e/ and /o/, the last of which otherwise occur only as part of diphthongs). One reason for these disagreements could be due to the fact that there is variation in the production of these vowels. The assumption of variation will motivate the first set of hypotheses presented in the next section.

3. Hypotheses

3.1 Internally-Motivated Change

The discrepancies in description of [ɪ] and [ʊ] could simply be due to the fact that different Cantonese speakers really do pronounce these two vowels at different points along the vowel continuum. Longer term historical changes in the language support this claim. Lau (2003), for example, describes the Cantonese Vowel Shift as shown in Figure 3 below. This vowel chart shows [e] and [o] as the vowels corresponding to [ɪ] and [ʊ] in Zee's (1999) description. These two vowels are also reflexes of Middle Chinese (ca. 600-1200 AD) *i and *u. If [ɪ] and [ʊ] are phonetically somewhere between [i] and [u] and [e] and [o], then it should be no surprise to find some speakers pronouncing them as [ɪ] and [ʊ] while others pronounce them as [e] and [o].

The empirical question for this paper is whether or not there is acoustic evidence showing variation in the production of these two vowels among two generations of Toronto HCAN speakers. If there is, the next question would be the extent to which this variation is socially conditioned. With [ɪ] and [ʊ] clearly as the more conservative variants, we would expect GEN 2 speakers to be closer to [e] and [o] than older speakers. If this turns out to be the case, there could be other consequences such as the lowering of [ɛː] and [ɔː] in the same context.

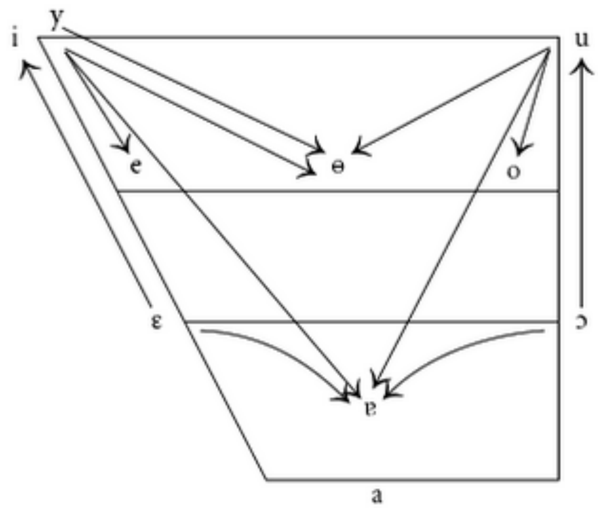


Figure 3: Vowel Shift from Middle Chinese to 21st Century Cantonese (from Lau 2003)

The hypotheses based on internal-motivation would, hence, be as follows and are stated in terms of rime groups[6]:

(1) GEN 2 speakers have lower [ɪk/ɪŋ] (higher F1) than GEN 1 speakers.

(2) GEN 2 speakers have lower [ʊk/ʊŋ] (higher F1) than GEN 1 speakers.

(3) GEN 2 speakers have lower [ɛːk/ɛːŋ] and [ɔːk/ɛːŋ] than GEN 1 speakers.

3.2 Toronto English Influenced Changes

The second set of hypotheses is motivated by similarities between Cantonese and TOENG. While previous research on bilingual Torontonians from different ethnic groups, including ethnic Chinese fluent in Cantonese, show no significant differences in vowel production in English based on ethnicity (Hoffman and Walker 2010; Hoffman 2010), it may still be possible to find transfer effects going in the other direction. In other words, if English is

[6] Rime groups are a unit of phonological description consisting of vowel plus coda sequences. They are traditionally used in Chinese linguistics in lieu of descriptions of vowels as phonemes independent of phonetic context. From this point on in the paper, I will use rime groups interchangeably with vowel allophones.

the dominant language of all HCAN speakers in this community, it may be more likely for phonological features of TOENG to transfer to HCAN than it is for features of HCAN to transfer to the TOENG spoken within this community.

The four Cantonese vowel categories under examination either overlap with or show similarity to six different vowel phonemes in TOENG. The similar TOENG vowels include /i/, /ɪ/, /ɛ/, /u/, /ʊ/, and /ɔ/. Like in many varieties of English, /u/ and /ʊ/ are fronted in TOENG although not as fronted as in British varieties. As is the case in Canadian English in general, TOENG also has a merger of the low back vowels (COT/CAUGHT) with the merged vowel closer to /ɔ/. According to Clarke, Elms, and Youssef (1995), the merger of these two vowels is the pivot for the "Canadian Vowel Shift" (CVS). The loss of this contrast, they argue, motivates the movement of the other low vowel in the system, [æ] to a lower and more centralized position. Thus, /æ/ moves towards the place formerly occupied by the pre-merged vowel in COT. The lowering and retraction of /æ/ also results in the lowering and retraction of two other lax vowels: /ɪ/ and /ɛ/. These vowel movements are illustrated in Figure 4 below.

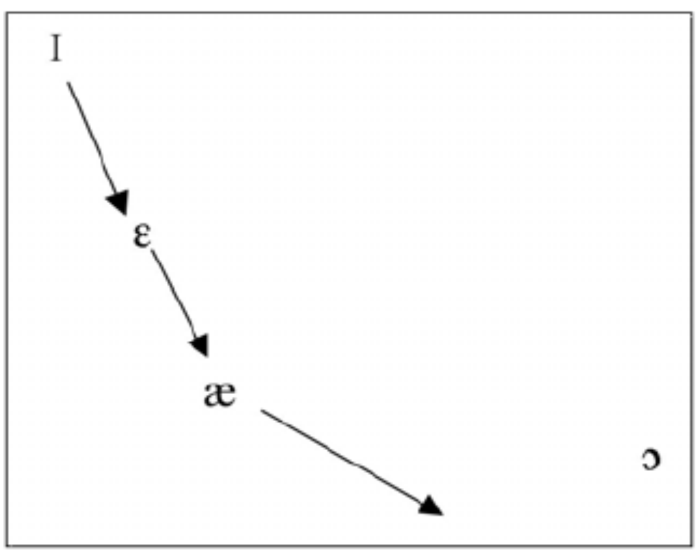


Figure 4: The Canadian Shift (image from Roeder and Jarmasz 2009)

Based on cross-linguistic comparison between the two languages, we can make predictions about change in /ɛː/ and /ɔː/ in HCAN. If TOENG has an influence on these vowels, we would expect the lowering and retraction of /ɛː/ in HCAN thus following the movement of the CVS. The closest counterpart of TOENG /ɔ/ appears to be lower than Cantonese /ɔː/. According to Bauer and Benedict (1997:55), the Cantonese vowel is slightly higher than the canonical English pronunciation of [ɔ][7]. Still, this may be similar enough to induce lowering of [ɔː] in HCAN so that it would approach the lower vowel found in Canadian English.

For the other vowels, we would have to also consider different phonological categories for phonetically similar vowels in the two languages. The vowels examined in this paper present a case in which allophonic differences in the production of two vowel categories (/i/ and /u/) in the HL correspond to four different phoneme categories in the dominant language. Thus, [i] and [ɪ] are phonologically contrastive in English, but not in Cantonese. Similarly, [u] and [ʊ] belong to different categories in English, but to a single category in Cantonese. If knowledge of two phonological systems means that HL speakers can maintain language-internal and cross-linguistic contrasts (Chang et al. 2011), then it seems possible that this knowledge of fine-grained phonetic detail could also influence low-level changes in allophonic variants in the HL.

For example, TOENG /ɪ/ involves a sound with a different phonological status within each language. Transfer of TOENG /ɪ/ could apply either to the pre-velar [ɪ] allophone only in Cantonese or it could apply to the Cantonese /i/ phoneme across all contexts. The latter seems less likely than the former. Since /i/ is a point vowel its lowering and retraction across all contexts would leave an empty space in the vowel system. Yet, if HCAN speakers make a distinction between [i] and [ɪ] in English, then it seems likely that they would at least maintain

[7] It is unclear whether this refers to British English or North American English.

the acoustic differences corresponding to the two allophonic variants in Cantonese. The CVS would also mean increasing differentiation between these two allophones. For [u] and [ʊ], there is a parallel phonological situation in both languages. The direction of change in TOENG, however, is the fronting of these two vowels. If there is influence from TOENG, then we would expect these two vowels in HCAN to also front. We would also expect the allophonic difference between [u] and [ʊ] to be at least maintained in HCAN. It may also be possible for these two allophones to become increasingly distinct from each other. To summarize, a list of hypothesized changes due to influence from TOENG is listed in Table 1 below.

Table 1: Expected Sound Changes Based on Contact-Induced Change

Cantonese Vowel Category	**Rime Groups**	**Similar Canadian English Vowel**	**Expected Change**
/**i**ː/	[iː]	/i/ as in 'see'	no change
	[ɪk]/[ɪŋ]	/ɪ/ as in 'sick'	lowering/retraction (Canadian Shift)
/**u**ː/	[uː]	/u/ as in 'do, food'	fronting
	[ʊk]/[ʊŋ]	/ʊ/ as in 'cook'	fronting
/**ɛ**ː/	[ɛː], [ɛːk]/[ɛːŋ]	/ɛ/ as in 'set'	lowering/retraction (Canadian Shift)
/**ɔ**ː/	[ɔː], [ɔːk]/[ɔːŋ]	/ɔ/ as in 'caught, saw'	lowering

4. The Data

The data examined in this paper include recorded interviews of 17 Cantonese speakers from the HerLD corpus. This includes seven male and 10 female speakers. Nine of these 17 are GEN 1 while eight are GEN 2. Audio quality of the interviews was the primary criterium in selecting these speakers, although there was also an attempt to balance for generation and sex. The GEN 1 (baseline) speakers in the corpus include those who grew up in Hong Kong, moved to the Greater Toronto Area (GTA) as adults, and have lived in the GTA for at least 20 years. GEN 2 speech refers to the Cantonese spoken by the children of GEN 1 speakers. GEN 2 speakers also include those who moved to Toronto from Hong Kong before the age of six[8]. The speech of GEN 1 speakers will be compared to the speech of GEN 2 speakers to determine if there are any inter-generational differences indicative of change.

The 17 speakers examined in this paper are listed in Table 2 based on their speaker code, which also indicates demographic information. The first character is a "C" indicating "Cantonese". This is followed by a number indicating the Generational group (1 or 2), an "M" or "F" indicating sex, and age. The last character is a letter used to distinguish between multiple speakers in the HerLD Corpus with identical demographic characteristics. For example, C2F16C is a Cantonese speaker, from GEN 2, female, and 16 years old. The "C" at the end indicates that there are two previously recorded speakers who are also Cantonese-speakers, GEN 2, female, and 16 years of age. These two other speakers would be labeled "C2F16A"and "C2F16B".

Table 2: Speakers Examined for this Paper

	Male	**Female**	
GEN 1	C1M46A C1M59A C1M61A C1M62A	C1F50A C1F54A C1F58A C1F78A C1F82A	N = 9
GEN 2	C2M21D C2M27A C2M44A	C2F16A C2F16B C2F16C C2F20A C2F21B	N = 8
	N = 7	N = 10	TOTAL N = 17

In addition to the .wav file recordings, the HerLD Corpus also includes time-aligned transcriptions of the data completed by native speakers using the program ELAN (Sloetjes and Wittenburg 2008). The Cantonese data was transcribed using the Jyutping Romanization System. To deal with code switching and code mixing with English, the general rule of thumb was to

[8] The HerLD Corpus also includes GEN 3 speakers, defined as those born in the GTA and that also have parents that qualify as GEN 2 speakers. This paper analyzes only GEN 1 and GEN 2 speakers.

transcribe in English orthography if the pronunciation was more English-like and in Jyutping if the pronunciation was more Cantonese-like. For the purpose of this study, however, only unambiguously Cantonese words were analyzed.

5. Methodology

5.1 Overview

The first step was to export a textgrid from the ELAN transcript readable by the phonetics analysis software, Praat (Boersma and Weenink 2014), which was then used to collect F1 and F2 measurements of a sample of vowels. A total of 75 vowel tokens were recorded on an Excel spreadsheet for each speaker. With a total of 17 speakers, this amounted to a grand total of 1275 vowel tokens. These 75 vowel tokens for each speaker included five vowel categories (/iː/, /uː/, /ɛː/, /ɔː/, and /aː/), and two contexts (open syllable and pre-velar). The composition of these 75 tokens is summarized in Table 3 below.

Table 3: Number of Tokens for Each Speaker (Manual Measurements)

Vowel (IPA)	Open syllable	Pre-velar	**Total**
/aː/	15 [aː]	0	N = 15
/ɛː/	10 [ɛː]	5 [ɛːk]/[ɛːŋ]	N = 15
/iː/	10 [iː]	5 [ɪk]/[ɪŋ]	N = 15
/ɔː/	10 [ɔː]	5 [ɔːk]/[ɔːŋ]	N = 15
/uː/	5 [uː]	10 [ʊk]/[ʊŋ]	N = 15
	N = 50	N = 25	**TOTAL N = 75**

As Table 3 shows, 15 tokens were collected for each vowel category. This included 10 tokens in open syllable context and 5 in pre-velar context. This was reversed for /uː/ due to the extremely low type and token frequency for /uː/ in open syllable contexts. Only 5 tokens of /uː/ were collected in open syllables. Another exception was made for /aː/ which includes only open syllable contexts due to the low overall frequency of /aː/ in pre-velar contexts. Since /aː/ is not the focus of this study, this was not a concern. Yet, /a:/ was still included as a point vowel for the purpose of normalization.

Finally, to control for the potential effects of tone, only words produced with the high-falling tone (also known as Tone 1) were included with an exception made for /u:/ due to low type and token frequency. For /u/, the tokens included a variable mixture of different tone categories. The words chosen were the first five that occurred in the recording after the 15-minute point. Tokens were also taken from the first 15-minutes if there were not enough tokens elsewhere in the recording. If these exceptions were not made for /u/, some speakers would have had zero tokens of [u:]. Ultimately, however, tone was found to have no significant effect on the formant frequencies of /u:/.

5.2. General Procedures

The formant measurement procedures for these 75 tokens began with the exported Praat Textgrid. The exported textgrid was modified with the addition of two tiers for a total of three tiers. The tiers were as follows: vowel, word, and original ELAN-exported transcript. The exported transcript tier was reviewed word-by-word for tokens of interest beginning at the 15-minute point of the interview. For low frequency vowels such as [u:], the search command was used to facilitate the identification process. Once a token was identified, the boundaries of the word and vowel were added and annotations were created so that these tokens could easily be identified later. Measurements were taken by selecting the entire vowel and using Praat's "get formant" command to calculate both the F1 and F2 means. Co-articulation effects were minimized by selecting only the steady state portion of vowels.

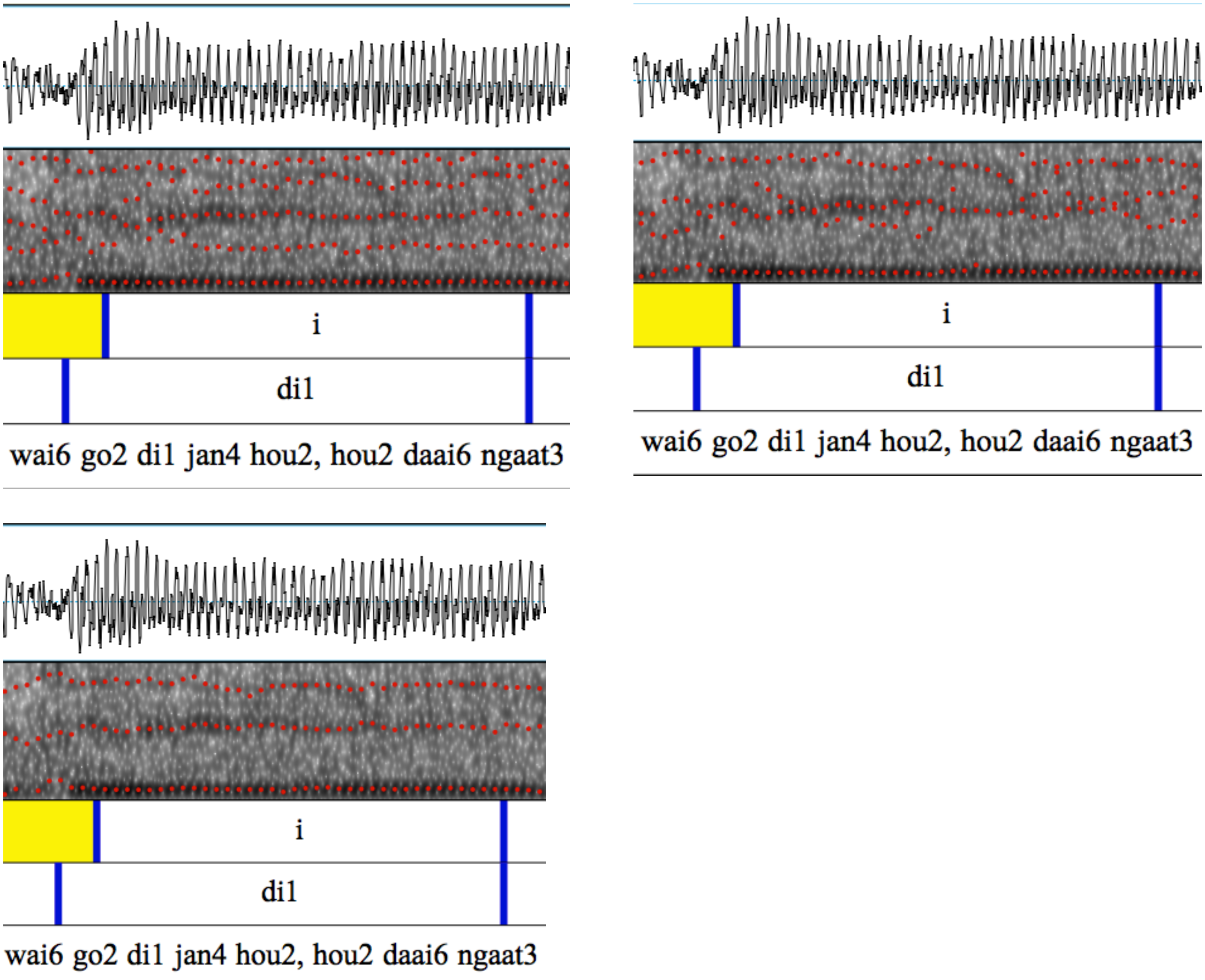


Figure 5: Praat Formant Tracker with different number of formants selected. Top left – 5 formants, Top right – 4 formants, Bottom left – 3 formants

The default settings were set to 5500 Hz for the maximum formant, five formants, and a window length of 0.025 seconds[9]. These settings were adjusted in cases of obvious errors. For example, sometimes the formant tracker misidentified F3 as F2 especially for back vowels. For front vowels like /i/, the formant tracker sometimes misidentified a formant between F1 and F2

[9] Although different settings are typically used for male and female speakers to address the problem of different vocal tract lengths, the procedure adopted here takes a different approach to addressing this problem by eye-checking for fit between the dark formant bands on the spectrogram and the Praat formant tracker calculations on an individual token basis. Ultimately it is accurate measurements of individual tokens that matter rather than whether a speaker is male or female per se because there can be quite a bit of variation in vocal tract length among both males and females.

and treated the actual F2 as F3. Increasing or decreasing the number of formants usually resolved this problem. Below in Figure 5 is an example from C1F50A that shows the formant tracker measurements with the settings set to 5, 4, and 3 formants. In this case, the setting with 3 formants provided the best fit. Finally, in cases in which these adjustments did not work or in cases in which there was poor recording quality, simultaneous laughter, or simultaneous speech from the interviewer, individual tokens were skipped and replaced with the next suitable token in the recording.

5.3 Normalization and Subsequent Steps

After recording the measurements for the 1275 tokens, the next step was to normalize the vowel measurements using the vowel normalization suite known as NORM (Thomas and Kendall 2007). The Watt & Fabricius Modified technique was selected and the output was scaled to Hertz values. As a speaker-intrinsic, vowel-extrinsic normalization method, the Watt & Fabricius Modified technique has been shown to be well suited for sociophonetic purposes in factoring out physiological differences while also minimizing distortion of the vowel space (Fabricius, Watt, and Johnson 2009).

Finally, the last step was to upload the normalized data to Rbrul (Johnson 2009) for statistical analysis of vowel formant measurements. Table 4 below, shows the variables examined. The dependent variable was either F1 (as an inverse acoustic correlate of vowel height) or F2 (as an acoustic correlate of vowel frontness). For each formant frequency for each vowel, a one-level analysis was run to show the overall pattern. The independent variables included both random effects (“speaker” and “word”) and fixed effects, which included external (generation, sex, age) as well as linguistic factors (preceding consonant, following velar consonant)[10].

To determine the extent to which male and female speakers from different generational groups may differ in their production of vowels in different phonetic contexts (or rime groups), a factor group was also created combining three categorical variables (generation, sex, and following velar consonant), each with two possible values (GEN 1 or GEN2, male or female, velar or non-velar) for a total of 8 possible values. Whenever this factor group was included in a run, generation, sex and velar consonant were excluded as distinct variables in the modeling. Analyses including this factor group were also run with step-up/step-down models for increased statistical robustness.

Table 4: Variables Examined

		Independent Variables			
		Random Effects	**Fixed Effects**		
			Social Factors	**Linguistic Factors**	**Factor Groups**
Dependent Variables	**F1**	Speaker, Word	Generation, Sex, Age	Preceding Segment, Following Velar, Tone (for /u:/)	Generation:Sex:Velar
	F2				

6. Results

6.1 Overall Results

Figure 6 below presents an overall plot showing the mean F1 and F2 calculated for each factor group. Zoomed-in images showing the means for each vowel category are presented in Section 6.2 along with a discussion of variation found for each of these categories. To visualize the degree of overlap between different rime groups, Figures 7, 8, 9, and 10 show plots with the

[10] Tone was also included for /u:/ since this was the only vowel with tokens from different tone categories. Ultimately, however, tone was shown to not have a significant effect.

mean ± 1 standard deviation for each of the four generation:sex factor groups (GEN 1 female, GEN 1 male, GEN 2 female, GEN 2 male). Thus, from these five charts, we can observe both variation in F1/F2 means as well as variation in how distinct different vowels are based on phonetic context for four different groups of speakers. The following section presents Rbrul (Johnson 2009) results for each vowel category.

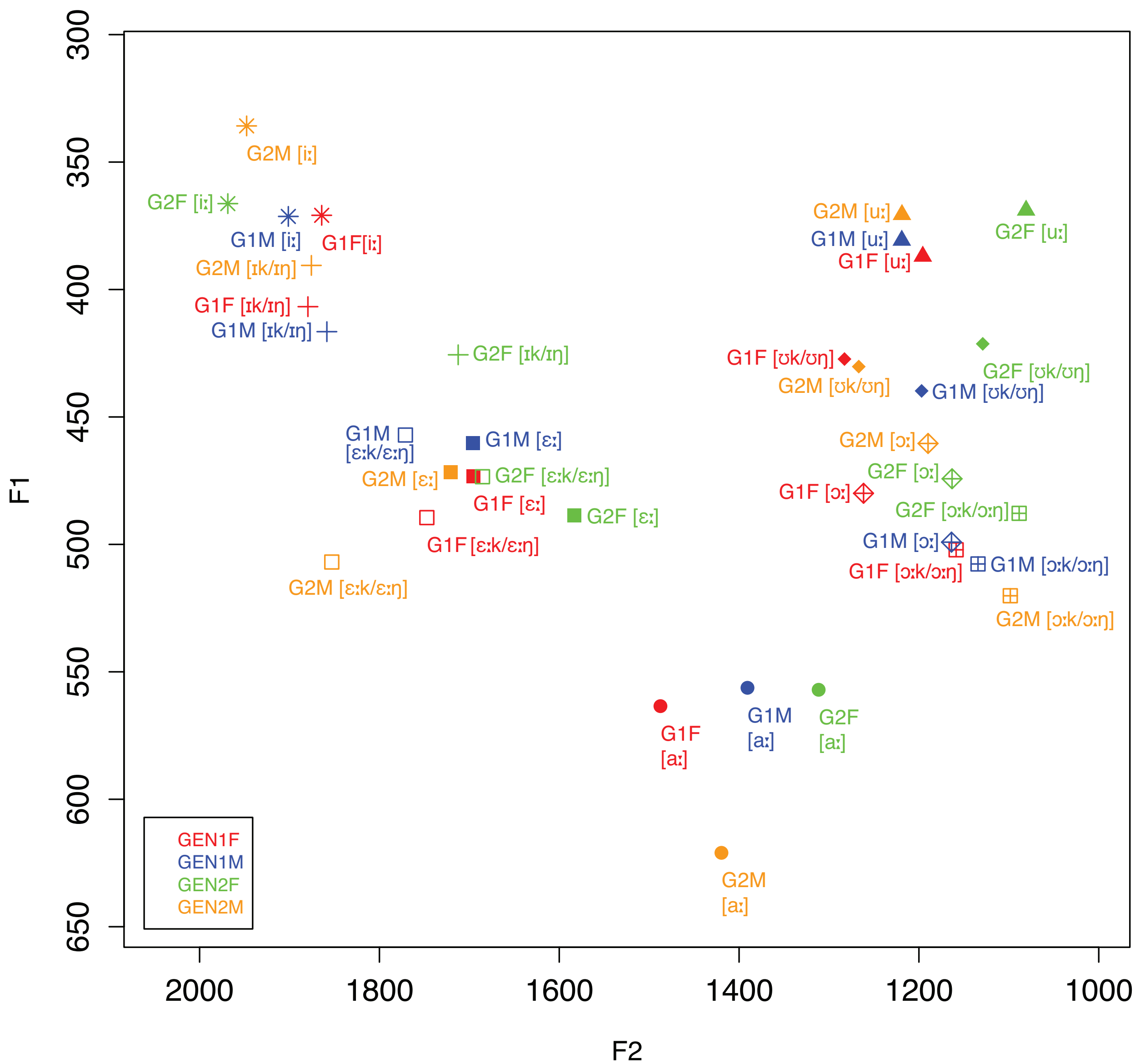


Figure 6: Overall F1/F2 Means for Each GEN:Sex:Velar Factor Group, WF-m Normalized

Figure 7: GEN 1 Female Speakers, WF Modified Mean F1/F2 with ± 1 Standard Deviation

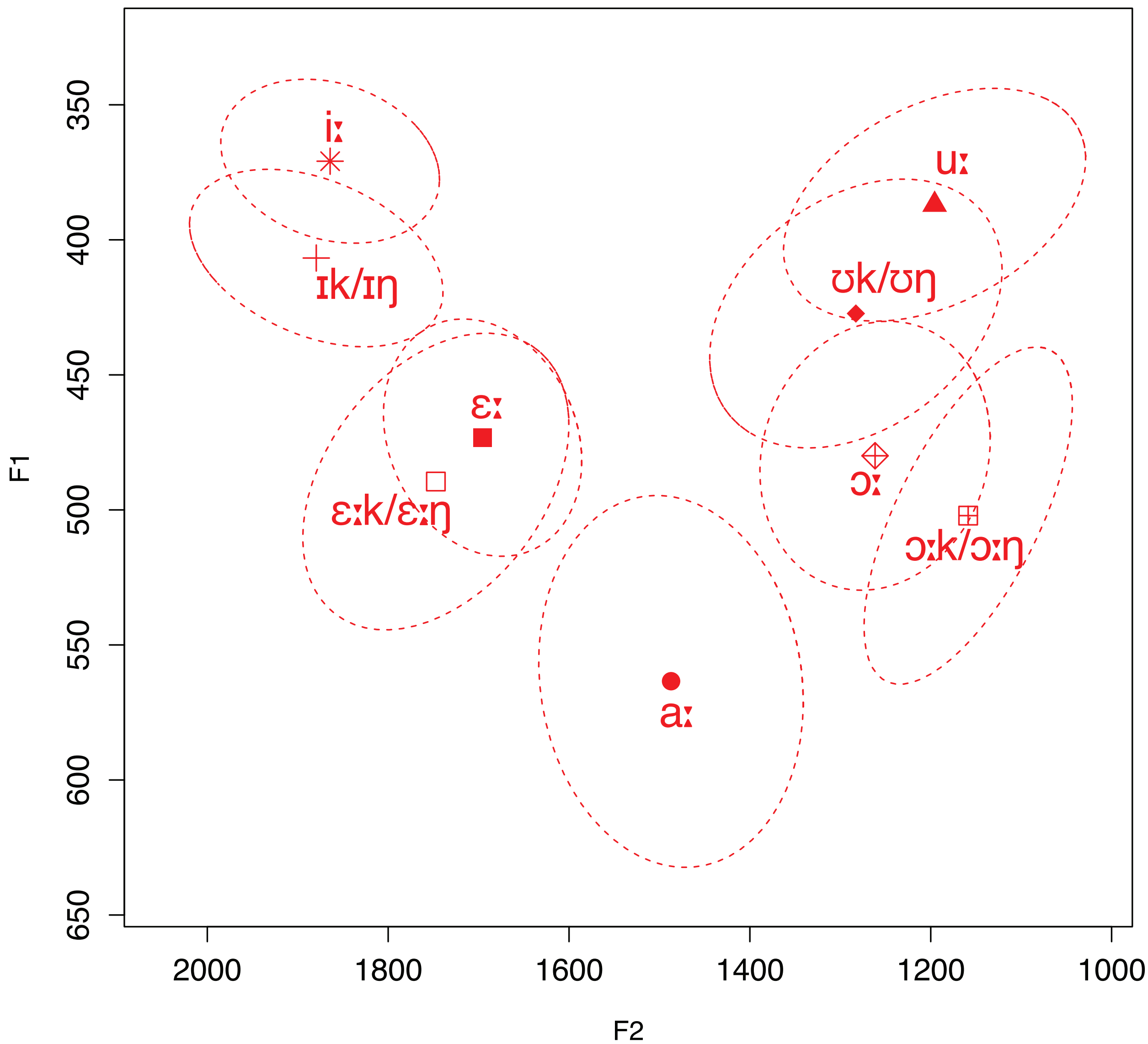


Figure 8: GEN 1 Male Speakers, WF Modified Mean F1/F2 with ± 1 Standard Deviation

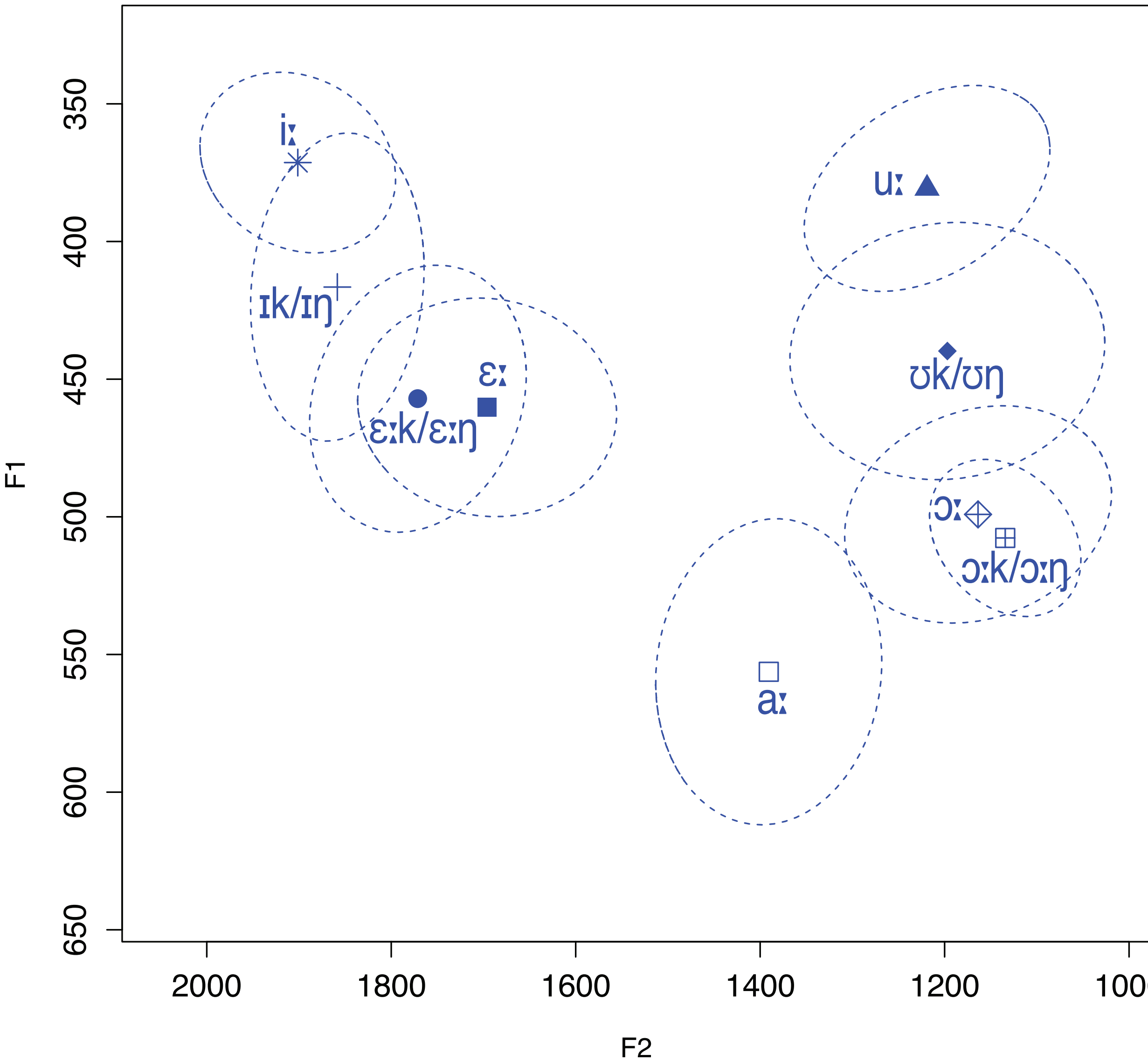


Figure 9: GEN 2 Female Speakers, WF Modified Mean F1/F2 with ± 1 Standard Deviation

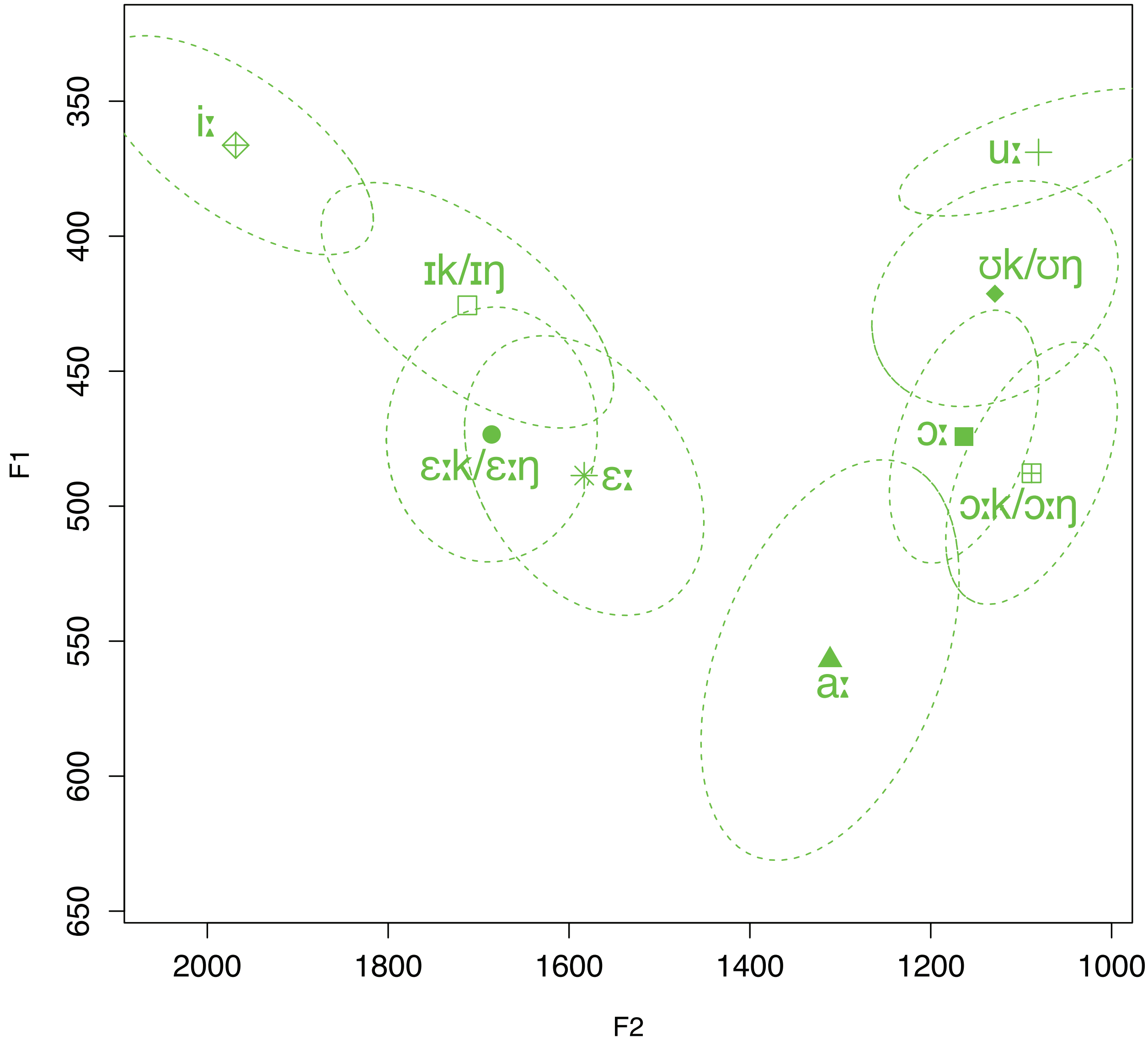
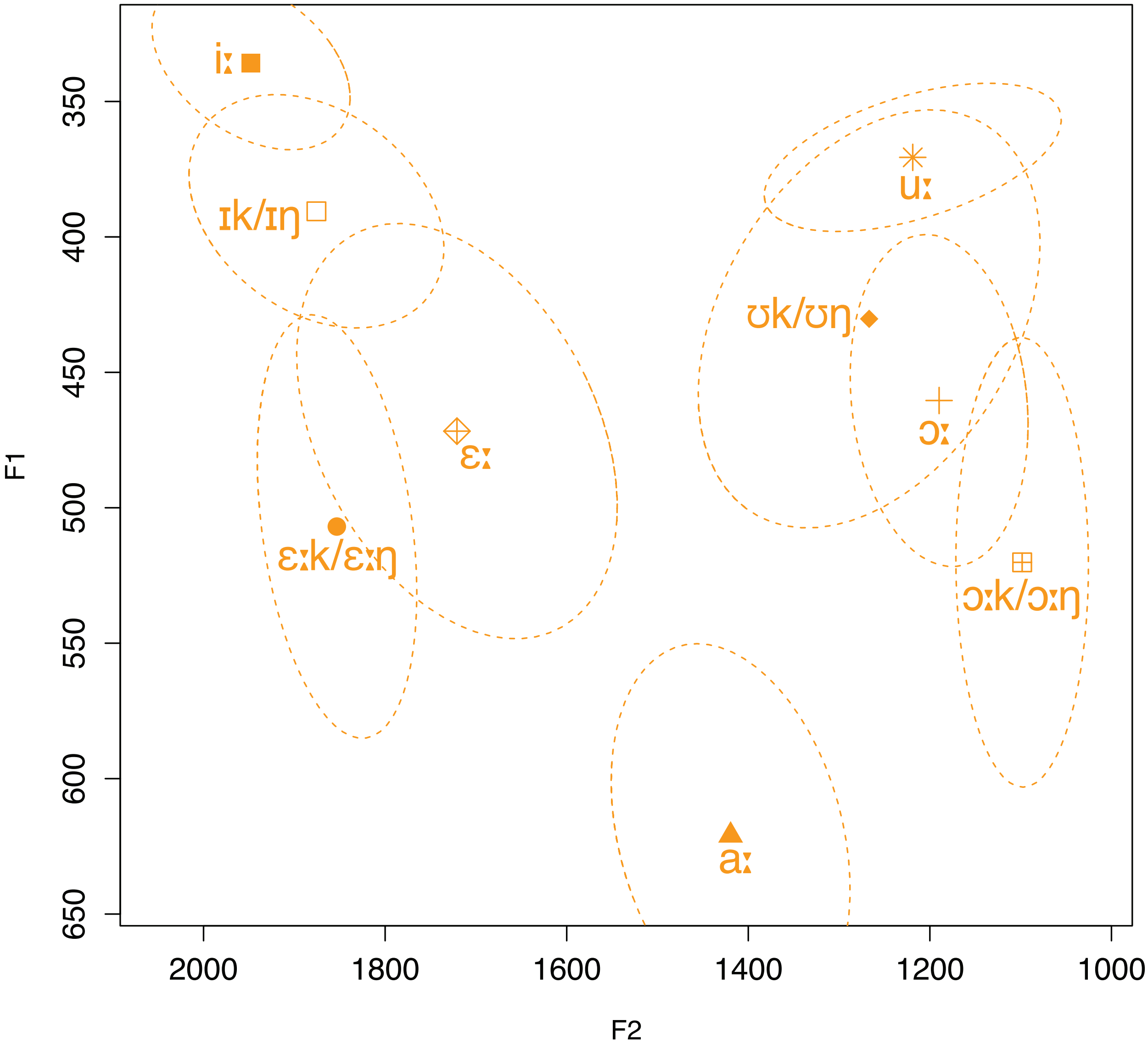


Figure 10: GEN 2 Male Speakers, WF Modified Mean F1/F2 with ± 1 Standard Deviation



6.2 Results for Individual Vowels

6.2.1: Results for /iː/

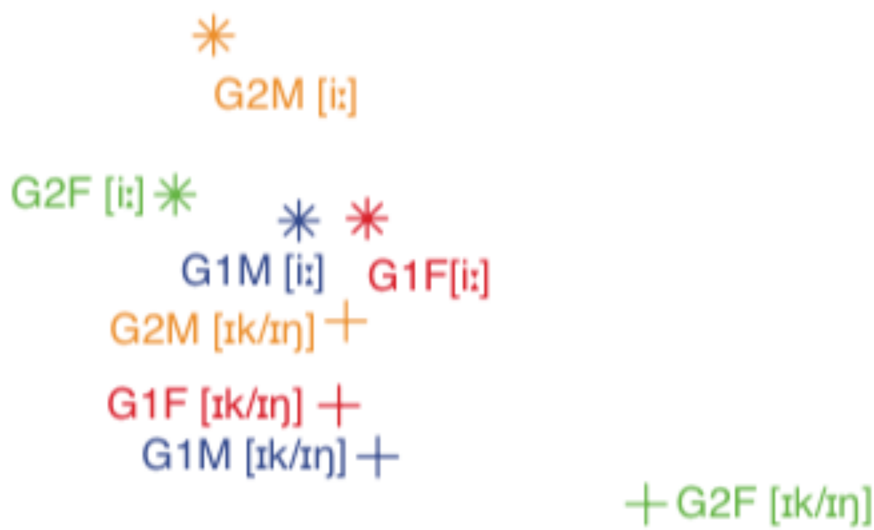


Figure 11: Zoomed-In Plot of Mean F1/F2 for /iː/

The first set of results presented is a one-level analysis of F1 and F2 for the vowel /iː/. As shown in Figure 12 below, velar context has a significant effect on both F1 ($p < 0.01$) and F2 ($p < 0.01$) values. The mean F1 is higher (lower vowel) while the mean F2 is lower (more retracted) in the vowel space when preceding velar consonants. Of the external variables examined, only generation was significant ($p < 0.05$) for either formant. The results show GEN 2 speakers more likely to produce raised (lower F1) tokens of /iː/ across all phonetic contexts.

The next set of results show a sex-based split among GEN 2 speakers. Figure 18 shows the best Step-Down Models for both the F1 and F2 of /iː/. The Generation.Sex.Velar factor group was included as a fixed effect in both models and was the only fixed effect that showed significance ($p < 0.01$ for both F1 and F2). The split occurs only for F2. The ranking of coefficients for Generation.Sex.Velar shows that GEN 2 female speakers have both the highest value (coefficient = 82.807, mean = 1968.61) and the lowest value (coefficient = -127.058, mean = 1712.407). GEN 2 female speakers, thus, produce the most fronted variants of [iː] and the most retracted variants of [ɪk]/[ɪŋ]. For GEN 2 male speakers as well as all GEN 1 speakers, the F2 difference between /iː/ in these two contexts is much smaller.

Figure 12: One-level Analysis Results for /iː/

F1 for /iː/			
One-level Analysis, R^2 [total] = 0.502			
Random Effects ($R^2 = 0.236$)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.266)			
Generation (p = 0.0448)*			
factor	coef	N	mean Hz
Gen 1	16	125	385
Gen 2	-16	120	374
Velar (p = 2.01e-06)**			
factor	coef	N	mean
[ɪk/ɪŋ]	34	85	412
[iː]	-34	160	363
Not Significant Factors			
Sex (p = 0.087)			
Age (p = 0.18)			
Preceding (p = 0.143)			

F2 for /iː/			
One-level Analysis, R^2 [total] = 0.428			
Random Effects ($R^2 = 0.305$)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.123)			
Velar (p = 0.00946)**			
factor	coef	N	mean Hz
[iː]	70	160	1918
[ɪk/ɪŋ]	-70	85	1825
Not Significant Factors			
Generation (p = 0.306)			
Sex (p = 0.111)			
Age (p = 0.739)			
Preceding (p = 0.156)			

For F1, GEN 2 female speakers are almost at both extremes in terms of coefficient rankings and means. GEN 2 female speakers have the highest F1 (most lowered vowel) in pre-velar contexts (coefficient = 35.161, mean = 425.617) and the second lowest F1 (raised vowel) in open syllable contexts. GEN 2 male speakers have the lowest F1 (most raised vowel) in open-syllable contexts (coefficient = -48.899, mean = 335.813). Thus, GEN 2 as a whole produces the most raised variants of /iː/ and appears to be increasing the acoustic difference between [iː] and [ɪk]/[ɪŋ].

Figure 13: Best Step-Down Regression Models for /iː/

STEP UP AND STEP DOWN MATCH			
F1 for /iː/			
Best Step-Down Model, R2 [total] = 0.421			
Random Effects (R2 = 0.12)			
Speaker [random]			
Word [random]			
Fixed Effect (R2 = 0.301)			
Generation.Sex.Velar (0.000641)**			
factor	coef	N	mean Hz
2.F.[ɪk/ɪŋ]	35	25	426
1.M.[ɪk/ɪŋ]	31	20	417
1.F.[ɪk/ɪŋ]	27	25	407
2.M.[ɪk/ɪŋ]	23	15	391
1.M.[iː]	-14	35	372
1.F.[iː]	-15	45	369
2.F.[iː]	-18	50	366
2.M.[iː]	-49	30	336
Not Significant Factors			
Preceding			
Age			

STEP UP AND STEP DOWN MATCH			
F2 for /iː/			
Best Step-Down Model, R2 [total] = 0.355			
Random Effects (R2 = 0.188)			
Speaker [random]			
Word [random]			
Fixed Effect (R2 = 0.167)			
Generation.Sex.Velar (1.9e-06)**			
factor	coef	N	mean Hz
2.F.[iː]	83	50	1969
2.M.[iː]	63	30	1948
2.M.[ɪk/ɪŋ]	43	15	1876
1.M.[iː]	4	35	1890
1.F.[ɪk/ɪŋ]	-17	25	1880
1.F.[iː]	-20	45	1864
1.M.[ɪk/ɪŋ]	-29	20	1858
2.F.[ɪk/ɪŋ]	-127	25	1712
Not Significant Factors			
Preceding			
Age			

6.2.2: Results for /uː/

Figure 15 shows the one-level regression analysis for /uː/ confirming velar context to be a significant fixed effect for both F1 ($p < 0.01$) and F2 ($p < 0.05$). [ʊk]/[ʊŋ] is lower (higher F1) and more fronted (higher F2) than [uː]. None of the external factors showed a significant effect for F1. This means the lowering effect is present among all speaker groups. For F2, we find that age has a significant effect[11]. Older speakers have more fronted (higher F2) /uː/ than younger speakers.

[11] Preceding context was also significant for F2. Due to the small number of words, however, there was quite a bit of overlap between the fixed factor "preceding" and the random factor "word".

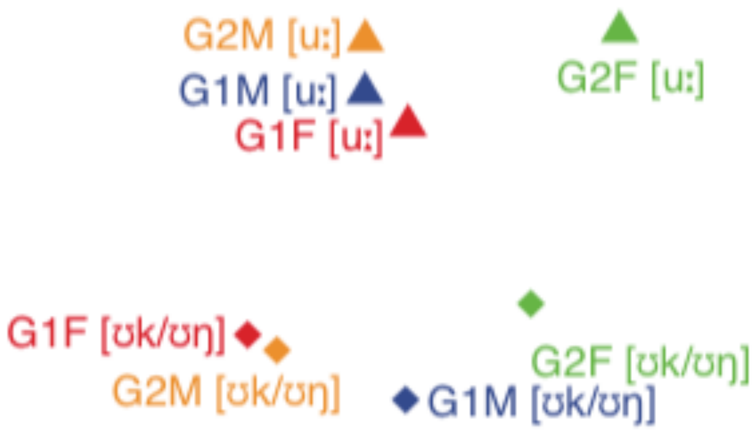


Figure 14 (above): Zoomed-in Plot of Mean F1/F2 for /uː/

Figure 15 (below): One-level Results for /uː/

F1 for /uː/			
One-level Analysis (R2 [total] = 0.367)			
Random Effects (R2 = 0.122)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.245)			
Velar (p=1.04e-05)**			
factor	coef	N	mean Hz
[ʊk]/[ʊŋ]	30	172	429
[uː]	-30	83	378
Not Significant Factors			
Generation (0.483)			
Sex (0.454)			
Age (0.189)			
Preceding (0.302)			

F2 for /uː/			
One-level Analysis (R2 [total] = 0.449)			
Random Effects (R2 = 0.148)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.301)			
Age (p=0.0163)*			
cont.	coef		
1	+4.097		
Velar (p=0.0207)*			
factor	coef	N	mean Hz
[uː]	40	83	1180
[ʊk]/[ʊŋ]	-40	172	1212
Not Significant Factors			
Generation (0.177)			
Sex (0.156)			

Figure 16: Best Step-Down Models of /uː/

STEP UP AND STEP DOWN MATCH			
F1 for /uː/			
Best Step-Down Model (R2 total] = 0.359)			
Random Effects (R2 = 0.148)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.21)			
Generation.Sex.Velar (p = 3.7e-06)**			
factor	coef	N	mean
1.M.[ʊk/ʊŋ]	37	37	440
2.M.[ʊk/ʊŋ]	27	30	430
1.F.[ʊk/ʊŋ]	23	49	427
2.F.[ʊk/ʊŋ]	20	56	421
1.F.[uː]	-14	26	387
1.M.[uː]	-23	23	381
2.M.[uː]	-32	15	371
2.F.[uː]	-38	19	369
Not Significant Factors			
Age			
Preceding			
Tone			

STEP UP AND STEP DOWN MISMATCH			
F2 for /uː/			
Best Step-Down Model, (R2 [total] = 0.435)			
Random Effects (R2 = 0.293)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.142)			
Generation.Sex.Velar (p = 0.0244)**			
factor	coef	N	mean Hz
2.M.[ʊk/ʊŋ]	71	30	1267
1.F [ʊk/ʊŋ]	57	49	1283
2.M.[uː]	34	15	1219
1.M.[uː]	32	23	1219
1.F.[uː]	23	26	1196
1.M.[ʊk/ʊŋ]	-10	37	1197
2.F.[ʊk/ʊŋ]	-93	56	1129
2.F.[uː]	-115	19	1081
Not Significant Factors			
Age			
Tone			

Figure 16 shows the best step-down models that include factor groups as fixed effects. For the F1 of [uː], GEN 2 speakers as a whole have a greater tendency to produce raised variants. The differences for F1, however, are relatively small compared to the differences found for F2. GEN 2 male and GEN 2 female speakers are at opposite ends in terms of coefficient values. The actual values are also relatively large (-115 Hz for [uː] for GEN 2 females and +71 Hz for [ʊk]/[ʊŋ] for GEN 2 males). There is also a small difference between male and female GEN 1 speakers but the pattern is almost reversed. While GEN 2 female speakers have a greater tendency to retract /uː/ across all contexts than GEN 2 male speakers, it is GEN 1 male speakers that have a greater tendency to retract pre-velar [ʊk]/[ʊŋ] (-10Hz) than GEN 1 female speakers (+57 Hz). This pattern may also account for the age effect observed in the one-level analysis since it happens to be the case that the GEN 2 female speakers examined are also the youngest speakers examined while the GEN 1 females speakers examined are also the oldest ones examined. Finally, tone was also included in the best step-down models and was not shown to be significant.

6.2.3: Results for /ɛː/

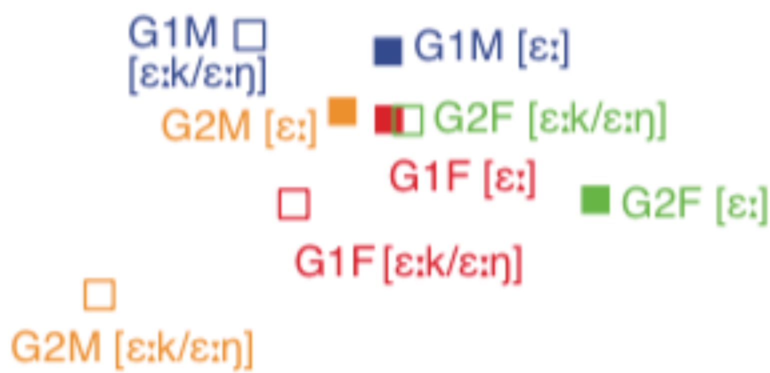


Figure 17: Plot of Mean F1/F2 for /ɛː/

As shown in Figure 18, velar context does not have a significant effect on /ɛ/. In fact, it has a p-value of 1. We can see why based on the vowel plot above in Figure 17. There is a wide range of overlapping variability in terms of production of this vowel. While GEN 1 speakers and GEN 2 female speakers lack differentiation based on velar context, GEN 2 male speakers are quite differentiated. On the other hand, however, GEN 2 female speakers have the most retracted production of [ɛː] while GEN 1 male speakers have the most fronted production of [ɛːk]/[ɛːŋ] in. Once again, this shows a split among GEN 2 speakers. The F2 results shown in Figure 18 confirm this split by showing GEN 2 male speakers in pre-velar contexts having the highest coefficient (+94 Hz, more fronting) and GEN 2 female speakers as being on the other extreme end in their production of [ɛː] (-143 Hz, more retraction).

Figure 18: R-Brul Results for /ɛː/

STEP UP AND STEP DOWN MATCH			
F1 for /ɛː/			
Best Step-Down Model, (R2 = 0.398)			
Random Effects (R2 = 0.307)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.091)			
Generation.Sex.Velar (p = 0.0054)**			
factor	coef	N	mean Hz
2.M.[ɛːk/ɛːŋ]	76	15	507
1.F.[ɛːk/ɛːŋ]	24	25	489
2.F.[ɛːk/ɛːŋ]	24	25	473
1.M.[ɛːk/ɛːŋ]	10	20	457
2.F.[ɛː]	-11	50	489
2.M.[ɛː]	-29	30	472
1.F.[ɛː]	-43	50	473
1.M.[ɛː]	-51	40	460
Not Significant Factors			
Age			

STEP UP AND STEP DOWN MATCH			
F2 for /ɛː/			
Best Step-Down Model, (R2 = 0.575)			
Random Effects (R2 = 0.392)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.183)			
Generation.Sex.Velar (p = 0.00598)**			
factor	coef	N	mean Hz
2.M.[ɛːk/ɛːŋ]	94	15	1853
1.M.[ɛːk/ɛːŋ]	27	20	1771
1.F.[ɛː]	24	50	1696
1.F.[ɛːk/ɛːŋ]	23	25	1747
1.M.[ɛː]	21	40	1696
2.M.[ɛː]	15	30	1721
2.F.[ɛːk/ɛːŋ]	-60	25	1685
2.F.[ɛː]	-143	50	1583
Not Significant Factors			
Age			

6.2.4: Results for /ɔː/

Figure 19: Plot of Mean F1/F2 for /ɔː/

Figure 20: R-Brul Results for /ɔː/

STEP UP AND STEP DOWN MATCH			
F1 for /ɔː/			
Best Step-Down Model (R2 total] = 0.263)			
Random Effects (R2 = 0.169)			
Speaker [random]			
Word [random]			
Fixed Effects (R2 = 0.094)			
Generation.Sex.Velar (p = 0.00317)**			
factor	coef	N	mean Hz
2.M.[ɔːk/ɔːŋ]	29	15	520
1.M.[ɔːk/ɔːŋ]	17	20	508
1.F.[ɔːk/ɔːŋ]	11	25	502
1.M.[ɔː]	7	40	499
2.F.[ɔːk/ɔːŋ]	-4	20	485
1.F.[ɔː]	-12	50	480
2.F.[ɔː]	-18	53	474
2.M.[ɔː]	-31	30	460
Not Significant Factors			
Age			
Preceding			

Finally, for /ɔː/, the one-level analysis shows only velar context significant for F1 ($p < 0.05$) with velar consonants having a lowering (higher F1) effect for all speaker groups according to the best-step down model presented in

Figure 20.[12] The greatest effect, however, is found for GEN 2 male speakers. GEN 2 males are also at opposite ends in terms of coefficient values. They have both the highest coefficient for [ɔːk]/[ɔːŋ] (+29 Hz) as well as the lowest coefficient for [ɔː] (-31 Hz). This means they exhibit the largest differentiation based on pre-velar vs. open-syllable context. GEN 2 female speakers, on the other hand, show much less differentiation (-4 vs. -18 Hz). For GEN 1, we see a reverse sex-based split that can also be visualized by comparing Figure 7 with Figure 8. GEN 1 male speakers have overlapping F1/F2 vowels for [ɔː] and [ɔːk]/[ɔːŋ] (+7 vs. +17 Hz) while GEN 1 female speakers show some differentiation (11 vs. -12 Hz)although clearly not as great as for GEN 2 male speakers.

7. Discussion

7.1 Linguistic Factors

To address the first research question of this paper, we look at the results of the one-level analysis for all four vowel categories. Velar context is a significant factor for two of the four vowels, namely /iː/ and /uː/. Thus, the overall results show a lowering effect across the speech community for these two vowel categories. This is consistent with previous descriptions of HKCAN phonology. There is hence continuity in at least one aspect of the vowel system of HCAN. A one-level analysis of the other two vowel categories, however, showed no significant effects for velar context. What may be a more notable finding from this study is how this factor interacts with external factors.

[12] There is also a fronting (higher F2) effect of preceding consonants that is not relevant to the current paper.

7.2 External Factors

In addressing the second research question, we can see from the overall results that both generation and sex have a significant effect on all four vowel categories but only if generation and sex are considered together as a factor group. Each generation:sex factor group had different patterns for velar conditioning for each vowel category. In some cases, a sex-based split for GEN 1 speakers is reversed for GEN 2 speakers.

For /iː/, we see little difference between male and female GEN 1 speakers. GEN 2 speakers as a whole, however, have the most raised variants and also show a sex-based split with females having the most retracted variants of [ik]/[ɪŋ]. For /uː/, we see a split for both generational groups. GEN 1 male speakers have more retracted productions of [ʊk]/[ʊŋ] than GEN 1 female speakers. For GEN 2, this pattern is reversed with female speakers rather than male speakers having the most retracted productions of both the [uː] and [ʊk]/[ʊŋ]. For /ɔː/, we see GEN 1 males with overlapping formant values across phonetic contexts while female speakers show some differentiation. This pattern is reversed for GEN 2 speakers with the male speakers having much more lowered variants of [ɔːk]/[ɔːŋ] than females. A similar split holds for /ɛː/ with GEN 2 male speakers showing significantly more fronting of [ɛːk]/[ɛːŋ] than other speaker groups while GEN 2 female speakers show significantly more retraction of [ɛː] than other speaker groups.

From these observations, we can conclude that there is a generational change characterized by different sex-based splits. While some vowels also show a sex-based split for GEN 1 speakers, the split does not appear to be as strong for any of these vowels as they are for GEN 2 speakers. Any differentiation existing in the baseline has clearly changed into a very different pattern of differentiation. This likely reflects a change in the social setting in which the language is used. GEN 2 speakers also differ from GEN 1 speakers in having early exposure to TOENG. This leads to the next research question regarding influence from TOENG

7.3 Influence from TOENG?

Table 5 below presents a summary of the major results along with the two sets of predictions presented in Section 3. In response to the third research question of the paper, we can see that there is evidence for influence from TOENG. The influence, however, is realized in different ways for GEN 2 male and GEN 2 female speakers.

For GEN 2 female speakers, some of the changes that can be attributed to influence from TOENG are also changes that follow the CVS. More specifically, GEN 2 female speakers are retracting both [ɪk]/[ɪŋ] and [ɛː]. The retraction of [ɪk]/[ɪŋ] may have motivated another change. This would be the retraction of [uː] and [ʊk]/[ʊŋ], a change that otherwise was not predicted by either of the hypotheses presented in Section 3. The other change observed among this group that was not predicted is the raising and fronting of [iː]. This, however, could also be attributed to influence from English if examined along with the retraction and lowering of [ɪk]/[ɪŋ]. The ultimate outcome of these opposing directions of movement is greater acoustic difference between [iː] and [ɪk]/[ɪŋ]. It appears that the phonological contrastiveness of acoustically similar vowels in TOENG are motivating an increase in acoustic distinctiveness for what would otherwise be considered different allophones of the same phoneme in Cantonese.

GEN 2 male speakers, on the other hand, do not show the Canadian Shift pattern observed among GEN 2 female speakers. Instead, the changes they show can all be described as changes that result in increased allophonic differentiation for three out of the four vowel categories examined. This includes the raising and fronting of [iː] resulting in greater difference between [iː] and [ɪk]/[ɪŋ], the lowering of [ɔːk]/[ɔːŋ], and the fronting of [ɛːk]/[ɛːŋ]. Although the lowering of [ɔːk]/[ɔːŋ] was a hypothesized change discussed in Section 3 that would be predicted based on internal motivation, this change seems more likely to be a contact-induced one if placed in the context of other changes observed among GEN 2 males speakers. The initial rationale for this change based on internal motivation would have been the purported lowering of [ʊk]/[ʊŋ]. There does not seem to be any evidence that this is happening. Instead, the results also show [ɔː] among GEN 2 male speakers to have the greatest tendency to raise (lower F1). This suggests the change would be better characterized in terms of increasing phonetic differentiation rather than lowering in articulatory space.

Table 5: Summary of Hypothesized vs. Observed Changes

Cantonese Vowel Category	**Rime Group**	**Changes Predicted by Internal Motivation Hypotheses**	**Contact-Induced Hypotheses**	**Observed for GEN 2 Male**	**Observed for GEN 2 Female**
/**i**ː/	[iː] (open syllable)	--	--	fronting, raising	fronting, raising
	[ɪk]/[ɪŋ] (pre-velar)	lowering	**lowering/retraction (Canadian Shift)**	--	**lowering/ retraction**
/**u**ː/	[uː] (open syllable)	--	fronting	--	retraction
	[ʊk]/[ʊŋ] (pre-velar)	lowering	fronting	--	retraction
/**ɛ**ː/	[ɛː] (open syllable)	--	**lowering/retraction (Canadian Shift)**	--	**retraction**
	[ɛːk]/[ɛːŋ] (pre-velar)	lowering	**fronting or lowering/retraction**	**fronting**	**--**
/**ɔ**ː/	[ɔː] (open syllable)	--	lowering	--	--
	[ɔːk]/[ɔːŋ] (pre-velar)	**lowering**	**lowering**	**lowering**	--

Finally, the fronting of [ɛːk]/[ɛːŋ] is another change that was not predicted. The source of this could be due to its phonetic similarity with the fronted and raised /æ/ vowel that occurs preceding nasals (ex: "ban") and preceding voiced velar stops (ex: "bag") as found in most varieties of Canadian English including TOENG (Boberg 2008)[13]. Again, this is a change that can be characterized in terms of a general pattern of increasing differentiation based on phonetic environment.

7.4 Implications

What should be clear from the results of this study is that the vowel system of a HL is more than simply about interference from a dominant language. While interference from TOENG can explain the types of changes observed, the effects of interference are not uniform. Social differentiation in vowel production clearly exists in the HCAN speech community such that GEN 2 males and females show different types of influence from TOENG. That this is possible supports the promise of future research on social factors in HCAN vowel variation and change. If it is true that HL speakers have a better command of both language-internal and cross-linguistic contrasts than other groups of bilingual speakers (Chang et al. 2011), then this means that HL speakers have a combined phonological inventory that is larger than the single phonological inventory of monolingual speakers. It follows that the possible types of low-level phonetic changes due to transfer are greater than the possible changes that can occur in monolingual speech communities. This is not to say that there are no constraints, but rather that the constraints are fewer.

When placed side-by-side with previous research on the English spoken within the same community, very different results emerge. Hoffman (2010), for example, examined the CVS among Torontonians with British, Italian, and Chinese ancestry. Many of the ethnic Chinese speakers examined were also bilingual in Cantonese. The study found no significant difference in

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[13] Although Boberg (2008) describes pre-velar /æ/-raising as less advanced in Ontario, there is still some raising and this may be adequate enough for HCAN speakers to draw a similarity between the pre-velar environment found in TOENG with the pre-velar environment found in Cantonese even though they are slightly different.

participation in the CVS based on ethnicity[14]. Instead, only sex and age were found to be significant with younger speakers leading. Young male speakers lead in the lowering of [ɪ] while young female speakers lead in the lowering of [æ]. If changes in HCAN were simply due to transfer from TOENG, we would expect GEN 2 male speakers to lead in the lowering of [ɪk]/[ɪŋ]. Yet, as has already been discussed, GEN 2 male speakers are raising [ɪk]/[ɪŋ] while GEN 2 female speakers are the ones leading in both the lowering and retraction of Cantonese [ɪk]/[ɪŋ].

One of the larger theoretical questions behind the HLVC Project is whether it is the same type of speakers who are the ones who lead changes in both their HLs and in English (Nagy et al. 2009). The results of this study support a "no" answer. First of all, the GEN 2 male and female speakers are innovating a different set of changes. So it is unclear whether or not we can describe either group as leading. Both groups are innovating but innovating in different ways. Second, as we have just seen, younger male speakers lead in the lowering of [ɪ] in English but the direction of change for an acoustically similar vowel in Cantonese is in the opposite direction for younger male speakers. Yet, we still see interference from English. The interference includes both transfer of phonological contrasts in TOENG to allophonic variants in HCAN as observed in the increasing differentiation between Cantonese [iː] and [ɪk]/[ɪŋ] for all GEN 2 speaker groups and transfer of low-level phonetic similarities from TOENG to HCAN such as the CVS-like pattern observed among GEN 2 female speakers.

While it should be clear that two phonological systems is what makes the observed sex-based split possible, what requires more research to address is why these specific patterns. Is there something about the meaning of the CVS that has motivated GEN 2 female speakers to

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[14] Hoffman and Walker (2010) also found lack of evidence for the emergence of "ethnolects" although they do discuss the possibility that some individual speakers may be using features such as /t/-deletion to index ethnic identity more so than others.

transfer these phonetically retracted and lowered vowels to their Cantonese speech? Likewise, what would be the social motivation behind GEN 2 male speakers creating allophonic splits for vowel categories that previously lacked phonetically differentiated allophones? Are these changes linked to gender identity or to something else that coincidentally correlates with speaker sex in the data examined? Addressing such questions would require discourse analysis of interview recordings and research on gender differences within the community. Both of these topics would be beyond the scope of the current paper but would be suitable topics for future research.

8. Conclusion

To summarize, this paper has shown how the production of four vowel categories across two phonetic contexts varies within a community of HCAN speakers in Toronto. This paper showed evidence for the lowering of /i:/ and /u:/ in pre-velar contexts across the speech community. This is an allophonic pattern consistent with previous descriptions of Cantonese. This paper also showed the emergence of a sex-based split found among GEN 2 speakers with females generally showing changes that follow the CVS and with males showing increasing differentiation based on phonetic context. These very different patterns of change illustrate what can be possible within a HL speech community in which the second generation of speakers have all had early exposure to the phonological systems of two different languages. Accounting for the changes that are realized and how they are socially patterned in HLs would be a ripe area for fruitful research in variationist sociolinguistics.

Finally, this study also has several limitations that could be addressed in future work. First of all, the set of speakers examined could be increased. Only three GEN 2 male speakers were analyzed. These speakers ranged in age from 21 to 44 while the GEN 2 female speakers ranged in age from 16 to 20. There is no overlap in age which raises the question of whether the observed differences are due to sex or due to different age cohorts. The type of words examined is also limited. In this study, all pre-velar rime groups were collapsed into one group. It is uncertain whether or not there is a significant difference between [k] and [ŋ] in terms of phonetic conditioning effects. Thus, future research could look at both more speakers and more token types to confirm the general patterns observed reported in this paper.

In spite of the limitations of this study, the results presented still show many opportunities for future work on HCAN and more generally on HLs within a variationist framework. Adopting a variationist approach has shown the potential for variation in HL speaker phonology to be tied to social organization. It also complements the large existing literature on vowel variation in English by showing that vowel variation in a non-Indo-European language can also provide valuable insights about the workings of the interface between structure and social factors in language change. At the same time, it also complicates existing scholarship on vowel variation and change by showing how it is possible to have such radically different patterns of change within the same speech community. Yet, this only emphasizes the importance of future work on a greater variety of languages spoken in a greater variety of social settings such as in a HL context. It also underscores the importance of investigating all languages spoken within a particular multilingual community. Speakers may not necessarily be doing the same thing in each language they speak. The fact that they are not adds a new dimension to variationist research on language and identity.

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