The Effects of Length of Residence (LOR) on L2 English Phonology

Donald White
The Chinese University of Hong Kong
donaldtimothywhite@gmail.com

ABSTRACT

This study is a phonetic investigation of six Cantonese L1-English L2 students living in English-speaking countries. The students were recorded three times during their first year abroad: before immigration, at six months, and at one year. Phonetic details from the three recordings have been measured and compared. Preliminary results suggest gradual but significant phonological reorganization during their first year after immigration. Suprasegmental modifications include increases in speech rate, a higher durational variability for vowels, and a lower global vocalic content in utterances. Segmental modifications include a widening distinction between /iː/ and /ɪ/, and, among the students studying in North America, a propensity for replacing word-medial /t^h/ with alveolar flaps. Taken together, these findings can broaden understanding of L2 phonological development, and the ways in which isolated phonetic modifications contribute to global foreign accent.

Keywords: L2 Phonology, Length of Residence, Speech Rhythm

1. INTRODUCTION

This study is an ongoing phonetic investigation of six Hong Kong students acquiring English as a second language (L2). These students are currently studying abroad in English-speaking countries (Canada (4), U.S.A. (1), and Australia (1)), and the first language (L1) of all six is Cantonese. The broad focus of these case studies is the effect that length of residence (LOR) has on the L2 English pronunciation of each student. In the present study, the main areas of focus are speech rhythm, the distinction between English /iː/ and /ɪ/, and the alveolar flap of North American English. In most of these areas, there are contrasts between the phonology of Hong Kong English and that of the countries to which the students immigrated. It is expected, therefore, that a close examination of these three aspects will reveal subtle acoustic differences between the students' English before leaving Hong Kong, and their English after a year abroad. Although several studies have investigated LOR previously, most of these have been cross-sectional; longitudinal studies have been far less common. The present study will provide details of how L2 accents evolve after immigration, when the target L2 becomes the ambient language.

2. PREVIOUS RESEARCH INTO LOR

It is widely accepted that the speech production of immigrant L2 learners is influenced by the quality and quantity of language input they receive. As a result, perceived foreign accent (FA) among L2 speakers tends to be correlated inversely with these two factors. While the quality of L2 input is difficult to measure precisely, the quantity of L2 input is often related to two variables. The first, LOR, quantifies the time spent in an environment where the ambient language is also the target language of the L2 speaker. The second, age of arrival (AOA), is the age at which the learner begins living in his/her new country.

Many researchers have hypothesized that a reduced foreign accent should correlate with a lower AOA and a higher LOR; however, in many studies to date, the effects of LOR and AOA have been difficult to separate. These variables tend to confound each other because the beginning of residence in a new country often coincides with the date that an L2 speaker is first exposed to her second language [17]. Consequently, a number of previous studies have investigated LOR and AOA simultaneously. The picture that has emerged from the results of these studies is not entirely clear. Some have found a stronger inverse correlation between a reduced FA and AOA [2, 24]; others have found that LOR has a stronger effect [19, 21]; others still have found a combined effect from both factors [1, 18].

Flege's work in this area has been substantial, including [9, 10, 11, 12]. Several of his studies have found that in immigrants with an arrival age greater than 12, the effects of LOR are limited to an initial burst during the first year after immigration [9, 10]. This prediction has been borne out by other studies such as [19] and [20].

The studies mentioned thus far have one methodological commonality: the FA judgements, in every case, were made by native language speakers. More recently, examinations of LOR and AO have begun to investigate specific acoustic correlates of

FA [13, 23].

2.1. Pronunciation differences in Hong Kong English

Like [13] and [23], the present investigation is concerned with the phonetic correlates of FA among Cantonese L1 learners of English. There are three specific areas of focus: the durational measurements of speech rhythm, the formant frequencies of /iː/ and /ɪ/, and the acoustic correlates of the flap allophone that replaces word-medial /t/ in many varieties of North American English.

Speech Rhythm- Stress-timed languages such as English have three defining characteristics: stressed syllables, reduced syllables, and more complexity in allowable syllables [6]. Conversely, syllable-timed languages such as Cantonese have lower levels of these three variables. Several studies have attempted to quantify speech rhythm using durational speech rhythm metrics. These metrics measure the durational variability of syllables (PVI-S, Varco S), vowels (PVI-V, Varco V), and consonants (PVI-C, Varco V) in a given utterance; in addition global vocalic proportion of utterances, is measured with percent V (%V) [7, 8, 14, 16, 23]. For the variability metrics, more durational variability (akin to stress-timing) results in higher scores (for %V, vice versa). Although the efficacy of these metrics has been subject to considerable criticism, one area in which they seem to be effective is the measurement of individual development over time [26], meaning that they could be useful to gauge L2 speech rhythm development [13].

An additional relevant correlate of speech rhythm is speech rate, which is measured by the number of syllables per second.

Close Front Vowels- The distinction between English /iː/ and /ɪ/ is elusive for many Cantonese L1 speakers [5]. This is likely due to negative phonological transfer: in Cantonese, these two vowels are allophones in complementary distribution [4]. As a result, the F1 and F2 values in /iː/ and /ɪ/ tend to be much closer in Hong Kong English than in native-English varieties.

Flapping- Similar to British English, word-medial /t/ before an unstressed syllable is realized as /t^h/ in Hong Kong English. In most accents of North America, however, /t/ in this context is realized as an alveolar flap, /ɾ/. There are clear spectrographic differences between these phones: /t^h/ has a clear break in voicing during its burst, and obvious aspiration, but /ɾ/ contains voicing throughout and has no aspiration.

2.2. Predictions of the present study

The present study predicts that during their first year abroad, the six students will exhibit some degree of phonetic change, manifested in the three areas detailed in section 2.2. Specifically, there are three main predictions: (1) durational variability scores and speech rates will increase, and %V scores will decrease; (2) the F1 and F2 frequencies for /iː/ and /ɪ/ will become more distinct; (3) for the students in North America, there will be a higher amount of flapping for word-medial /t/.

3. METHODOLOGY

The data in this study come from six Hong Kong students currently studying abroad in secondary school and/or university (see Table 1). All of these students attended the same secondary school in Hong Kong, so they had received similar instruction in English up until the time that they emigrated. Although the ages of the students varied at the time of emigration, all of them began studies for university preparation when they arrived in their new cities, including secondary and post-secondary. In the present study, therefore, it is expected that two factors will maximally separate the effects of LOR and AOA: the similar arrival ages of the students at immigration, and the parallel L2 experience of the students prior to departure.

Table 1: Participant Details

Student	AOA	Destination
CANGIRL1	17;9	Toronto, Canada
CANBOY1	17;11	Toronto, Canada
AUSBOY1	20;6	Sydney, Australia
CANBOY2	18;5	Comox, BC, Canada
CANGIRL2	17;10	Toronto, Canada
USAGIRL1	16;7	Wausau, WI, USA

3.1. Recordings

Students were recorded in a variety of quiet locations in Hong Kong, Canada, and the United States using a Zoom H2 recorder, with digital sampling at 44.1 Hz. Each student was recorded three times: before emigration (R1), approximately six months after immigration (R2), and approximately one year after immigration (R3). (For AUSBOY 1, R2 and R3 were three months and nine months after immigration, respectively.)

Three types of data were collected in the recordings: read passages, read word tokens in identical carrier sentences, and informal conversation.

3.2. Data Analysis

For the measurements of speech rhythm, read passages were probed for utterances of five syllables or longer occurring within the same breath group, and containing no pauses or stumbles. For an utterance to be suitable for analysis, all of the criteria above had to have been met for the same utterance in R1, R2, and R3. This method entailed that the utterances and the number of utterances varied from student to student; however, for a single student, the exact utterances were compared in the three different recordings.

Utterances were segmented in the Praat software [3] according to the following rules: (1) utterance initial stops were not included unless they were preceded by a word in the same breath group; (2) breath-group-final syllables were excluded due to final-syllable lengthening; (3) because syllabic segmentation is often a judgment call, this study roughly followed the Maximum Onset Principle [14], but with some room for subjective judgments.

The segments were also analysed in the Praat software [3]. F1 and F2 frequency values of /iː/ and /ɪ/ were taken at the midpoint of each vowel, and presence and degree of voicing was noted in the allophones of /t/.

4. RESULTS

Although some data has yet to be analysed, preliminary results suggest that all three predictions will be borne out to some degree. The results thus far will be discussed according to the areas specified in section 2.1.

4.1 Speech Rhythm

Thus far, the speech rhythm and speech rates of four students have been measured. Three students' scores changed significantly in some respect, with a variety of specific changes across students. Three students had significantly faster speech rates after one year abroad. Table 2 compares the mean speech rates for recordings 1 and 3. In each case, the rate of syllables per second is significantly higher (CANBOY1: $t(8) = -7.333$, $p < .001$; AUSBOY1- $t(12) = -5.495$, $p < .001$; CANGIRL1- $t(10) = -4.69$, $p = .001$).

Table 2: Mean Speech Rate (Syllables/second) (Standard Deviation (SD) in Parentheses)

Student	R1 (SD)	R3 (SD)
CANBOY 1	3.87 (.52)	5.44 (.65)
AUSBOY 1	4.88 (.69)	5.79 (.97)
CANGIRL 2	4.96 (.63)	5.54 (.84)

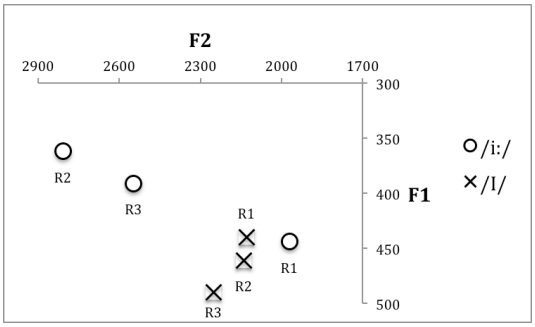
For the remainder of the speech rhythm metrics, the majority of significant differences were found in the vowel metrics. In comparisons between R1 and R3, CANBOY 1 and AUSBOY 1 both had significantly lower %V scores (CANBOY1: R1- M= 53.48, SD= 8.75; R3- M= 48.65, SD= 8.3; (8)t= 2.93, p= .019; AUSBOY1: R1- M= 52.93, SD= 5.34; R3- M= 46.72, SD= 5.96; (12) t=3.513, p= .004). CANGIRL 2's R3 %V (M= 45.23, SD = 5.92) was significantly lower than that of her R2 (M = 47.89, S.D.=5.89; (10)t=2.558, p=0.28). Additionally, AUSBOY 1's R3 score for vocalic PVI (normalized) (M= 62.16, S.D. = 15.62) was significantly higher than his R1 score (M= 55.81, S.D.= 19.03) (12)t=-2.851, p=.015), and his Varco V increased significantly after six months in Australia.

In contrast, the scores for CANGIRL1 did not have any significant changes. Her speech rate scores were around 4.5 syllables per second in all three recordings. Her other scores remained relatively stable and did not trend in any obvious direction.

4.2 Comparison of /iː/ and /ɪ/

CANGIRL 2's formant results, shown in Figure 1, affirm the prediction in 2.2. In R1, CANGIRL 1 had very similar F1 and F2 values for these two vowels. After six months in Canada, however, both values separated significantly (F1: $t(9) = -4.366$, $p = .002$; F2: $t(9) = 10.066$, $p < .001$), and they remained separated in R3 (F1: $t(9) = -4.551$, $p = .001$; F2: $t(9) = 9.229$, $p < .001$). Additionally, it appears that this separation is not the result of the formant values moving away from each other. Most of the change is in the /iː/ vowel, whose R1 values are significantly different from those in R2, (F1: $t(9) = 5.423$, $p < .001$; F2: $t(9) = -3.767$, $p = .004$). The same is not true for the /ɪ/ vowel. Data from the other five students are currently being analysed to determine whether their patterns are similar to CANGIRL 2.

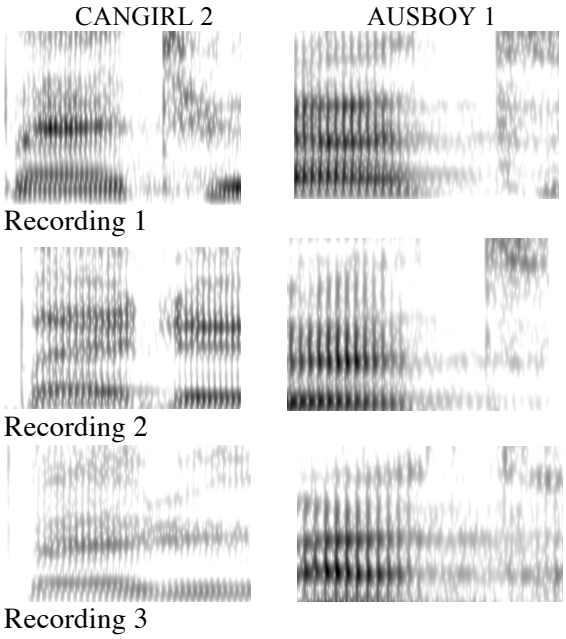
Figure 1: Formant values for /iː/ and /ɪ/ CANGIRL 2



4.3 Flapping

Figure 2 shows spectrograms for the word medial /t/ of "better" as spoken by CANGIRL 2 and AUSBOY1 in each of the three recordings.

Figure 2: Spectrograms for "better"



Both CANGIRL 2 and AUSBOY 1 have aspirated /t/ before they leave Hong Kong. After six months away, their articulations have begun to diverge. The student in Australia retains aspiration, but the Canadian student does not. Instead, CANGIRL 2's articulation is similar to /d/ in this instance. Her tendency toward North American flap continues in the third recording. In her spectrogram, there is continuous, heavy voicing through the /t/ segment, and scant evidence of closure. In contrast, AUSBOY 1's articulation is largely the same in the third spectrogram as in the other two. This is the pattern predicted by the present study. A number of tokens follow this pattern for these two students, and data from the other students is currently being analysed to corroborate these findings.

5. DISCUSSION

The study described above employs a novel approach for gauging the effects of LOR. The preliminary results align well with previous findings, which found that a reduction in FA takes place during the first year after immigration [9, 10, 19, 20]. The results for both speech rhythm and vowel data suggest that the vocalic constituents of the data have undergone significant changes in many cases. With respect to the speech rhythm results, it is noteworthy that the majority of significant differences were found in the vocalic metrics. According to [26], which is a critical survey of the rhythm metrics, %V is the most reliable measurement, especially when used in conjunction with vocalic PVI and/or Varco V. If this assessment is correct, it lends credence to the preliminary findings reported above. While the speech rhythm metrics are undoubtedly controversial, their use in the present study follows guidelines recommended by [26], and the scores that reflect changes are thought to be the most reliable.

The preliminary formant measurements are an additional indication that the vocalic segments underwent modification during the first year after immigration. There are clear acoustical differences between the /iː/ vowels of CANGIRL 2 prior to immigration, and those at the 6-month and one-year marks. These results are similar to [19], which found that immigrants improved the intelligibility of their L2 English vowels during their first year living in Canada.

Finally, there are preliminary indications that word-medial /t/ is also affected by increased LOR. The spectrographic evidence suggests that the allophonic path followed by two of the students is influenced by the accent of the ambient English in the countries to which they immigrated.

On the whole, these preliminary findings suggest that all three areas contain measurable differences in the L2 English of the students during their first year abroad.

6. CONCLUSION

This longitudinal investigation has found a number of probable effects of LOR on the L2 English of Cantonese L1 students living abroad. Several of these students seem to modify their L2 phonology in subtle but discernable ways. The present study has investigated speech rhythm, vowel formants, and allophonic variation of /t/. To varying degrees, it appears that three out of four students were affected by the ambient language during their first year abroad.

7. REFERENCES

[1] Asher, J., Garcia, R. 1969. The optimal age to learn a foreign language. *The Modern Language Journal*, 53, 334-341.

[2] Baker, W., Trofimovich, P. 2006. Perceptual paths to accurate production of L2 vowels: The role of individual differences. *International Review of Applied Linguistics in Language Teaching*, 44, 231–250.

[3] Boersma, P., Weenink, D. 2014. Praat: doing phonetics by computer [Computer program]. Version 5.4.04, retrieved 28 December 2014 from http://www.praat.org/

[4] Bauer, R., Benedict, P., 1997. *Modern Cantonese Phonology*. de Gruyter: Berlin.

[5] Chan, A. Y. W., Li, D. C. S. 2000. English and Cantonese phonology in contrast: Explaining Cantonese ESL learners' English pronunciation problems. *Language, Culture and Curriculum, 13*, 337-356.

[6] Dauer, R. M. 1983. Stress-timing and syllable-timing reanalyzed. *Journal of Phonetics*, 11, 51-62.

[7] Deterding, D. 2001. The measurement of rhythm: A comparison of Singapore and British English. *Journal of Phonetics, 29*, 217-230.

[8] Dellwo, V. 2006. Rhythm and speech rate: A variation coefficient for ΔC. In P. Karnowski, I. Szigeti (eds.), *Language and language processing*. Frankfurt am Main: Peter Lang, 231-241.

[9] Flege, J. E. 1988. Factors affecting degree of perceived foreign accent in English sentences. *Journal of the Acoustical Society of America*, 84, 70–79.

[10] Flege, J. E., Munro, M. J., MacKay, I. R. A. 1995. Factors affecting strength of perceived foreign accent in a second language. *Journal of the Acoustical Society of America,* 97, 3125–3134.

[11] Flege, J. E., Bohn, O.-S., Jang, S. 1997. Effects of experience on non-native speakers' production and perception of English vowels. *Journal of Phonetics*, 25, 437–470.

[12] Flege, J. E., Yeni-Komshian, G., Liu, H. 1999. Age constraints on second language acquisition. *Journal of Memory and Language*, 41, 78–104.

[13] Jang, T. Y. 2008. Speech rhythm metrics for automatic scoring of English speech by Korean EFL learners. *Malsori (Speech Sounds) The Korean Society of Phonetic Sciences and Speech Technology*, 66, 41–59.

[14] Kahn, M. 1976. *Borrowing and regional variation in a phonological description of Kurdish*. Ann Arbor, Michigan: Phonetics Laboratory of the University of Michigan.

[15] Low, E., Grabe, E., Nolan, F. 2000. Quantitative characterisations of speech rhythm: 'syllable-timing' in Singapore English'. *Language and Speech, 43*, 377-401.

[16] Mok, P., Dellwo, V. 2008. Comparing native and non-native speech rhythm using acoustic rhythmic measures: Cantonese, Beijing Mandarin and English. *4th Conference on Speech Prosody,* Campinas, Brazil. 423-426.

[17] Moyer, A. 2009. Input as a critical means to an end: quantity and quality of experience in L2 phonological attainment. In Piske, T., Young-Scholten, M. (eds.), *Input Matters in SLA*. Bristol: Multilingual Matters, 159-174.

[18] Moyer, A. 2011. An investigation of experience in L2 phonology: Does quality matter more than quantity? *The Canadian Modern Language Review*, 67, 191-216.

[19] Munro, M., Derwing, T. 2008. Segmental acquisition in adult ESL learners: a longitudinal study of vowel production. *Language Learning*, 58, 479-502.

[20] Munro, M., Derwing, T. 2013. The development of L2 oral language skills in two L1 groups: a 7-year study. *Language Learning*, 63, 163-185.

[21] Purcell, E. T., Suter, R. W. 1980. Predictors of pronunciation accuracy: a reexamination, *Language Learning*, 30, 271-287.

[22] Ramus, F., Nespor, M., Mehler, J. 1999. Correlates of linguistic rhythm in the speech signal. *Cognition, 73*, 265-292.

[23] Saito, K., Brajot, F-X. 2013. Scrutinizing the role of length of residence and age of acquisition in the language pronunciation development of English /r/ by late Japanese bilinguals. *Bilingualism: Language and Cognition*, 16, 847-863.

[24] Thompson, I. (1984). Experimental study of foreign accents. *Unpublished Ph.D. Thesis,* George Washington University.

[25] White, L., Mattys, S. L. 2007. Calibrating rhythm: First language and second language studies. *Journal of Phonetics, 35*, 501-522.

[26] Wiget, L., White, L., Schuppler, B., Grenon, I., Rauch, O., Mattys, S. 2010. How stable are acoustic metrics of contrastive speech rhythm? *Journal of the Acoustical Society of America, 127*, 1559-1569.