Chang, D., & Weng, C. (2013). Late ESL learners' difficulties of distinction between lax and tense vowels. In J. Levis & K. LeVelle (Eds.). *Proceedings of the 4th Pronunciation in Second Language Learning and Teaching Conference.* Aug. 2012. (pp. 129-139). Ames , IA: Iowa State University.

LATE ESL LEARNERS' DIFFICULTIES OF DISTINCTION BETWEEN LAX AND TENSE VOWELS

Daniel Chang, Simon Fraser University

Calvin Weng, Simon Fraser University

The present research is to analyze the production of English lax and tense vowels by early learners of English and late learners of English (namely, Early Bilinguals and Late Bilinguals). According to Flege, Munro, and McKay's research in 1995, they discovered that Italian speakers who arrived in Canada late tended to have a noticeable foreign accent in English, whereas early Italian arrivals in Canada performed better at English pronunciation tasks. This suggests that older second language learners may have more difficulties in pronouncing native-like sounds in speech. Therefore, given that acoustic cues of vowels varied by the formant frequencies and perceived by speakers, it is likely to conclude that age of acquisition (AOA) might be the important factor that prohibits language learners to perceive, distinguish, and produce these formant frequencies correctly.

The present paper intends to analyze the speech of six Chinese Canadian English speakers differed by age of arrival in Canada. We created a reading task which contains 135 randomized one-syllable English words, purposefully mixed with lax and tense vowels. Preliminary results have shown that the Late Bilinguals are more likely to mispronounce lax and tense vowels in English than the Early Bilinguals. Therefore, the results taken from the present research have several pedagogical values, which intend to help prospective ESL educators to consider integrating pronunciation teaching in the curriculum design.

INTRODUCTION

Infants were found to have the language-general mechanism in perceiving all the sounds in the world (Best, McRoberts, & Sithole, 1988). However, by the end of the sixth month, the infants have started to pay attention to and acquired the sounds in their first language (L1), implying that they have begun to lose the ability to perceive all the sounds other than their native language (Best & MacRoberts, 2003; Werker, Gilbert, Humphrey, & Tees, 1981). Based on Lenneberg's *Critical Period Hypothesis* (1967), such inability to perceive the non-native sound contrasts was due to the loss of neural plasticity in the brain, suggesting that human beings might not achieve native-like proficiency in an L2 if the learning takes place after the critical period. According to the critical period account from Lenneberg, subsequent research has focused extensively on how age of acquisition (AOA) (Babcock, Stowe, Maloof, Brovetto, & Ullman, 2012; Best & Tyler, 2007; Birdsong, 1992, 2006; Flege, 1988, 1995; Gut, 2010; Palmer & Havelka, 2010; Piske, MacKay, & Flege, 2001; So, 2006), length of residence (LOR) (Babcock et al., 2012; Bardovi-Harlig & Bastos, 2011; Birdsong, 1992, 2006; Flege et al., 2006, 1997, 1999; Piske et al., 2001) and L1 interference (Best & Tyler, 2007; Flege et al., 2006; Picard, 2002; So, 2006) have influenced the quality of L2 learning.

Effects of Age of Acquisition (AOA) on ultimate L2 learning have been consistently reported in the literature. Studies have shown that AOA can predict the degree of foreign accent (Flege, Munro, & MacKay, 1995; Flege et al., 1999; Jia, Strange, Wu, Collado, & Guan, 2006; Piske et al., 2001), the accuracy of morphosyntatic judgement (Birdsong, 1992, 2006; Birdsong & Molis, 2001; Johnson & Newport, 1989), and the learnability of vocabulary words (Birdsong, 1992; Izura et al., 2011; Kato, 2005; Palmer & Havelka, 2010). For example, Flege et al. (1995) discovered that early L1Italian/L2 English bilinguals in Canada tend to have more native-like English accent, whereas the late bilinguals' production of English has been judged to contain a noticeable foreign accent. This has suggested that age of acquisition of L2 is negatively correlated with the degree of perceived foreign accent and that older learners of L2 may face more difficulties in pronouncing non-native contrasts. Furthermore, Johnson & Newport (1989) examined a group of Chinese and Korean ESL learners' accuracy on grammatical judgement. Their results indicate a strong negative correlation between AOA and the accuracy of grammatical judgement. Similarly, Palmer & Havelka (2010) found out that L2 learners' speed of recognition is faster at the words which they acquired at an earlier stage. However, in Birdsong (2006)'s review of past studies on AOA and second language attainment, he has concluded that research on the effect of AOA and early bilinguals' L2 ultimate attainment were likely inconsistent due to various definitions of AOA. For instance, in a replication of Johnson & Newport (1989)'s research, after splitting the subjects into two groups with age of 16 as the cut-off line, Birdsong & Molis (2001) found out that the correlation between age and scores is not statistically significant for the early L2 learners, whereas, the relationship between the two variables is negative for the late L2 learners.

In Second Language Acquisition (SLA) research, studies have discovered that the length of stay in the target-L2-speaking country influences L2 production and perception (Bardovi-Harlig & Bastos, 2011; Best & Tyler, 2007; Flege, 1988, 1995; Gut, 2010; Jia et al., 2006; Lai, 2010; So, 2006; Sun & Heuven, 2007; Wang & Munro, 2004). For instance, in Flege et al. (2006)'s study, 155 native Korean listeners, grouped into early arrivals (6-14 years old) and late arrivals (21-38 years old), were asked to produce 8 English sentences at two different points of their residence. Study results have indicated that the late arrivals were rated as possessing a stronger foreign accent than the early arrivals; however, the early arrivals' production of English was rated lower than the native English counterparts. This findings seem to go against previous studies that report an effect of early AOA on native-like L2 learning because the finding have suggested that the early arrivals still speak English with an accent when compared to the native-born English-speaking children. Flege et al. (2006) has attributed this phenomenon to the amount of L2 exposure which the children had received compared to the adults.

Similarly, one's native language may interfere with the L2 ultimate production. Studies have shown an effect of native language on the L2 vowel production (Flege et al., 2006, 1997; Jia et al., 2006; Sun & Heuven, 2007; Wang & Munro, 2004) and prosody (Gut, 2010; Nava & Zubizarreta, 2009; Rasier & Hiligsmann, 2007; So, 2006). For instance, Jia et al. (2006) studied three groups of native Mandarin speakers with various amount of English exposure: 91 native Mandarin speakers in China and 131 native Mandarin-speaking immigrants in the United States. For the immigrant group, 131 immigrants were sub-divided into two groups with past arrivals (LOR 3-5 years) and recent arrivals (< 2 years). All participants were asked to perform an AXB discrimination task, containing pairs of English vowels, and were asked to imitate eight English vowels. Results showed that the older native Mandarin speakers in China have more accurate scores of discrimination and imitation, while the immigrant groups register no effect of age on discrimination and imitation. Their findings have also shown the influence of Mandarin phonology on the discrimination and production of English vowels, in which, for example, /ɛ/ and /æ/ were found to be the most difficult pair of discrimination. For imitation, /ʌ/ and /ɑ/ were confusing for the Mandarin speakers as well. These results point to two important implications: one is that AOA and LOR both mutually influence L2 learning, and the other is that L2 performance is perceptually affected by the experience of L1. In the same manner, Nava & Zubizarreta (2009) have uncovered that L1 Spanish/L2 English adult learners are more likely to transfer their L1 Spanish prosody in pronouncing L2 English sentences. Results have indicated that new L1 Spanish/L2 English learners tend to preserve their L1 Spanish prosodic behaviors in reading L2 English sentences. Nevertheless, with the increase in the amount of L2 English exposure and in their L2 English proficiency, the Spanish speakers have exhibited prosodic modification, suggesting that there is a positive interference coming from Spanish to the acquisition of English prosody. As reviewed above, adult L2 learners may have difficulty achieving native-like L2 oral proficiency because research findings have revealed that adult L2 learners always speak with a noticeable accent, perceptually influenced by the phonology from their native language (Flege et al., 1995), the age that they acquired the L2 (Flege et al., 1999), or the amount of L2 exposure (Flege, 1988) in an immersion setting.

Regarding to the influence of L1on L2 perceptual learning, two dominant theoretical accounts have been established to explain the perceptual error patterns made by L2 learners: *Perceptual Assimilation Model (PAM)* (Best, 1995) and *Speech Learning Model(SLM)* (Flege et al., 1995). PAM proposes that L2 learners tend to perceive the non-native segments based on the similarities and dissimilarities to the native L1 phonetic inventory. This model predicts that perceptual difficulty may arise from the articulatory assimilation of native and non-native segments. Secondly, SLM has attached more importance to the age-related issues in second language learning. Based on PAM, SLM predicts that the effect of age along with the experience of L1 may exert greater influences on L2 speech sound learning. That is, the spectral distance between L1 and L2 determines the formation of L2 sound categories. The difficulty to establish an L2 sound in one's mind is its similarity to the L1 phonetic inventory. If an L2 sound is perceived to be dissimilar to an L1 sound, then it will be more likely for a L2 speaker to establish a new sounding category and acquire the sound.

RATIONALE OF THE PRESENT RESEARCH AND RESEARCH QUESTIONS

As reviewed above, past studies along with these theoretical models have pointed to the implication that age of L2 acquisition (AOA) may determine the outcomes of L2 production, given that L2 learners are likely to make perceptual mistakes based on their L1 experience or the amount of L2 exposure. In a multilingual society, like Vancouver, bilingual speakers will be the group of interest in the area of SLA because upon immigration of the family, they were typically born in a bilingual setting, in which L1 and L2 exposure is simultaneous, yet L2 receives greater attention due to academic education while the L1 proficiency is still remained at a certain level. If the effect of age is salient, then it is likely that early bilingual children and late bilingual children will exhibit difference in their production of English. If this is the case, then the late bilinguals' difficulty in English production may arise from their L1 experience, in which some English vowels may be similar or dissimilar to their L1 phonetic inventory.

The following research questions are addressed, given the scope of this pilot research:

1. Are there differences in the English lax-tense vowels production among the bilinguals who differed in the age of L2 acquisition (AOA)?
2. If late L2 AOA predicts difficulty of production in L2, will L1 experience also exert negative influence on the vowel productions of L2?

METHOD

Participants

Six participants (2 males; 4 females) were selected for the present study. The mean age of the participants is 21.7 years old. They differed in the age of L2 acquisition (AOA), in which early bilinguals were defined coming to Canada before the age of 14 and having completed formal elementary education in Canada, whereas the late bilinguals coming to Canada after the age of 14 years old and completed their middle secondary education in Taiwan or in China (Flege et al., 1997). Regardless of AOA, all of our speakers were proficient bilinguals of Canadian English and Mandarin. However, proficiency level in both languages was not controlled because they were all college/university students at the point of this research experiment. It was assumed that their English proficiency should have reached a certain level in order to be admitted to the university. Table 1 shows the descriptive statistics for the six participants in the study.

Table 1

Summary of Six Participants

	Present Age	**AOA**	**Years of Schooling in Canada**
Mean	21.7	13	8.7
Standard Deviation	1.26	1.29	1.71
Range (Min; Max)	7 (19; 26)	8 (9; 17)	12 (4; 16)

Stimuli

We created a reading task stimulus that consisted of 135 randomized words. Table 1 shows the reading list that was distributed to our speakers. All the minimal papers were generated by the researchers with reference to an online English dictionary website. Five pairs of tense and lax vowel pair were categorized, such as [i-ɪ], [e-ɛ], [o-ɔ], [u-ʊ], and [a-æ] and ten random words with each vowel quality composed too, such as *sheep, meet* for */i/*, and *pit, ship* for */I/*. Twenty words per tense and lax vowel pairs were listed. In order to prevent speakers from fixating their pronunciation on recognizable monosyllabic words, twenty distracter words of /ʌ/ and bi-syllabic words were also included on the word list.

Table 2

Reading list distributed to the speakers; tense and lax vowels with distracter words

[i]	**[I]**	**[e]**	**[ɛ]**	**[o]**	**[ɔ]**	**[u]**	**[ʊ]**	**[a]**	**[æ]**	**[ʌ]**	**Distracter**
Bead	Kit	Cake	Egg	Old	Call	**Boot**	**Book**	Bob	Bat	but	about
Sheep	Pit	Mate	**Bet**	Boat	**Caught**	Mood	Put	Pot	Mat	Hut	Account
Peach	Pig	Date	Shed	sold	Mall	Shoot	foot	Hot	Mad	Hum	Upon
Meat	Myth	**Bait**	Met	Go	Cause	Choose	Look	Cot	Fat	Luck	Written
Deed	**Did**	Fate	Get	Told	Bought	Goose	Could	Tom	Fad	Stuff	Pause
Feed	Shit	Bake	Pet	**Coat**	Doll	Too	Good	Lot	App	Cuff	Dance
Read	Bit	Gate	Fed	Foe	Ball	Noob	Wood	Rod	Rat	Shut	But
Geek	Zit	Hate	Med	Choke	Chalk	Cool	Would	Lost	Pat	Bud	Con
Beat	Bid	Shame	Let	Mote	Fault	Soup	Cook	Boss	Hap	Dump	Stand
Sea	Sit	Nate	Set	Dote	doggy	Suit	Push	Shot	**Nat**	Study	Firm
See	Tit	Rate	Yet	Goat	Fog	Root	Butch	**Not**	Sad	Such	Fur
Cheat											Umbrella

Procedure and Data Collection

To make sure sound files are free from unnecessary noises, all of our experiments were conducted in quiet locations like library study room, or house basements. The reading task was recorded with a Logitech headset (a microphone included) connected to an ACER laptop. Wavesurfer freeware software was used as the recording device as well as the formant analysis tool for this study, because the researchers were taught to use this program in an undergraduate Phonetics training.

Upon setting up the computer and the recording device, the reading word list in paper format was placed in front of each participant. A sound testing run was performed beforehand to ensure the equipment and the microphone were fully functional. Each participant was then asked to read the word list out loud to the microphone, and was also asked to articulate clearly and slowly to avoid any possible atypical speaking rate.

Analysis

There are two stages of the analyses. On completion of the recordings gathered from the six participants, a vowel formant analysis was conducted using Wavesurfer. The built-in function within WaveSurfer's LPC and formant plot was used to determine the values of F1, F2, and F3 manually. Measurements of F1, F2, and F3 were the midpoint of the vowels, subjectively determined by the researchers. Only the underscored words shown on Table 1 were analyzed, as these words or word pairs were the minimal pairs which were commonly-seen words. Each participant has a F1, F2, and F3 value for each word that they produced. Then, the mean scores of F1, F2, and F3 extracted from each word produced by each participant were calculated.

In order to see if there is a group difference in the production of these vowel pairs, an independent sample t-test was conducted using SPSS. The independent variable is defined as Group (Early Bilinguals, Late Bilinguals), and the dependent variables are the F1 value and the F2 value extracted from each word. F3 values are excluded because only F1 and F2 determine the height and the backness of the vowel space.

RESULTS

Figure 1 showed the overall word-by-word comparisons of formant frequencies from Early Bilinguals and Late Bilinguals. It can be generally seen that two groups produce the lax and tense vowels (e.g. [ɛ] and [e]) quite distinctively. For instance, Early Bilinguals produce the pair of "Bet" and "Bait" with distinctive F1 and F2 formant frequencies, whereas Late Bilinguals have the tendency of producing identical F1 and F2 formant frequencies. Furthermore, in the case of the front vowels (e.g. [ɛ] [e] [i] [ɪ]), Early Bilinguals have distinctive F1 and F2 values, while Early Bilinguals seem to produce close-to identical F1 values and "somehow-varied" F2 values. However, because the two figures do not really display whether a group difference exists in the production of each word with respect to F1 and F2 values, a statistical analysis was conducted using the independent-sample t test.

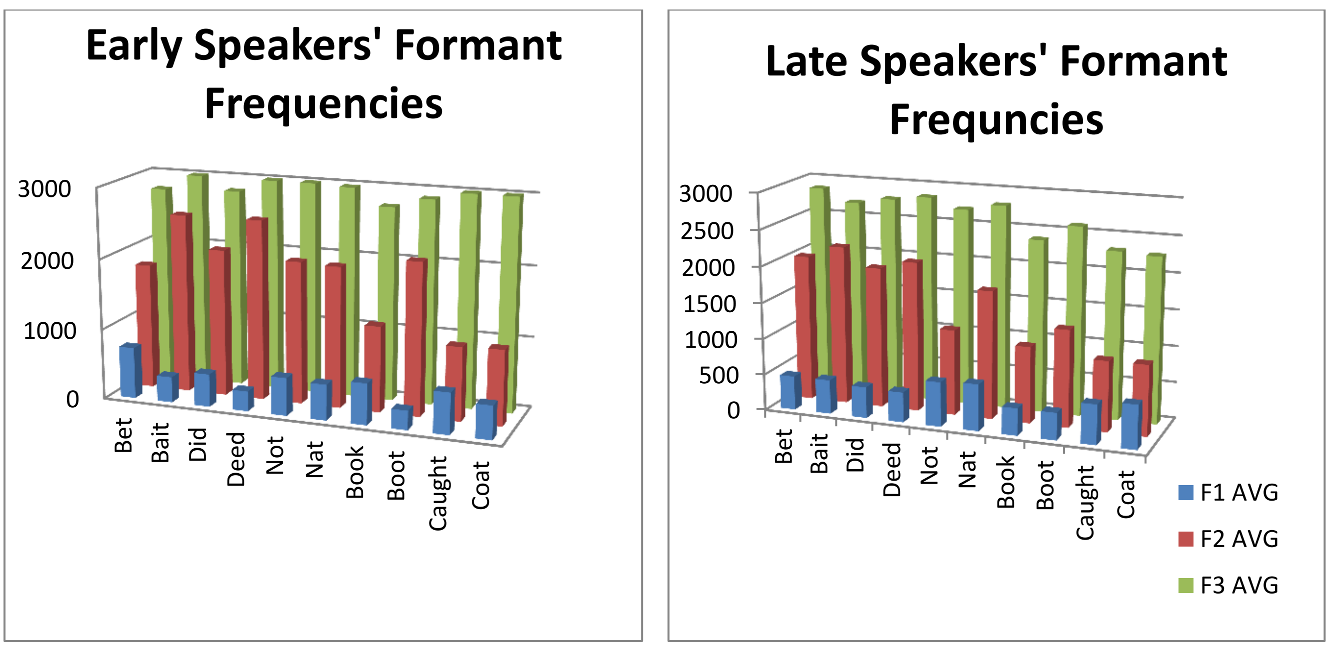

Figure 1. Overall comparison of F1, F2, and F3from early bilinguals and late bilinguals

The results from an independent-sample t-test, conducted to compare each word's vowel production by two groups (Early Bilinguals and Late Bilinguals), are displayed in Table 3 below. For the vowel [ɛ, e, ɪ, a, æ, ʊ], there was no significant difference in the F1 and F2 values for Early Bilinguals and Late Bilinguals

However, for the vowel [i], there was a significant difference in the F1 values for Early Bilinguals and Late Bilinguals; $t(4)=-2.879$, $p=0.045$ ($p<0.05$), but no significant difference in the F2 values for Early Bilinguals and Late Bilinguals was found; $t(4)=2.193$, $p=0.093$($p>0.05$).

Furthermore, For the vowel [ɔ], although there was no significant difference in the F1 values between Early Bilinguals and Late Bilinguals for the vowel [ɔ], $t(4)=0.104$, $p= 0.922$ ($p>0.05$), a significant difference in the F2 values was found, $t(4)=4.867$, $p= 0.008$ ($p<0.05$). Similarly, for the vowel [o], there was a significant difference in the F1 values for Early Bilinguals and Late Bilinguals; $t(4)=-3.006$, $p= 0.04$ ($p<0.05$), yet no significant difference in the F2 values for Early Bilinguals and late Bilinguals was found; $t(2.1)= 1.177$, $p=0.358$ ($p>0.05$).

For the vowel [u], there was no significant difference in the F1 values for Early Bilinguals and Late Bilinguals; $t(4)=-1.191$, $p= 0.299$($p>0.05$), yet a significant difference in the F2 values for Early Bilinguals and late Bilinguals was found; $t(4)=3.352$, $p= 0.029$ ($p<0.05$).

Table 3

Descriptive Statistics and Independent t-test

Test Word	Group	F1 Mean (SD)	F2 Mean (SD)	t-value for F1	t-value for F2
Bet	EB	763 (135)	1873 (324)	2.423	-0.734
	LB	483 (147)	2016 (92)		
Bait	EB	340 (74)	2748 (731)	-1.524	1.439
	LB	484 (146)	2133 (104)		
Deed	EB	306 (55.8)	2698 (549)	-2.879*	2.193
	LB	413 (32.1)	1940 (238)		
Did	EB	484 (52)	2213 (444)	1.874	1.174
	LB	421 (27)	1859 (275)		
Not	EB	529 (32)	1745 (927)	-1.582	1.050
	LB	594 (63)	1179 (105)		
Nat	EB	479 (94)	1802 (667)	-2.186	0.594
	LB	614 (53)	1535 (400)		
Caught	EB	559 (94)	1049 (16)	0.104	4.867*
	LB	551 (101)	960 (27)		
Coat	EB	483 (17)	1167 (279)	-3.006*	1.177
	LB	584 (55)	976 (31)		
Boot	EB	310 (111)	2170 (25)	-1.191	3.352*
	LB	410 (94)	1444 (374)		
Book	EB	631 (144)	1255 (140)	2.219	1.983
	LB	410 (95)	1075 (72)		

*indicates p<.05; *SD indicates Standard Deviation

DISCUSSION

The main purpose of the present study is to examine whether there is an effect of early age of English acquisition on English lax-and-tense vowel productions. Although the results in the present study are not statistically significant, they are still worth further discussion, which may motivate further research on such issues with respect to bilingualism.

Production

Due to the sample size, the independent-sample t-test does not yield any significant results on the group differences of F1 and F2 values for all words, with only a few exceptions on "Deed", "Caught", "Coat", and "Boot". For instance, there is a significant group difference in the F1 values for the word "Deed", suggesting that Early Bilinguals and Late Bilinguals produce this word with a distinctive height spectral distance in the vowel space. Interestingly, for the words "Coat" and "Caught", there is a group difference in the F2 values for "Caught" and the F1 values for "Coat". Because "Caught" and "Coat" are both back vowels, it would be expected that there is no group difference in the F2 values for these two words. However, the present result shows a group difference of F2 values of "Caught", suggesting that either (1) the Late Bilinguals exhibit backness confusion for the word "Caught" or (2) the Early Bilinguals have a Canadian way of pronouncing "Caught", which is different from the way that the Late Bilinguals were taught to pronounce. The former interpretation suggests that the Late Bilinguals may have been confused with the pronunciation of "Caught" and "Coat" with respect to the spectral space. The latter interpretation, however, needs further investigation because there is no way to control for the L2 learning environment of the subjects, and lacks convincing evidence to attribute the result to a sociolinguistic factor without any qualitative data. Lastly, for the word "Boot", there is a group significance in the F2 value, suggesting that the Late Bilinguals may have been confused with the backness of the vowel [u] and [ʊ]. Therefore, this may motivate further research on the effect of L2 vowel learning experience (or L2 vowel exposure) on the ultimate L2 vowel productions. Although the present results only yield limited statistical significance, it can be seen that, from Figure 1, when these words are paired up with respect to their spectral distance, Late Bilinguals tend to be confused while producing each pair (e.g. the F1 for both "Bait" and "Bet"). Thus, consistent with previous studies that have found a younger-AOA advantage of English vowel productions (Jia et al., 2006), we anticipate that early AOA may facilitate more native-like vowel formant frequencies.

Regarding why there is a group difference in producing the lax and tense English vowels, past studies have found the influence of additional English experience on the productions of between-category vowels. From Flege et al. (1997)'s study, they have found that an additional experience with English (regardless L1 background) facilitates more native-like productions of vowel [I]. If we define the Early Bilinguals as the experienced subjects whereas the Late Bilinguals as the inexperienced ones, then we may conclude that an early additional English exposure may lead to more native-like productions of English vowels. However, we cannot make a firm conclusion at this point because of a limitation in our study where we lack of native English-speaking control groups, and do not have the vowel productions rated by native English judges.

A Possible Link between Perception and Production

Previous research has found an effect of native language background on the perception (mis-perception) of an L2, based on Perceptual Assimilation Model (Jia et al., 2006; Sun & Heuven, 2007). In the present study, all participants are native speakers of Mandarin, so it would be expected that they will make use of their Mandarin experience on acquiring the English vowels. From the production data, it can be seen that the Late Bilinguals tend to have difficulty of producing the target-like lax vowels with a correct spectral vowel distance. This may suggest two research areas for further research: (1) because the lax vowels in the English do not existent in Mandarin phonology, the Late Bilinguals may have the difficulty of perceiving such differences (even with extensive exposure to the L2 in the immersion setting) because they tend to assimilate the lax-vowel category in English to the tense-vowel category in Mandarin. Therefore, the acquisition of the lax vowels in English may be unsuccessful due to the inability to perceive the differences. (2) In what period of early AOAs will it predict a more successful native-like perception of English as well as native-like production? The latter point may require a regression analysis on two factors: AOA and Perception (or Production) scores of English.

In sum, in the present study, two research questions are addressed: (1) Are there differences in the English lax-tense vowels production among the bilinguals who differed in the age of L2 acquisition (AOA)? (2) If late L2 AOA predicts difficulty of production in L2, will L1 experience also exert negative influence on the vowel productions of L2?

With respect to the former question, the descriptive statistics, outlined in Figure 1 and Table 2, have shown that there are indeed group differences between the Early Bilinguals and the Late Bilinguals' production of lax and tense vowels, but the tokens obtained from the study do not lead to a statistical analysis. Therefore, this question will be left open for further investigation. Regarding the latter question, if we regard the Early Bilinguals' productions as the baseline, the Late Bilinguals' productions of vowels are different, suggesting possible difficulty in producing the lax-and-tense vowel distinction. However, to firmly conclude such claim, a native L1-English speaking control needs to be provided.

Limitations

A major limitation from the present study is lack of the control for proficiency of the two languages in both groups, as differed proficiency in either language might have affected the L2 production. For instance, it is possible that learners with more proficient Mandarin may exhibit higher possibility of producing non-native-like English words. Furthermore, the reading list provided to the participants was chosen arbitrary; thus, it would have been ideal if a previously-established reading list has been used, so that the vowel measurements could have been yielded a better control. Lastly, the sample size in the current study is small, so the generalizability of the results is quite limited. It would have been better if future research could extend the scope of the present research in order to establish a firm conclusion. Thirdly, a rating task could have been included in order to show whether an effect of confusion occurs while the Late Bilinguals were asked to produce these vowels; furthermore, this would have allowed us to create a confusion matrix to investigate the rate of vowel confusion.

CONCLUSIONS

The present research examined whether there is an effect of early age of English acquisition on English lax-and-tense vowel productions. Descriptive statistical results have shown a possible pattern of assimilation between the lax vowels and the tense vowels by late Mandarin-English speakers. Early Mandarin-English speakers, however, may possess the advantage for producing such vowel distinctions. Since the present study only selects 5 minimal pairs of lax-and-tense vowels (as indicated in Table 2) for analysis, the rest of words will be analyzed when we record the productions from native English speakers. Therefore, these results not only motivate further research on the link between L2 perception and L2 production but also add pedagogical values for ESL teachers in pronunciation teaching.

ABOUT THE AUTHORS

Daniel Chang has a BA in Linguistics from Simon Fraser University. He continues his MA at SFU too in hoping to learn more about second language acquisition. His research interest includes Second Language Phonetics and TESL Curriculum Design.

Calvin Weng has a BA in Linguistics from Simon Fraser University. He is now continuing his TESL certification at SFU in hoping to motivate his students to learn English as their second language.

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