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Production of the English "sh" by L2 Thai Learners: An Acoustic Study

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***Abstract*—L2 sound production might vary in accordance with factors such as the vowel context and L2 experience held. This study investigates the production of the English "sh" by L2 Thai learners via acoustic analysis. The target sounds in this study were those in the initial position in three vowel contexts: high, low and back. The data were drawn from 48 subjects who were Thai undergraduate students. This sample was divided between two groups: high-experienced and low-experienced. All read the stimuli with the target sound in a carrier phrase. From this, their production was acoustically analysed with six acoustic measurements; duration, peak location, centroid, SD, skewness and kurtosis. The findings show that the English /ʃ/ produced by the high-experienced group was different from the English [ʃ] produced by the low-experienced group in many acoustic measurements. Furthermore, the English [ʃ] produced by the low-experienced group was found not to be different from the Thai [tɕʰ] in many acoustic aspects. These findings suggest that L2 experience supports L2 speech production. They also showed the effect of vowel context in relation to peak location and duration, as suggests the consideration of vowel context in the teaching of the L2 speech sounds.**

***Index Terms*—English "sh", Thai, English, vowel context, acoustic, experience**

I. Introduction

In the learning of the L2 sound, there are four influential models – the Contrastive Analysis Hypothesis (CAH) (Lado, 1957), the Speech Learning Model (SLM) (Flege, 1995), the Perceptual Assimilation Model-L2 (PAM-L2) (Best & Tyler, 2007) and the Second-Language Linguistic Perception (L2LP) Model (Escudero, 2005). CAH has been developed to account for L2 production and perception, while SLM aims to explain changes across a life span in L2 speech perception with a linkage to production, PAM-L2 seeks to account for the perception of non-native sounds by L2 listeners in L2 natural settings. Finally, L2LP is a new model that focuses on accounting for L2 sound perception at all stages of learning. All models are similar in that they agree that the learning of L2 sound is filtered via the native language (L1) of L2 learners.

In this regard, not only does an individual's L1 tend to influence L2 sound learning, but also L2 experience is influential here (e.g., Baker & Trofimovich, 2006; Flege et al., 1997). For example, in the study of Kitikanan (2017), the perceptual assimilation of English fricatives by L2 Thai learners was investigated. The findings showed that vowel context and L2 experience affected the perceived similarities of both shared and non-shared sounds. Kitikanan (2020a), as also considered the perceptual assimilation of British English monophthongs by L2 Thai learners, found that high-experienced and low-experienced groups had different assimilation patterns for the English /æ, iː, uː, ɒ/. The findings of these studies suggest that L2 experience should be taken into account when exploring L2 sound production.

Aside from L2 experience, vowel context is also found to be important in the production of L2 consonant sounds. Notably, L2 learners might find some vowel contexts more difficult to learn than other vowel contexts (e.g., Hardison, 2003; Kitikanan, 2016; Schmidt, 1996). For example, Schmidt (1996) had 20 Korean subjects listening to English consonant sounds at the initial position in three vowel contexts. This group also judged the level of similarity between English consonants and Korean consonants on a scale of 1 to 5. The results highlight that the rating scores of the English /m, n, j, p, t, k, h/ were greater in low and high vowel contexts and lower in the back vowel context, suggesting that the lip rounding of vowels hinders the perception of L2 consonant sounds.

The investigation of L2 speech production is not easy, namely as there are many factors shown to affect production. For instance, as noted by Flege (1987), it is difficult to interpret age effect in L2 speech exploration as the age of learning is often found to be related to other factors influencing L2 sound production. Although there are many studies on L2 sound production which have considered a diversity of factors (e.g., Baker, 2008; Flege, 1991), to the best of our knowledge the relative importance of vowel context, L2 experience and L1 impact on L2 sound production is not yet known. Thus, the present study is the first of its kind on this topic.

Acoustic analysis is a well-known method through which to explore sound production as it provides insight as to the characteristics of speech sound which might not be perceivable via an impressionistic study (Kitikanan, 2016). This present study is a continuation of that provided by Huang (2020) as to the production of the English /tʃ/ and /ʃ/ in an

initial position by L2 Thai learners via an impressionistic study. In that earlier study, two English native speakers with phonetic transcribing experience judged the production of English [ʃ]. It was found that learners with high-experience and low-experience demonstrated an accurate production (of over 90%) as to the English [ʃ] across the vowel contexts. This suggests that those learners had encountered success in learning L2 sounds that do not exist in their native phonological inventory, seemingly indicating a lack of influence of L2 experience and vowel context. This present study aims to find out whether this presupposition is true. If such a statement has veracity, the L2 learners – regardless of their level of L2 experience and the vowel context – should produce the acoustic characteristics of the English [ʃ] in contrast to those of the Thai [tɕʰ] as these two sounds are different when compared phonemically. The specific research question held here is: To what extent are the L2 speech sounds produced by the L2 Thai learners affected by their L1, their L2 experience and the vowel context? This study seeks to provide insight as to the learning of the L2 English /ʃ/ by Thai learners using acoustic measurements.

II. Review of Literature

A. English /ʃ/ and Thai /tɕʰ/

The English /ʃ/ is produced with the blade of the tongue raising towards the alveolar ridge or the hard palate, as is more backward and articulated with a larger air channel than for /s or z/ and as is produced with lip protruding (Aslaksrud & Haarberg, 1967). When producing the English /ʃ/, the area of turbulence is wider (more grooved than /s/) (Strevens, 1960). Whereas the English /ʃ/ is fricative, the Thai /tɕʰ/ is affricate (Kitikanan, 2020b). To be specific, the Thai /tɕʰ/ is a voiceless aspirated alveolo-palatal affricate. When producing this sound, the lips are spread rather than protruding as in the production of the English /ʃ/. In the initial position, L2 Thai learners tend to replace the English /ʃ/ with the Thai /tɕʰ/ (Kanokpermpoon, 2007), such as producing 'shoe' as /tɕʰuː/.

B. Acoustic Study as to the Production of the English /ʃ/ by L2 Thai Learners

In regards to the acoustic study of the production of the English /ʃ/ by L2 Thai learners, only two studies have been found. The first, as carried out by Roengpitya (2011), investigated the acoustic properties of the L2 English /ʃ/ in initial, intervocalic and final positions. The words were produced by three female Thai subjects. Each production was measured with seven acoustic measurements; amplitude at three temporal points (onset, duration, offset), fricative duration, vowel duration, fundamental frequency of voiced fricatives, voicing duration (if any), fundamental frequency of vowels and formant frequencies of the adjacent vowels (onset, mid duration, offset). However, as noted by Kitikanan (2016), no statistical analysis was undertaken to identify the difference between L1 Thai and L2 English fricatives nor was the environment of the vowel context controlled.

The second study, as carried out by Kitikanan (2016), studied the acoustic characteristics of the L2 English [ʃ] as opposed to L1 English [ʃ] produced by British native speakers of English. Here, the effects of the speakers' sex and the vowel context were explored. It was found that, for the production of females, there were two possibilities as to the interpretation; 1) that the L2 English [ʃ] was more fronted than the native English [ʃ] and 2) that the L2 English [ʃ] was more retracted than the native English [ʃ]. In the production of males, the L2 English [ʃ] was produced with higher effort than the native English [ʃ]. The vowel context was also found to affect the L2 English [ʃ] production. In the high and low vowel contexts, there were two possibilities as to the interpretation; 1) that the L2 English [ʃ] is more fronted than the native English [ʃ] and 2) that the L2 English [ʃ] is more retracted than the native English [ʃ]. Additionally, in the high vowel context of the production of males, the L2 English [ʃ] is more fronted than the native English [ʃ]. Nevertheless, the exploration of the L2 English [ʃ] in Kitikanan's study is different from that undertaken in this present study as the former compared the production of the L2 English [ʃ] with that of the L1 English [ʃ] while this study compares the production of the L2 English [ʃ] with the L1 Thai [tɕʰ].

III. Methodology

A. Subjects

In this study, the 48 subjects were Thai students at Naresuan University. This sample was divided into two groups; a high-experienced group and low-experienced group. The high-experienced group's studies comprised an English-language major whereas the low-experienced group's studies related to Food Science and Technology. Each group contained 24 students. The subjects had studied English in a Thai context. The low-experienced group had only been exposed to English via an English module which was positioned among other courses. The high-experienced group had studied many modules in English – including modules in Linguistics and Literature. However, outside of the English module(s) studied, all subjects used Thai in their daily lives. In addition, all were female and none reported having disorders in their speech or hearing. These subjects were the same subjects as in the study of Huang (2020).

B. Stimuli

The stimuli in this study consisted of 18 words (9 Thai words and 9 English words). The target sounds, the English [ʃ] and the Thai [tɕʰ], were in the initial position. The words were in three different vowel contexts; high, low and back. Each vowel context had three words. For the Thai words, these were: /tɕʰiː/, /tɕʰîːp/, /tɕʰíː/, /tɕʰâːt/, /tɕʰáː/, /tɕʰaː/, /tɕʰuː/,

/tɕʰúː/, /tɕʰúːt/. For the English words, there were 9 which started with the English [ʃ] as the initial consonant sound; 'she', 'sheet', 'sheep', 'sharp', 'shark', 'shack', 'shoot', 'should' and 'shoe'.

C. Data Collection

Each subject sat in a soundproofed meeting room and read the stimuli presented on a laptop screen. The English stimuli were read via the carrier phrase 'Say____again', whereas the Thai stimuli were read via the phrase /oːkʰeː_____ìːk. kʰráŋ/ 'Okay____again.' Each stimulus was articulated five times. The entire process for each subject to produce words in phrases had a duration of 15 minutes. This research study received ethical approval from the Naresuan University Institutional Review Board (COA No. 112/2019 and IRB No. 0096/62).

D. Acoustic Analyses

Acoustic analysis was undertaken through the facilitation of Praat 6.0.23 (Boersma & Weenink, 2019). The realisations of the L2 English [ʃ] and the L1 Thai [tɕʰ] were only the target-like ones from the study of Huang (2020). In segmenting the target sounds and vowels, both waveform and spectrogram were considered. The starting point of the target sounds and vowels was the onset of an increase in the frication noise amplitude in the waveform. The final point of the target sound was decided at the offset of the frication noise. The final point of the vowel was the onset of the following vowel in the carrier speech. The segmentations were made using a Praat script written by Al-Tamimi (Al-Tamimi & Khattab, 2015). Six acoustic measurements were utilised for the English [ʃ] and Thai [tɕʰ] – duration, peak location, centroid, standard deviation (SD), skewness and kurtosis. The production of the target sounds followed the interpretation of the English [ʃ] in the study of Kitikanan (2016). Hence, the interpretations of each acoustic characteristic were as follows:

Duration: high for fricatives and low for affricates (Repp et al., 1978).
Peak location and centroid: high for more fronted (Jongman et al., 2000) fricatives.
SD: high for non-sibilant (Jongman et al., 2000) fricatives.
Skewness: high for more retracted (Jongman et al., 2000) fricatives.
Kurtosis: high for sibilant (Jongman et al., 2000) fricatives.

E. Statistical Analysis

The number of target-like realisations was 3,093 (1,080 realisations for the L1 Thai [tɕʰ] and 2,013 realisations for the L2 English [ʃ]). To explore the acoustic properties of the target sounds, linear mixed models were carried out using the *lme4* package in *R* statistical software (Bates et al., 2015). The independent variables were vowel context (high vowel, low vowel and back vowel) and the language experience of the L2 learners (high-experienced and low-experienced). The dependent variables were the acoustic characteristics. The optimal model was selected by comparing the model with two-way interaction to the model with no interaction of the two factors using the *anova* function. Where there was significant difference found between the two models, the model with the smaller Akaike Information Criterion was chosen (Zheng et al., 2014). Where there was no significant difference between the two models, the model with no interaction was chosen as it was understood to be simpler. Tukey's HSD post-hoc tests using *emmeans* package in *R* statistical software *(*Lenth et al., 2021) were used to find significant difference between the language pairs.

IV. Results

Three groups of the target sounds – the English [ʃ] produced by the high-experienced and low-experienced groups and the Thai [tɕʰ] – were compared in three vowel contexts; high, low and back. The results are below separated into six parts in accordance with the acoustic characteristics of duration, peak location, centroid, SD, skewness and kurtosis.

A. Duration

Tukey's HSD post-hoc test indicates that in the high vowel context, the duration of the English /ʃ/ produced by the high-experienced group was significantly higher than that produced by the low-experienced group (b = 14.65, SE = 2.64, df = 2725.51, t = 5.56, $p < 0.01$) and of the Thai [tɕʰ] (b = 21.82, SE = 2.18, df = 3078.66, t = 9.99, $p < 0.01$). In the same vowel context, the duration of the English [ʃ] produced by the low-experienced group was significantly higher than that of the Thai [tɕʰ] (b = 7.17, SE = 2.18, df = 3085.39, t = 3.29, $p < 0.05$). In the low vowel context, the duration of the English [ʃ] produced by the high-experienced group (b = 25.62, SE = 2.18, df = 3078.85, t = 11.74, $p < 0.01$) and the low-experienced group (b = 23.60, SE = 2.18, df = 3086.56, t = 10.81, $p < 0.01$) were significantly higher than that of the Thai [tɕʰ]. Similarly, in the back vowel context, the duration of the English [ʃ] produced by the high-experienced group (b = 27.83, SE = 2.18, df = 3079.36, t = 12.77, $p < 0.01$) and the low-experienced group (b = 20.84, SE = 2.18, df = 3083.13, t = 9.57, $p < 0.01$) were significantly higher than that of the Thai [tɕʰ]. These results suggest that in the high vowel context, the English [ʃ] produced by the high-experienced group was the most fricative-like, with this being followed by the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ], respectively. The findings also suggest that in the low and back vowel contexts, the English [ʃ] produced by the high-experienced and low-experienced groups were more fricative-like than the Thai [tɕʰ]. The means of the duration recorded for [ʃ] and [tɕʰ] according to the group x vowel context from pairwise comparison based on LMM are presented in Figure 1.

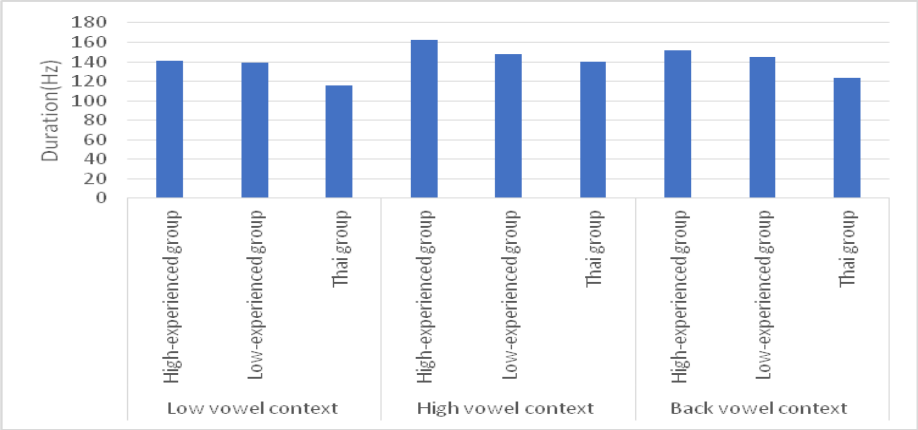

Figure 1. Means of the Duration Recorded for [ʃ] and [tɕʰ] According to the Group x Vowel Context From Pairwise Comparison Based on LMM

B. Peak Location

Tukey's HSD post-hoc test shows that in the high vowel context, the peak location of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -964.57, SE = 206.51, df = 2517.13, t = -4.67, $p < 0.01$) and of the Thai [tɕʰ] (b = -919.42, SE = 171.93, df = 3048.28, t = -5.35, $p < 0.01$). Similarly, in the low vowel context, the peak location of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -1197.00, SE = 207.16, df = 2530.27, t = -5.78, $p < 0.01$) and of the Thai [tɕʰ] (b = -1380.67, SE = 171.80, df = 3048.63, t = -8.04, $p < 0.01$). In the back vowel context, the peak location of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -874.99, SE = 206.46, df = 2510.09, t = -4.24, $p < 0.01$). These results suggest that in the high and low vowel contexts, the English [ʃ] produced by the high-experienced group was less fronted than the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ]. The findings also suggest that in the back vowel context, the English [ʃ] produced by the high-experienced group was less fronted than the English [ʃ] produced by the low-experienced group. The means of the peak location recorded for [ʃ] and [tɕʰ] according to the group x vowel context from pairwise comparison based on LMM are presented in Figure 2.

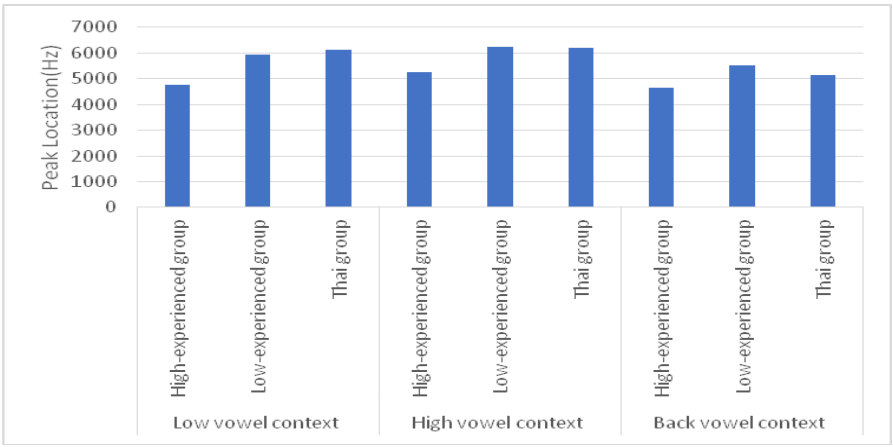

Figure 2. Means of the Peak Location Recorded for [ʃ] and [tɕʰ] According to the Group x Vowel Context From Pairwise Comparison Based on LMM

C. Centroid

Tukey's HSD post-hoc test indicates that in the high vowel context, the centroid of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -1152.92, SE = 96.73, df = 3074.01, t = -11.92, $p < 0.01$) and of the Thai [tɕʰ] (b = -1058.30, SE = 79.37, df = 3097.84, t = -13.33, $p < 0.01$). In the same way, in the low vowel context, the centroid of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -1254.52, SE = 97.01, df = 3075.41, t = -12.93, $p < 0.01$) and of the Thai [tɕʰ] (b = -1438.40, SE = 79.31, df = 3097.81, t = -18.14, $p < 0.01$). Similarly, in the back vowel context, the centroid of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -974.68, SE = 96.73, df = 3073.26, t = -10.08, $p < 0.01$) and of the Thai [tɕʰ] (b = -732.72, SE = 79.18, df = 3097.72, t = -9.25, $p < 0.01$). These results suggest that across the vowel contexts, the English [ʃ] produced by the high-experienced group was less fronted than the English [ʃ] produced by the

low-experienced group and the Thai [tɕʰ]. The means of the centroid recorded for [ʃ] and [tɕʰ] according to the group x vowel context from pairwise comparison based on LMM are showed in Figure 3.

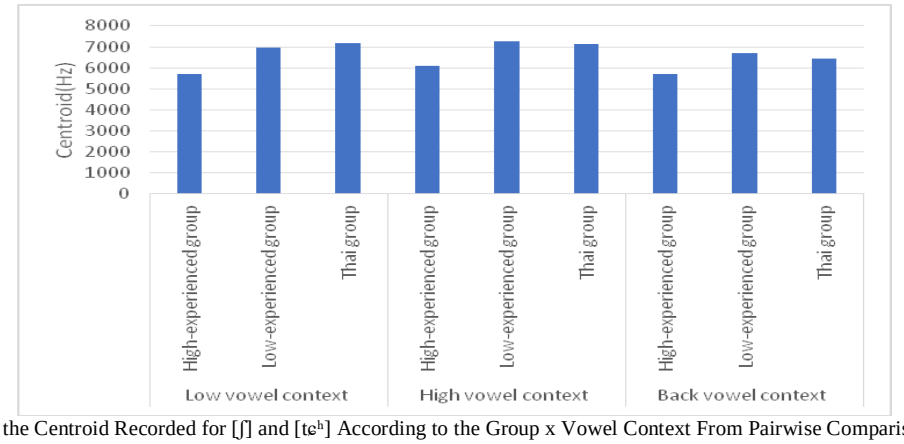

Figure 3. Means of the Centroid Recorded for [ʃ] and [tɕʰ] According to the Group x Vowel Context From Pairwise Comparison Based on LMM

D. SD

Tukey's HSD post-hoc test indicates that the SD of the English [ʃ] produced by the high-experienced group was significantly lower than that produced by the low-experienced group (b = -512.20, SE = 37.12, df = 2587.66, t = -13.80, $p < 0.01$) and that of the Thai [tɕʰ] (b = -520.39, SE = 26.85, df = 2990.62, t = -19.38, $p < 0.01$). These results suggest that the English [ʃ] produced by the high-experienced group was more sibilant than the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ]. Figure 4 shows the means of SD recorded for [ʃ] and [tɕʰ] according to different language groups based on LMM.

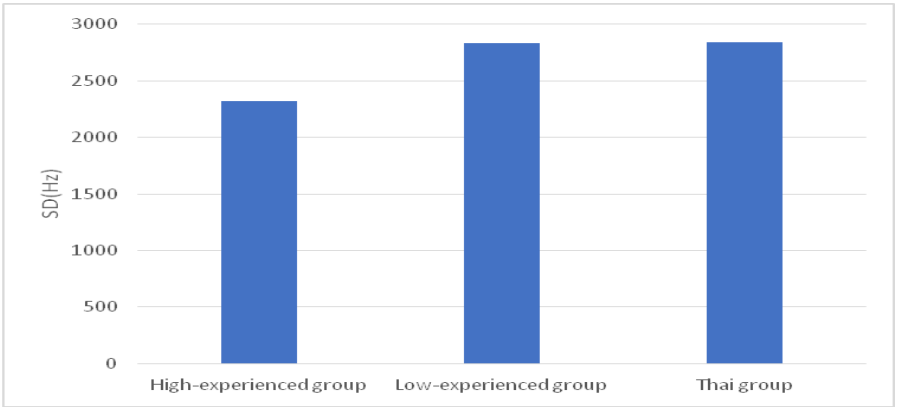

Figure 4. Means of the SD Recorded for [ʃ] and [tɕʰ] According to Different Language Groups Based on LMM

E. Skewness

Tukey's HSD post-hoc test indicates that in the high vowel context, the skewness of the English [ʃ] produced by the high-experienced group was significantly higher than that produced by the low-experienced group (b = 0.81, SE = 0.07, df = 2978.36, t = 10.96, $p < 0.01$) and that of the Thai [tɕʰ] (b = 0.76, SE = 0.06, df = 3100.42, t = 12.59, $p < 0.01$). In the same way, in the low vowel context, the skewness of the English [ʃ] produced by the high-experienced group was significantly higher than that produced by the low-experienced group (b = 0.83, SE = 0.07, df = 2982.62, t = 11.30, $p < 0.01$) and that of the Thai [tɕʰ] (b = 0.90, SE = 0.06, df = 3100.44, t = 14.78, $p < 0.01$). Similarly, in the back vowel context, the skewness of the English [ʃ] produced by the high-experienced group was significantly higher than that produced by the low-experienced group (b = 0.71, SE = 0.07, df = 2976.09, t = 9.66, $p < 0.01$) and of the Thai [tɕʰ] (b = 0.58, SE = 0.06, df = 3100.49, t = 9.60, $p < 0.01$). These results suggest that across the vowel contexts, the English [ʃ] produced by the high-experienced group is less fronted than the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ]. Figure 5 illustrates the means of skewness recorded for [ʃ] and [tɕʰ] according to the group x vowel context from pairwise comparison based on LMM.

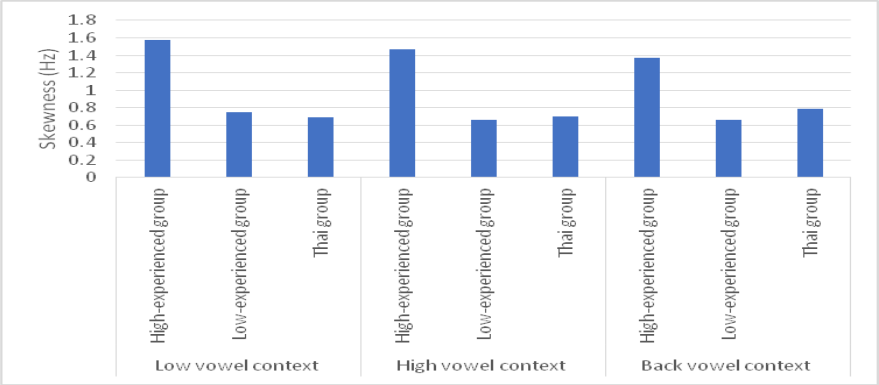

Figure 5. Means of the Skewness Recorded for [ʃ] and [tɕʰ] According to the Group x Vowel Context From Pairwise Comparison Based on LMM

F. Kurtosis

Tukey's HSD post-hoc test indicates that the kurtosis of the English [ʃ] produced by the high-experienced group was significantly higher than that produced by the low-experienced group (b = 2.42, SE = 0.30, df = 1751.34, t = 8.20, $p < 0.01$) and of the Thai [tɕʰ] (b = 2.89, SE = 0.22, df = 2630.01, t = 13.33 $p < 0.01$). These results suggest that the English [ʃ] produced by the high-experienced group was more sibilant than the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ]. The means of the kurtosis recorded for [ʃ] and [tɕʰ] according to different language groups based on LMM are presented in Figure 6. Additionally, Table 1 presents a summary of the acoustic measurements used and the interpretations derived.

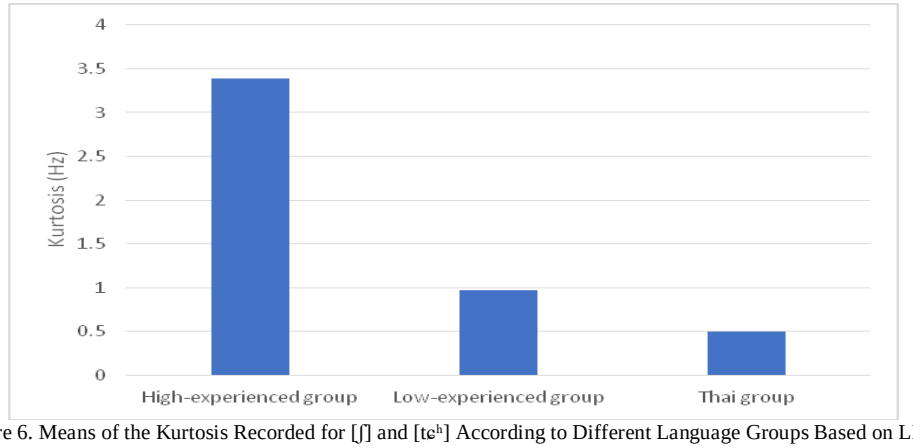

Figure 6. Means of the Kurtosis Recorded for [ʃ] and [tɕʰ] According to Different Language Groups Based on LMM

TABLE 1
SUMMARY OF THE ACOUSTIC MEASUREMENTS USED AND THE INTERPRETATIONS DERIVED

Measurement	Vowel Context	Difference	Interpretation
Peak Location	High & Low	High < Low & Thai	High = less fronted than Low & Thai
	Back	High < Low	High = less fronted than Low
Centroid	All	High < Low & Thai	High = less fronted than Low & Thai
Skewness		High > Low & Thai	
SD	All	High < Low & Thai	High = more sibilant than Low & Thai
Kurtosis		High > Low & Thai	
Duration	High	High > Low > Thai	High = most fricative-like
	Low & Back	High & Low > Thai	High & Low = more fricative-like than Thai

Note: The first column denotes the measurement used. The second column sets out the vowel context. For this column, 'High' is the high vowel context, 'Back' is the back vowel context, 'Low' is the low vowel context and 'All' is all vowel contexts. The third column details the significant differences found in each pair of language group. For this column, 'High' is the English [ʃ] produced by the learners with high experience of the L2; 'Low' is the English [ʃ] produced by the learners with low experience of the L2 and 'Thai' is the Thai [tɕʰ]. The last column provides the interpretation derived.

V. DISCUSSION AND CONCLUSION

Overall, the English [ʃ] produced by the high-experienced group was different from the English [ʃ] produced by the low-experienced group in many acoustic measurements – including peak location, centroid, skewness, SD, kurtosis and duration in the high vowel context. Furthermore, the English [ʃ] produced by the low-experienced group was found not

to be different from the Thai [tɕʰ] in many acoustic aspects – including centroid, skewness, SD and kurtosis across the vowel contexts, and peak location in the high and low vowel contexts. The findings as to the peak location recorded in the high and low vowel contexts and spectral moments across contexts show that that the English [ʃ] produced by the high-experienced group was less fronted and more sibilant than the one produced by the low-experienced group. The results also demonstrate that these acoustic measurements in these contexts between the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ] were not significantly different. This suggests that the L2 learners with a high exposure to their L2 can decrease the negative influence of their native language when pronouncing L2 sounds. In other words, L2 experience has a positive effect upon L2 speech production. This implication is consistent with the findings produced in studies as to the positive effect of L2 experience on L2 sound learning (e.g., Baker, 2008; Flege et al., 1997; Kitikanan, 2017). The assumption that the learning of L2 speech sounds is filtered by a learner's L1 (Best & Tyler, 2007; Escudero, 2005; Flege, 1995; Lado, 1957) is supported only in the findings as to the low-experienced group in the above measurements. The findings of the high-experienced group in these acoustic measurements seem to advocate the SLM's last hypothesis – that bilinguals will be able to produce native-like L2 sounds eventually. This is because many of the acoustic characteristics of the English [ʃ] produced by the high-experienced group were different from the Thai [tɕʰ]. However, this presupposition requires further investigation.

As the findings show significant difference between the English [ʃ] produced by the high-experienced group and the English [ʃ] produced by the low-experienced group, and no significant difference between the English [ʃ] produced by the low-experienced group and the Thai [tɕʰ], these are contrastive to those findings presented in Huang (2020). The findings from the earlier impressionistic analysis undertaken as to the same realisations transcribed by two native speakers of British English showed that both groups of learners had over 90% accuracy in the production of the English [ʃ] in all vowel contexts. This suggests that both groups of L2 learners had no difficulty producing the English [ʃ]. However, the findings of our study suggest that, in many acoustic measurements, the English [ʃ] produced by the low-experienced group was influenced by the Thai /tɕʰ/ unlike with the English [ʃ] produced by the high-experienced group. These findings imply that such acoustic measurements can provide insight as to L2 speech realisations beyond the perceptions of humans.

The findings of this study also show the effect of vowel contexts towards the learning of L2 sounds. This is supported by the findings recorded as to peak location and duration. In the peak location recorded, the production of the English [ʃ] produced by the high-experienced group was found to be less fronted than that produced by the low-experienced group and the Thai [tɕʰ] in the high and low vowel contexts. However, in the back vowel context, the English [ʃ] produced by the high-experienced group was found to be less fronted than the low-experienced group whereas there was no significant difference between the Thai [tɕʰ] and the English [ʃ] produced by the two groups of learners. In regards to the duration recorded, in the high vowel context, the English [ʃ] produced by the high-experienced group was found to be the most fricative-like among three groups. In contrast, in the low and back vowel contexts, the English [ʃ] produced by the two groups of learners was found to be more fricative-like than the Thai [tɕʰ]. These findings suggest the influence of the vowel context in L2 speech learning as pointed out in a number of studies (e.g., Hardison, 2003; Kitikanan, 2016; Schmidt, 1996). In the teaching of L2 sounds, teachers might take vowel context into consideration when designing teaching materials. For example, in the teaching of the English [ʃ] as L2, the target sound might be presented in high, low and back vowel contexts to expose the learner to the target sound in distinct vowel contexts.

There are three limitations of this study. Firstly, this study did not investigate the production of the English [ʃ] produced by native speakers of English. Addressing the production of sound by native speakers of the L2 under consideration could help to determine the extent to which L2 learners are successful in producing the L2 sound in question. This would answer the last hypothesis in SLM – that an L2 sound will be produced with phonetic characteristics that are similar to the phonetic qualities of the L2 sound produced by L2 native speakers. Secondly, this study only explored six acoustic measurements, yet others are available in studying the production of fricatives – such as F2 frequency (Jongman et al., 2000). Exploring more acoustic properties might result in greater insight as to the aspects of the English [ʃ] produced by both groups of learners. It is possible that the English [ʃ] produced by L2 learners, regardless of their L2 experience, shall be different from the Thai [tɕʰ]. Lastly, the subjects in this study were L2 Thai learners. When the English /ʃ/ is produced by L2 learners of other linguistic backgrounds, the results might differ – for example, in showing the influence of the vowel context in all acoustic characteristics.

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