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# AN ACOUSTIC INVESTIGATION OF THE PRODUCTION OF ENGLISH /s/ BY L2 THAI LEARNERS

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## ABSTRACT

In the field of second language (L2) production, phonetic investigations of L2 fricatives are rare due to the complexity of establishing similarities and differences between L1 and L2 fricatives. The study of English /s/ production by L2 Thai learners has not received much attention, as researchers on L2 English have typically believed that learners would produce this sound with ease due to the positive influence from /s/ in their L1 Thai sound system. In this study, /s/ production in three language groups - L1 English, L1 Thai and L2 English was acoustically compared as a function of gender and three vowel contexts. Findings showed that the acoustic characteristics of L1 Thai /s/ were different from its L1 English counterparts in many speakers and vowel contexts, and that L2 English /s/ production was different from either, suggesting that L2 Thai learners use different strategies for their /s/ production in English and Thai.

**Keywords:** L2 production, fricatives, Thai, acoustic investigation, crosslinguistic comparison

## 1. INTRODUCTION

In earlier theories of L2 production such as the Contrastive Analysis Hypothesis (CAH), L2 learners were assumed to have no difficulty producing an L2 sound which also existed in their L1 sound system [8]. However, in current theories such as the Speech Learning Model (SLM), it is believed that L2 sounds that also exist in the L1 sound system of the L2 learners are difficult to learn [3]. Among the investigations of L2 learners' productions, comparisons of L2 learners' production are usually made with those of native speakers of L2, but not of the L1. In this study, L2 English /s/ was selected for this investigation as it occurs in both L1 Thai and L1 English so is usually ignored by researchers working on Thai, due to the assumption that it poses no problem for L2 learners [5, 12]. While it may sometimes be difficult to discern any differences in the auditory impression of the 'same' fricative in two languages [6], an investigation of the detailed

acoustic implementation of these fricatives might reveal subtle language-specific patterns of realisation. In terms of phonetic studies, only one study by Roengpitya [11] has investigated English /s/ production by Thai learners using acoustic analysis, with no clear conclusion as to the extent to which the production of this sound was similar to L1 English /s/. Hence it is worth carrying out a more in-depth study on L2 English /s/.

## 2. METHODS

### 2.1 Speakers

Target English words with initial /s/ were produced by 20 native British English speakers (ten males and ten females) from various regional backgrounds to reflect the actual L2 environment for the Thai learners in this study (university environment). Target Thai words with initial /s/ were produced by 20 native Thai speakers (ten males and ten females) who had lived in the UK for less than 10 months to minimise the L2 influence. In addition, target /s/ - initial English words were produced by 50 Thai learners of English (27 females and 23 males). The L2 Thai participants had been studying at a higher education institution in the UK and had learned English as a foreign language for several years back in Thailand.

### 2.2 Stimuli

The stimuli for this study come from a larger project on L2 fricative production in which seven English fricatives (/f, v, θ, ð, s, z, ʃ/) in initial position were elicited from native English and Thai learners. Thai stimuli were word lists with fricatives /f, s/ in initial position (Thai only has three fricatives; the third one, /h/, was not investigated in the large project [6]). For /s/, the targeted fricatives were followed by three groups of vowels: front high, front low, and back mid to low, such as 'see', 'sad', 'sought' for English and /sii/ 'color', /sàat/ 'mat', /süu/ 'you' for Thai.

### 2.3 Data collection

Speakers were recorded in a sound-proof room in the laboratory while reading words in carrier sentences displayed on a computer screen. For the English stimuli, speakers produced the words in the context of 'Say \_\_\_ again' whereas in Thai stimuli, the sentence '/oo.k<sup>h</sup>ee \_\_\_ iik.k<sup>h</sup>rán/' 'Okay \_\_\_ again' was used. Each target word was repeated three times in a random order across the task.

### 2.4 Acoustic analyses

The acoustic measurements were made using Praat 5.3.63 [2]. Well-known acoustic measurements for fricatives, spectral moments (centroid, SD, skewness and kurtosis) and peak location, were used in this study. All measurements were calculated by time-averaged spectra for fricative sounds. After downsampling and high-pass filtering the sound file with frequency range of 0 to 16 kHz, the sound file is pre-emphasised by a factor of 0.98. The fricative portion excluded the onset and offset by using 80% of the total duration of the fricative to remove coarticulatory effects of the surrounding vowels. Nine 10-ms Kaiser-2 intervals (overlapping or not) were used for the total duration of the fricative. Then a 256-point DFT spectrum was generated for each interval and all intervals were then time-averaged. The interpretations of each measurement for fricative production were made based on sibilance, hyperarticulation and frontness. The details of interpretations were as follows: 1) higher peak location and kurtosis suggests higher sibilance [4]; 2) higher values of each measurement suggests more hyperarticulation [10]; and/or 3) higher peak location and centroid suggest more fronted of articulation [4].

### 2.5 Data analysis

Linear mixed models (LMMs) were conducted in *lme4* package of the R statistical software [1]. Independent variables (fixed factors) were language group (L1 English, L1 Thai, L2 English), gender (male, female) and vowel context (high vowel, low vowel and back vowel) whereas dependent variable was each acoustic measurement. For random factors, they were item as random intercept, and vowel and speaker as random intercept and slope (1|item) + (1+vowel|speaker). Three models were run for each acoustic measurement: a full model with a three-way interaction, a model with two-ways and a one-level model. Then these were compared using the anova function and the optimal model was selected based on the significantly lowest Akaike Information criterion (AIC). *Tukey's HSD* Post-hoc tests using *lsmeans* package of the R statistical software [9] were

performed on factors relating to language group based on the optimal LMM model.

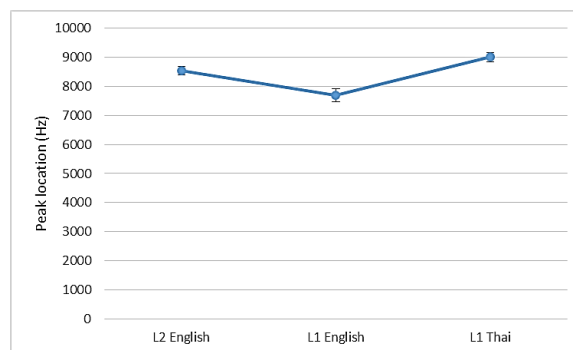
## 3. FINDINGS

From five acoustic measurements, as *Tukey's HSD* Post-hoc tests of SD and kurtosis showed no differences between language pairs, their findings are not shown here. The remaining findings were as follows:

### 3.1 Peak location (in Hz)

*Tukey's HSD* Post-hoc test indicated significant differences between: 1) higher peak location of L2 English /s/ than that of L1 English /s/ ( $b = 853.44$ ,  $SE = 261.34$ ,  $t = 3.27$ ,  $p < 0.01$ ); 2) lower peak location of L2 English /s/ than that of L1 Thai /s/ ( $b = -464.77$ ,  $SE = 83.78$ ,  $t = -5.55$ ,  $p < 0.01$ ); and 3) lower peak location of L1 English /s/ than that of L1 Thai /s/ ( $b = -1318.21$ ,  $SE = 268.82$ ,  $t = -4.90$ ,  $p < 0.01$ ). These findings suggest that L1 Thai /s/ had the most fronted articulation, was most hyperarticulated and most sibilant in its realisation, followed by L2 English /s/ and L1 English /s/, respectively.

**Figure 1:** Mean of peak location (Hz) for /s/ according to language groups produced from pairwise comparison based on LMM.



### 3.2 Centroid (in Hz)

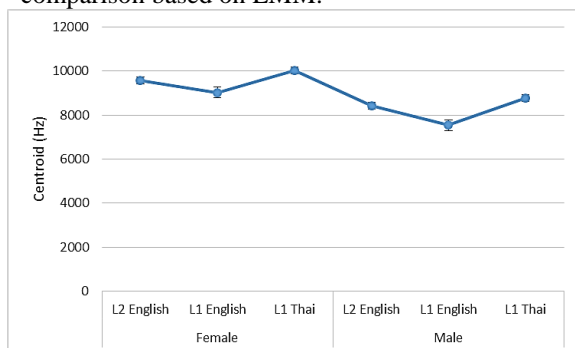
*Tukey's HSD* Post-hoc test of language  $\times$  gender interaction indicated that in the females' production, the centroid of L2 English /s/ was significantly lower than that of L1 Thai /s/ ( $b = -446.51$ ,  $SE = 64.20$ ,  $t = -6.95$ ,  $p < 0.01$ ), and the centroid of L1 English /s/ was significantly lower than that of L1 Thai /s/ ( $b = -988.34$ ,  $SE = 289.12$ ,  $t = -3.42$ ,  $p < 0.01$ ). In the males' production, the post-hoc test indicated that: 1) the centroid of L2 English /s/ was significantly higher than that of L1 English /s/ ( $b = 897.33$ ,  $SE = 291.05$ ,  $t = 3.08$ ,  $p < 0.05$ ); 2) the centroid of L2 English /s/ was significantly lower than that of L1 Thai /s/ ( $b = -333.32$ ,  $SE = 63.88$ ,  $t = -5.22$ ,  $p < 0.01$ ); and 3) the centroid of L1 English /s/ was significantly lower

than centroid of L1 Thai /s/ ( $b = -1230.66$ ,  $SE = 295.33$ ,  $t = -4.17$ ,  $p < 0.01$ ).

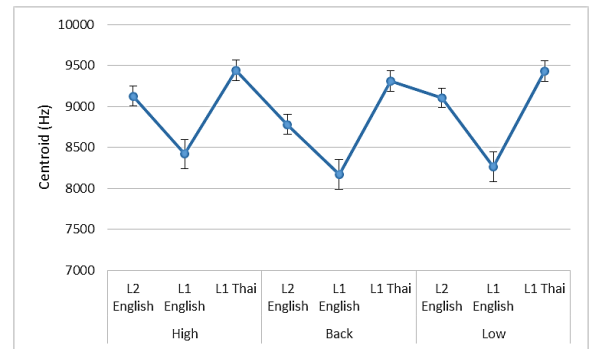
*Tukey's HSD* Post-hoc test of language  $\times$  vowel interaction indicated that in the high vowel context, the centroid of L2 English /s/ was significantly higher than that of L1 English /s/ ( $b = 707.10$ ,  $SE = 207.50$ ,  $t = 3.41$ ,  $p < 0.05$ ) but lower than that of L1 Thai /s/ ( $b = -315.09$ ,  $SE = 85.89$ ,  $t = -3.67$ ,  $p < 0.01$ ). Also in high vowel context, the centroid of L1 English /s/ was significantly lower than that of L1 Thai /s/ ( $b = -1022.20$ ,  $SE = 218.26$ ,  $t = -4.68$ ,  $p < 0.01$ ). In the low vowel context, the centroid of L2 English /s/ was significantly lower than that of L1 Thai /s/ ( $b = -325.75$ ,  $SE = 78.63$ ,  $t = -4.14$ ,  $p < 0.01$ ) but higher than that of L1 English /s/ ( $b = 841.55$ ,  $SE = 209.60$ ,  $t = 4.01$ ,  $p < 0.01$ ). In the low vowel context, the centroid of L1 English /s/ was significantly lower than that of L1 Thai /s/ ( $b = -1167.30$ ,  $SE = 219.67$ ,  $t = -5.31$ ,  $p < 0.01$ ). The post-hoc test also showed that in the back vowel context, the centroid of L1 Thai /s/ was significantly higher than that of L2 English /s/ ( $b = 528.90$ ,  $SE = 81.37$ ,  $t = 6.50$ ,  $p < 0.01$ ) and L1 English /s/ ( $b = 1139.00$ ,  $SE = 225.34$ ,  $t = 5.05$ ,  $p < 0.01$ ).

These findings suggest that in female's production, L1 Thai /s/ was more fronted and more hyperarticulated than L2 English /s/ and L1 English /s/ whereas in male production, L1 Thai /s/ was the most fronted and most hyperarticulated followed by L2 English /s/ and L1 English /s/, respectively. In high and low vowel contexts, L1 Thai /s/ was the most hyperarticulated and most fronted, followed by L2 English /s/ and L1 English /s/ respectively; however, in back vowel context, L1 Thai /s/ was more fronted and more hyperarticulated than L2 English /s/ and L1 English /s/.

**Figure 2:** Mean of centroid (Hz) for /s/ according to language groups  $\times$  gender produced from pairwise comparison based on LMM.



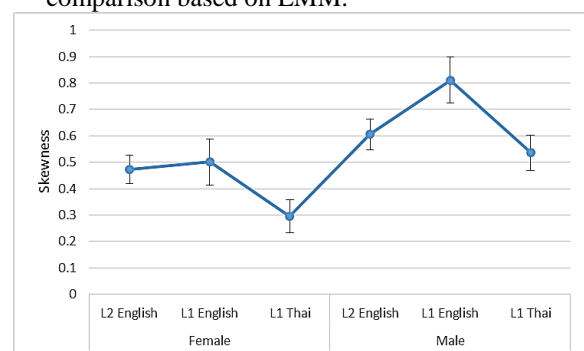
**Figure 3:** Mean of centroid (Hz) for /s/ according to language groups  $\times$  vowel contexts produced from pairwise comparison based on LMM.



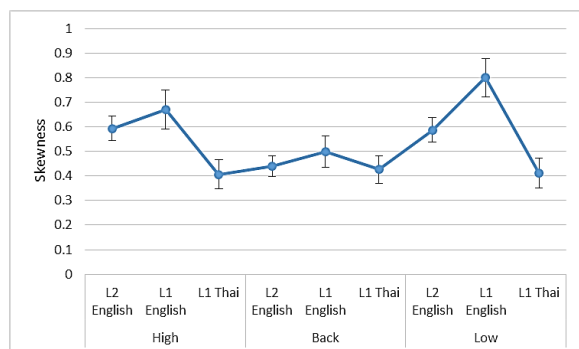
### 3.3 Skewness

*Tukey's HSD* Post-hoc test of language  $\times$  gender interaction showed that in females' production, skewness of L2 English /s/ was significantly higher than skewness of L1 Thai /s/ ( $b = 0.18$ ,  $SE = 0.04$ ,  $t = 4.18$ ,  $p < 0.01$ ) suggesting that L1 Thai /s/ was more fronted and less hyperarticulated than L2 English /s/. *Tukey's HSD* Post-hoc test of language  $\times$  vowel interaction indicated that in the high vowel context, skewness of L2 English /s/ was significantly higher than that of L1 Thai /s/ ( $b = 0.19$ ,  $SE = 0.05$ ,  $t = 3.66$ ,  $p < 0.01$ ) suggesting L1 Thai /s/ was more fronted and less hyperarticulated than L2 English /s/. In the low vowel context, skewness of L1 Thai /s/ was significantly lower than both for L2 English /s/ ( $b = 0.17$ ,  $SE = 0.05$ ,  $t = 3.60$ ,  $p < 0.01$ ) and L1 English /s/ ( $b = 0.39$ ,  $SE = 0.10$ ,  $t = 3.89$ ,  $p < 0.01$ ), suggesting that in the low vowel context L1 Thai /s/ was more fronted and less hyperarticulated than L2 English /s/ and L1 English /s/.

**Figure 4:** Mean of skewness for /s/ according to language groups  $\times$  gender produced from pairwise comparison based on LMM.



**Figure 5:** Mean of skewness for /s/ according to language groups  $\times$  vowel contexts produced from pairwise comparison based on LMM.



#### 4. DISCUSSION AND CONCLUSION

Detailed acoustic comparisons of L1 Thai, L1 English and L2 English /s/ production in this study showed that peak location indicated differences in all language pairs on the whole – L1 Thai /s/ was produced with the most fronted articulation and was most hyperarticulated and most sibilant, followed by L2 English /s/ and L1 English /s/, respectively. These findings suggest that L2 English /s/ production occupies an intermediate category of realisations, which is different from both L1 English /s/ and L1 Thai /s/.

This suggests that L2 learners discern subtle phonetic differences between L1 and L2 sounds produced by native speakers and try to maintain contrast between their L1 and L2 sounds, resulting in an L2 sound which has phonetic qualities that are different from those of their L1 [3]; however, this L2 sound still does not have identical phonetic qualities to that by native speakers of L2.

Some gender differences in L2 English /s/ production were observed. While there were no differences between L2 English and L1 English /s/ production by the females in this study, male production showed that L2 English /s/ had an intermediate position along the front back and hyperarticulation dimension compared with L1 Thai and L1 English.

In terms of vowel contexts, this study found that high and low vowel contexts were associated with realisations that were the most different from those of native English speakers, but not with respect skewness measure. In back vowels, however, overall findings from the centroid measure showed that L2 English /s/ and L1 English /s/ were comparable in that they were more backed and less hyperarticulated than L1 Thai /s/, suggesting that L2 learners seem to exhibit production that are closer in their realisations to those of native speakers in the back vowel context than the high and low vowel contexts.

In conclusion, this study suggests that while the production of an L2 sound which also exists in the L1 sound system might sound similar from an impressionistic perspective, their acoustic

characteristics might show subtle phonetic differences which are sometimes difficult to discern from auditory analysis alone. While this has been suggested for other sounds in the literature, /s/ really does present an example of a very fine distinction which would be expected to present a challenge for the L2 learner given the pull towards using the spectral properties of their L1 sound. The participants in this study exhibited a different category of production properties for their L2 English /s/ compared with their L1 Thai realisations, suggesting that they are aware of the fine phonetic differences between the two languages. The results of this study suggest that L2 English /s/ was a similar sound to that they produced in L1 Thai /s/, rather than identical sound as these two sounds have many different phonetic qualities [3]. It also suggested that it is not completely true to conclude the possibility that a similar sound is difficult to learn, as suggested by the SLM [3] without regard to contexts (such as the results of females as compared to males). This study also presented the first comparison between L1 English and Thai /s/, showing detailed crosslinguistic differences in the phonetic realisation of these sounds.

The differences in acoustic measurements might not necessarily mean that these are discernible in perception, as they might be below the 'just-noticeable difference' level [7]. Current work is therefore focussing on an accent rating task which aims to compare the degree of accentedness in L2 English /s/ when judged by native speakers of English. This would inform discussions around the relationship between acoustics, articulation, and native-like perception in L2 learning.

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