หน่วยเสียงพยัญชนะเสียดแทรกและพยัญชนะกึ่งเสียดแทรกภาษาอังกฤษและภาษาไทยที่รับรู้โดยผู้เรียนชาวไทยที่เรียนภาษาอังกฤษเป็นภาษาต่างประเทศ

English and Thai Fricatives and Affricates Perceived by Thai EFL Learners

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การเรียนภาษาอีกภาษาหนึ่งนับเป็นความท้าทายเมื่อเสียงในภาษาที่สองแตกต่างจากเสียงในภาษาที่หนึ่ง คำถามสำคัญคือผู้เรียนภาษาต่างประเทศหรือภาษาที่สองรับรู้เสียงในภาษาต่างประเทศที่เหมือนหรือแตกต่างจากเสียงในภาษาแม่อย่างไร โดยเฉพาะระบบเสียงภาษาแม่เช่น ภาษาไทยเมื่อเปรียบกับระบบเสียงภาษาต่างประเทศเช่น ภาษาอังกฤษ ปรากฏว่าภาษาอังกฤษนั้นมีชุดหน่วยเสียงพยัญชนะเสียดแทรกและหน่วยเสียงพยัญชนะกึ่งเสียดแทรกในจำนวนที่มากกว่าภาษาไทย นอกจากนั้นชุดหน่วยเสียงพยัญชนะดังกล่าวยังมีความแตกต่างไม่เพียงแต่ในด้านการสั่นของเส้นเสียง แต่ยังแตกต่างด้านฐานที่เกิดของเสียงและด้านลักษณะการเกิดของเสียง งานวิจัยนี้มีวัตถุประสงค์หลักในการศึกษาว่า (i) ผู้เรียนชาวไทยที่เรียนภาษาอังกฤษเป็นภาษาต่างประเทศรับรู้หน่วยเสียงพยัญชนะเสียดแทรกของภาษาอังกฤษจำนวนแปดหน่วยเสียง /f, v, θ, ð, s, z, ʃ และ ʒ/ และหน่วยเสียงพยัญชนะกึ่งเสียดแทรกจำนวนสองหน่วยเสียง /ʧ และ ʤ/ อย่างไรและ (ii) มีตัวช่วย (cues) ด้านการรับรู้ใดบ้าง ในเมื่อภาษาไทยที่เป็นภาษาแม่มีหน่วยเสียงพยัญชนะเสียดแทรกจำนวนเพียงสองหน่วยเสียง /f และ s/ และหน่วยเสียงพยัญชนะกึ่งเสียดแทรกจำนวนเพียงหนึ่งหน่วยเสียง /ʧ/ การทดลองด้านการรับรู้นี้ใช้เทคนิคใหม่ในการเตรียมคำทดสอบ ผู้เรียนชาวไทยที่เรียนภาษาอังกฤษเป็นภาษาต่างประเทศจำนวน ๒๐ คนเข้าร่วมการทดลองนี้โดย

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ชี้ได้ว่าคำทดสอบที่มีหน่วยเสียงพยัญชนะเสียดแทรกและพยัญชนะกึ่งเสียดแทรกในภาษาอังกฤษและภาษาไทยทั้งเสียงต้นฉบับและเสียงที่ได้รับการดัดแปลงดิจิตัลว่าเป็นหน่วยเสียงใด ผลการวิจัยนี้เสนอหลักฐานใหม่ว่าด้วยวิธีการเตรียมคำทดสอบแบบใหม่ พบว่าผู้เรียนชาวไทยที่เรียนภาษาอังกฤษเป็นภาษาต่างประเทศใช้ตัวช่วยในการรับรู้ซึ่งรวมถึงตัวช่วยภายในหน่วยเสียงพยัญชนะทั้งสองส่วนและตัวช่วยที่อยู่ในหน่วยเสียงรอบๆหน่วยเสียงพยัญชนะ ข้อค้นพบใหม่ในการวิจัยนี้ยังประโยชน์ให้เกิดความเข้าใจสัทศาสตร์ด้านการรับรู้ภาษาที่สองได้ดียิ่งขึ้นและส่องทางสำหรับการวิจัยในอนาคต

คำสำคัญ: หน่วยเสียงพยัญชนะกึ่งเสียดแทรก ภาษาอังกฤษ หน่วยเสียงพยัญชนะเสียดแทรก การรับรู้ ภาษาไทย

Abstract

Learning another language is challenging when the sounds of the foreign or second language (FL/L2) differ from those of the first language (L1). A key question concerns how FL/L2 learners acquire FL/L2 sounds either similar to or different from those in their native language. Specifically, when comparing the Thai (L1) and English (FL/L2) sound systems, English has a richer set of fricatives and affricates, contrasting not only in voicing but also in place and manner of articulation. The aims of this paper are (i) to examine how Thai EFL learners perceive eight English fricatives /f, v, θ, ð, s, z, ʃ, and ʒ/ and two affricates /ʧ and ʤ/, while their native Thai language has only two voiceless fricatives: /f/ and /s/ and a voiceless affricate /ʧ/ and (ii) to find the perceptual cues for these sounds. A perception study was conducted using a novel technique for creating processed tokens. Twenty Thai EFL learners participated in the experiment, identifying test words that contained English and Thai fricatives and affricates, presented in both original and digitally modified forms. The results provide new evidence that, with the new token-processing technique, Thai EFL learners relied on perceptual cues both within the target fricatives and affricates and in the surrounding sounds. These findings contribute to a better understanding of phonetic perception in second language acquisition and suggest directions for future research.

Keywords: Affricates, English, Fricatives, Perception, Thai

Introduction

In acquiring another language, learners have to study the sound system of that language. Some learners have an aim of reaching the native-like proficiency, or the right end of the L1-L2 continuum in the interlanguage theory (Selinker, 1972; Tarone, 1983). Basically, based on the second language acquisition theories (Ortega, 2013) such as the contrastive analysis theory (Yavaş, 2011), the sound system of learners' first or native language (L1), when compared and contrasted with the foreign/second (FL/L2) set, shares some similar phonemes or sounds as the FL/L2 ones. At the same time, the other L1 sounds differ from the FL/L2 phonology, as exemplified from some different L1-L2 phonological systems, including Spanish-English, Turkish-English, Greek-English, French-English, German-English, Arabic-English, Russian-English, Korean-English, Portuguese-English, and Persian (Farsi)-English (Yavaş, 2011, pp.185-205). These ten pairs with English as the second language show that, of all consonant sounds, fricatives and affricates are found to be the common mismatches in the L1-L2 sound systems. It is, then, very interesting to further investigate on the Thai-English phonological systems, particularly the fricative and affricate sets.

Generally, fricatives are phonetically described in phonetics textbooks as obstruent consonants with acoustic cues of frication noise and voicing (if they are voiced) (Ashby & Maidment, 2005; Ladefoged & Johnson, 2015; Wayland, 2019). Fricatives can be tested in terms of aerodynamics to see their pressure and airflow in the onset and coda positions (Solé, 2003). However, there is less information about affricates. Phonetically, an affricate is a combination of a stop and a fricative with the acoustic cues of a stop burst and a portion of a frication noise.

In this paper, the main focus is on the perception of English and Thai fricatives and affricates by Thai EFL learners. In the English phonology (Jongman, Wayland, & Wong, 2000; Jotikasthira, 2014, p.9; Ladefoged & Johnson, 2015, p.46), there are eight fricative phonemes /f, v, θ, ð, s, z, ʃ, and ʒ/ and two affricate phonemes /ʧ and ʤ/. Note that the other

fricative: voiceless glottal fricative /h/ is excluded in this research, as it has been controversial whether it can be treated as a voiceless glottal fricative or a kind of a voiceless vowel.

In comparison, Thai has only two initial voiceless fricatives /f/ and /s/ (Naksakul, 2008, p.49) and two initial voiceless affricates /c/ and /c^h/ (Roengpitya, 2001; Timyam, 2015). It can be noted here that Naksakul (2008) classified the two initial voiceless affricates /c/ and /c^h/ as voiceless palatal stops. In this paper, two initial voiceless fricatives /f/ and /s/ and one voiceless affricate /c^h/ (/ʧ/, hereafter) will be focused on. The other voiceless phoneme /c/ without the aspiration or frication noise is considered as a voiceless unaspirated palatal stop.

In the L1 (Thai) – L2 (English) previous research, English fricatives are found to be problematic for Thai learners (Charumanee & Wongkittiporn, 2024; Chunsuwimon & Ronnakiat, 2001; Kanokpermpoon, 2007; Noobutra, 2019; Peerachachayanee, 2022; Ronnakiat, 2020; Yiamkhantithaworn, 2012). This is mainly because of the fact that English has as many as eight voiceless-voiced fricatives and two voiceless-voiced affricates in the initial, intervocalic, and final positions while Thai has two voiceless fricatives and one voiceless affricate in the initial position only, as stated above. This mismatch makes it difficult for Thai EFL learners to acquire the English fricatives and affricates, especially the voiced ones. Most literature of Thai-English fricatives has been conducted through the views of articulatory phonetics, contrastive analysis, and error analysis. However, as technology becomes more advanced, branches in phonetics such as acoustic phonetics and speech perception (Ohala, 1981) can provide us more solid understandings of the Thai-English production and perception of Thai EFL learners. Up to today, a few investigations on Thai-English fricatives and affricates have been conducted acoustically (Kitikanan, Al-Tamimi, & Khattab, 2015; Roengpitya, 2011) and perceptually (Kitikanan, 2017; Lerdpaisalwong, 2015). Kitikanan (2017) concentrated on how English fricatives in different vowel contexts were identified as which consonant sounds by Thai learners with different

English experiences. Lerdpaisalwong (2015) used familiarization and nonsense words in perception trainings for Thai learners to learn American English consonants and vowels. In fact, a research gap can be pointed out that further perceptual studies need to be conducted to provide more perceptual perspectives on how Thai EFL learners can perceive Thai-English fricatives and affricates and what the major perceptual cues are for ESL learners to perceive such as places of articulation, manners of articulation, voicing, positions (initial, intervocalic, or final), and contexts (in citation form versus in connected speech). It is hoped that the gained new knowledge from this perceptual test can be adapted in teaching and learning in L1-L2 classrooms.

Objectives

The objectives of this study are to find out (i) how Thai EFL learners perceive the English and Thai fricatives and affricates and (ii) what the main perceptual cues are for perceiving these English-Thai sounds.

Methodology

In this research, the methodology was based on perceptual phonetics (Ohala, 1981), which involve stimuli, participants, procedures, and data analysis.

Stimuli

This perceptual study had two sets of stimuli. The first one contained 31 English words with the eight English voiceless-voiced fricatives /f, v, θ, ð, s, z, ʃ, and ʒ/ and two English voiceless-voiced affricates /ʧ/ and /ʤ/, appearing in the initial, intervocalic (medial), and final positions (*See Table 1 in Appendices*). Unlike Lerdpaisalwong (2015), in this perceptual study, all the words were meaningful. The other set had 15 Thai meaningful words with the two Thai voiceless fricatives /f/ and /s/ and the Thai voiceless affricate /ʧ/ in the initial position (*See Table 2 in Appendices*). These English and Thai words were read in citation form and in a framed sentence: “Say the word _____ twice.” (English) and “/phûut kham wâa _____ sɔ̌ɔŋ krá̀ŋ/ ‘Say word that _____ two times.”

All the words were digitally recorded in the Praat sound analysis program (Boersma & Weenink, 2012, 2025, the present version) and were digitally modified into five main process types (Types AB, CD, EF, GH, and IJ), as follows. For **Types A (Voiceless = Voiceless) and B (Voiced = Voiced)**, the original fricatives and affricates were not modified. For **Types C (Voiceless > Voiced) and D (Voiced > Voiceless)**, the original fricatives and affricates were replaced by the counterparts. For **Types E (Voiceless = ½ Voiceless + ½ Voiced) and F (Voiced = ½ Voiced + = ½ Voiceless)**, the original fricatives and affricates had the first half of the original sounds with the counterparts as the second half portions. For **Types G (Voiceless = ½ Voiced + ½ Voiceless) and H (Voiced = ½ Voiceless + = ½ Voiced)**, the original fricatives and affricates had the first half of the counterpart sounds with the original as the second half portions. For **Types I (Voiceless = 0) and J (Voiced =0)**, the original fricatives and affricates were totally cut off. This new technique of the token preparation for the perception test on English-Thai fricatives and affricates was adapted from Roengpitya (1998) which found that the higher-lower F0 pitch perturbations on vowels after voiceless-voiced stops, respectively, functioned as a major perceptual cue for voiceless-voiced stops in Thai, leading to the possible Thai tonogenesis.

In this perception test, there were 312 randomized processed tokens, which were grouped into six groups (**Group 1** for English voiceless-voiced labiodental fricatives /f-v/, **Group 2** for English voiceless-voiced interdental fricatives /θ-ð/, **Group 3** for English voiceless-voiced alveolar fricatives /s-z/, **Group 4** for English voiceless-voiced palatal fricatives /ʃ-ʒ/, **Group 5** for English a combination of the voiceless palatal fricative and voiceless-voiced palatal affricates /ʃ-ʧ-ʤ/, and **Group 6** for the Thai fricatives and affricate /f-s-ʧ/. There were a total of 6,240 answers (312 items X 20 listeners).

Participants

In this study, the participants were divided into two groups: the group of speakers and the group of listeners. As for speakers, there were two native-American middle-aged male speakers who read the original English tokens and a native-Thai female speaker who

read the original Thai tokens. The other group consisted of 20 native-Thai EFL listeners (14 females and 6 males) with the age ranging from 19-23 years with the mean age of 20 years. All were undergraduate students in arts and science at a public university in Thailand and voluntarily participated in this perceptual study. They had Thai as their native language and English as a foreign language. All speakers and listeners had normal speech and hearing.

Procedures

The procedures of this study were in three phases. In the first phase, the two native-American speakers were asked to read the 31 English words in citation form and in the framed sentence, and the native-Thai speaker read the 15 Thai words in citation form and in the framed sentence. In the Praat program, all the words were digitally recorded.

The second phase was the preparation of the stimuli for a perception test. All the original words were digitally modified in five process types (Types A-B, C-D, E-F, G-H, and I-J), as described in the stimuli section above.

The third phase was the perception test, designed as an identification task, which was adapted from perception tests in Flege, MacKay, & Meador (1999), Reis, Kluge, & Bettoni-Techio (2007), and Tsukada & Roengpitya (2008). The 20 Thai EFL listeners were asked to listen to all 312 items. Each item had two choices (English voiceless versus voiced fricative or affricate in Groups 1-4) or three choices (English fricative and affricates in Group 5 and Thai fricatives and affricate in Group 6). Each word contained the target English or Thai fricative or affricate. Each listener had to choose the choice which matches the word they heard the most.

Data Analysis

All the gained results were documented in the Excel program and were quantified to find the percentage of correct answers for the tokens containing English and Thai fricatives and affricates identified by Thai EFL learners.

The next section presents the results of this perceptual study.

Results

The results gained from the perception test are presented in two main sections: (1) English fricatives and affricates and (2) Thai fricatives and affricate, perceived by Thai EFL learners, as below.

(1) English Fricatives and Affricates Perceived by Thai EFL Learners

In this perception test, the results of how Thai EFL listeners perceived the eight English voiceless-voiced fricatives /f, v, θ, ð, s, z, ʃ, and ʒ/ and two English voiceless-voiced affricates /ʧ/ and /ʤ/ are shown in terms of ***manners of articulation*** (fricatives and affricates), ***places of articulation*** (labio-dental, interdental, alveolar, and palatal), ***voicing*** (voiceless and voiced), ***contexts*** (in citation form versus in connected speech), ***positions*** (initial, intervocalic, and final), and ***process types*** (Types A-J), as in Figures 1-3 below.

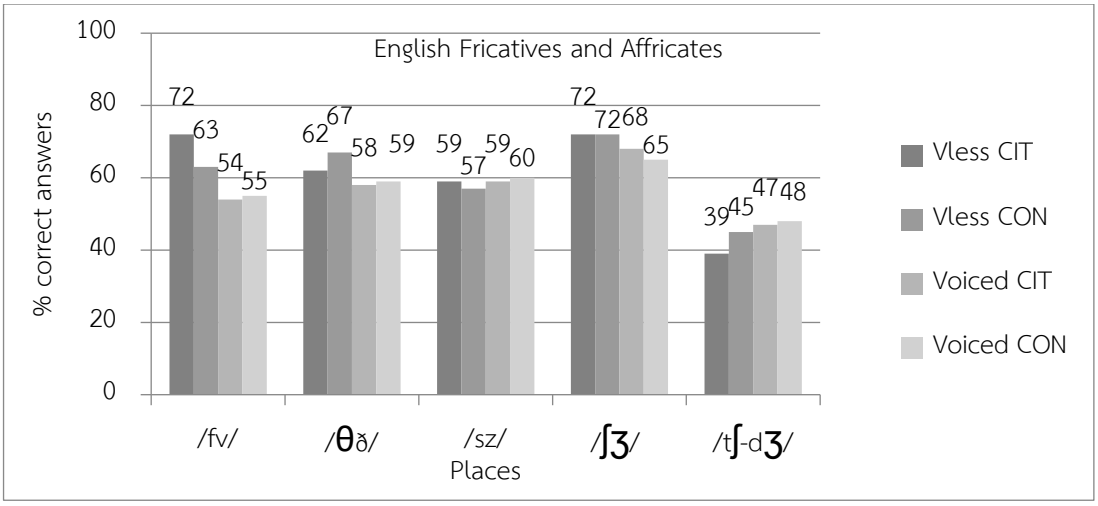

Figure 1 English Fricatives and Affricates in Citation Form (CIT) and in Connected Speech (CON)

Figure 1 presents the percentage of correct answers of how Thai EFL learners perceived the eight English fricatives and two English affricates. For ***manners of articulation*** (fricatives and affricates), the percent correct answers of English fricatives, ranging from 55-72% (mean = 62.62%), were higher than those of affricates, ranging from 39-48% (mean 44.75%). For ***places of articulation***, the percent correct answers of English fricatives were the highest for palatal fricatives (ranging from 65-72%; mean = 69%), followed by interdental fricatives (ranging from 58-67%; mean = 62%), labio-dental fricatives (ranging

from 54-72%; mean = 61%), and the lowest, alveolar fricatives (ranging from 57-60%; mean = 59%). For ***voicing***, the percent correct answers of English voiceless fricatives and affricates, ranging from 39-72% (mean = 61%), were higher than the voiced counterparts (ranging from 48-68%; mean = 57%). As for ***contexts***, the percent correct answers of English fricatives and affricates in citation form had a greater range than those in connected speech, but the two groups did not differ in average. The range of the percent correct answers for the tokens in citation form was 39-72% (mean = 59%), and the range of those in connected speech was 45-60% (mean = 59%).

From the results in Figure 1, it can be implied that Thai EFL learners can perceive English fricatives better than English affricates. Among English fricatives with different places of articulation, they can perceive palatal fricatives the best and less for interdental, labiodental, and, interestingly, the least for alveolar fricatives. Additionally, English voiceless fricatives and affricates were perceived better than voiced counterparts. Based on the two contexts, the tokens in citation form had a greater range of the percent correct answers than those in connected speech but did not differ in average.

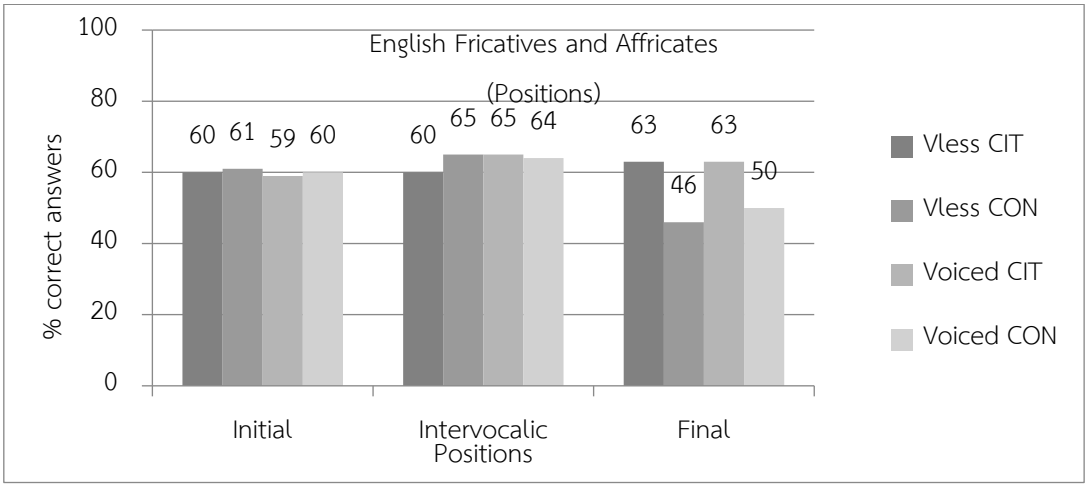

Figure 2 English Fricatives and Affricates in Different Positions (Initial, Intervocalic, and Final)

Figure 2 above illustrates how Thai EFL learners perceived English fricatives and affricates in different ***positions*** (initial, intervocalic, and final). The percent correct answers ranged the highest for those in the intervocalic (medial) position (range = 60-65%; mean =

63.27%), followed by those in the initial position (range = 59-61%; mean = 60.1%) and the ones in the final position (range = 46-63%; mean = 55.05%). In other words, Thai EFL learners were able to identify English fricatives and affricates in the intervocalic position at the highest rate. This suggests that there could be extra perceptual cues for English fricatives and affricates embedded on the preceding and following sounds. On the contrary, those in the final positions, especially the voiced ones, were least identified correctly. This was probably due to the reduced oral pressure and amplitude of coda fricatives, as stated in Solé (2003), which could serve as extra perceptual cues.

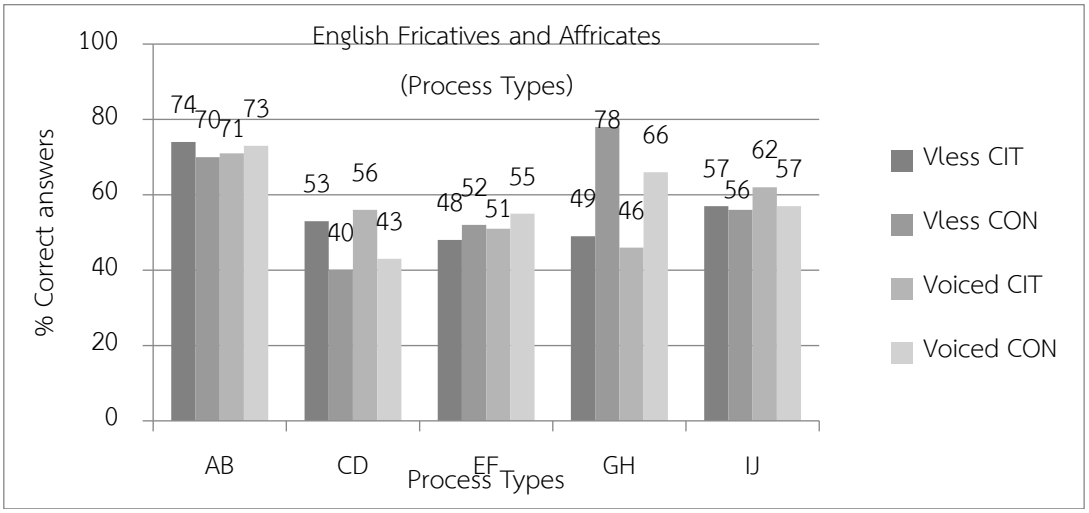

Figure 3 English Fricatives and Affricates in Different Process Types (Types A-J)

In Figure 3, among all ***process types*** (Types A-J), the percent correct answers were the highest for the tokens with the original fricatives and affricates (Types AB) (range = 70-74%; mean = 72%), followed by those which had the combination of ½ counterpart + ½ original portions (Types GH) (range = 46-78%; mean = 60%), those which were totally cut off (Types IJ) (range = 56-62%; mean = 58%), those which had the combination of ½ original + ½ counterpart portions (Types EF) (range = 48-55%; mean = 52%), and the least for those which were totally replaced by the counterparts (Types CD) (range = 40-56%; mean = 48%). The results from this figure can be interpreted that English fricatives and affricates carry the main perceptual cues not only in both first and second halves, but also on the sounds preceding and following them. Interestingly, Thai EFL listeners can still identify English and

Thai fricatives and affricates beyond 50% correct answers even when the entire consonants of the targeted tokens were spliced off (Types IJ).

In sum, this section reveals how Thai EFL learners perceived English voiceless and voiced fricatives and affricates and, through the new technique of stimuli preparation (process types), this perception test provided novel knowledge of what possible perceptual cues for these sounds can be: the manners of articulation, the places of articulation, voicing, contexts (in citation form versus connected speech), positions (initial, intervocalic, and final), and environments (the preceding and following sounds) embedded with possible extra perceptual cues such as F0 perturbation (Roengpitya, 1998), an oral gesture, and amplitude of frication (Solé, 2003).

(2) Thai Fricatives and Affricate Perceived by Thai EFL Learners

The previous section displays English fricatives and affricate perceived by Thai EFL learners. In this section, the results of the Thai set are reported. Unlike English, Thai has only two fricatives /f/ and /s/ and one affricate /tʃ/. In Thai, these three sounds can be found to be voiceless and appear in the initial position only. The results of the Thai set were shown in terms of the process types (Types A, E1, E2, G1, G2 and I) in citation form in Figure 4 and in connected speech in Figure 5.

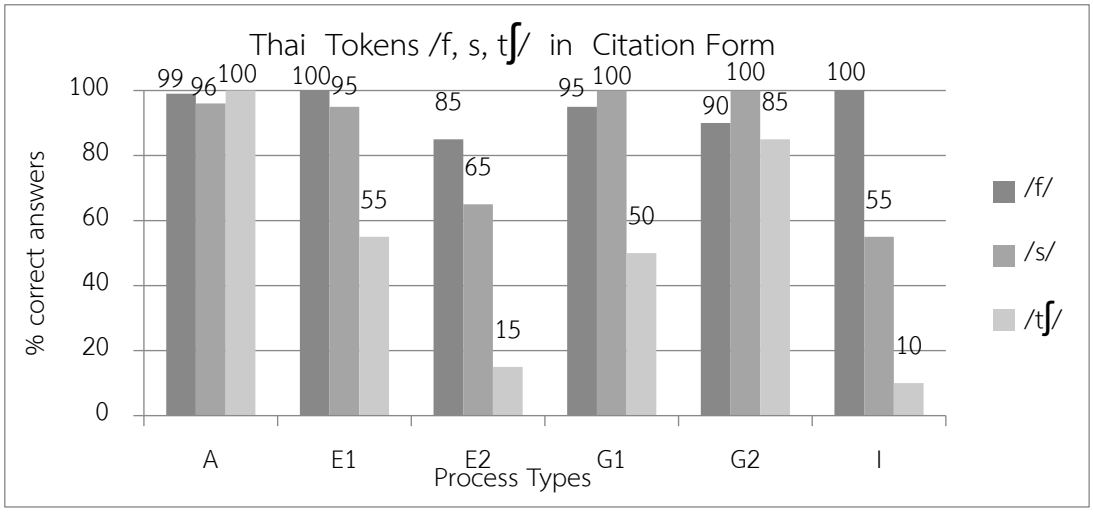

Figure 4 Thai Fricatives and Affricate in Citation Form

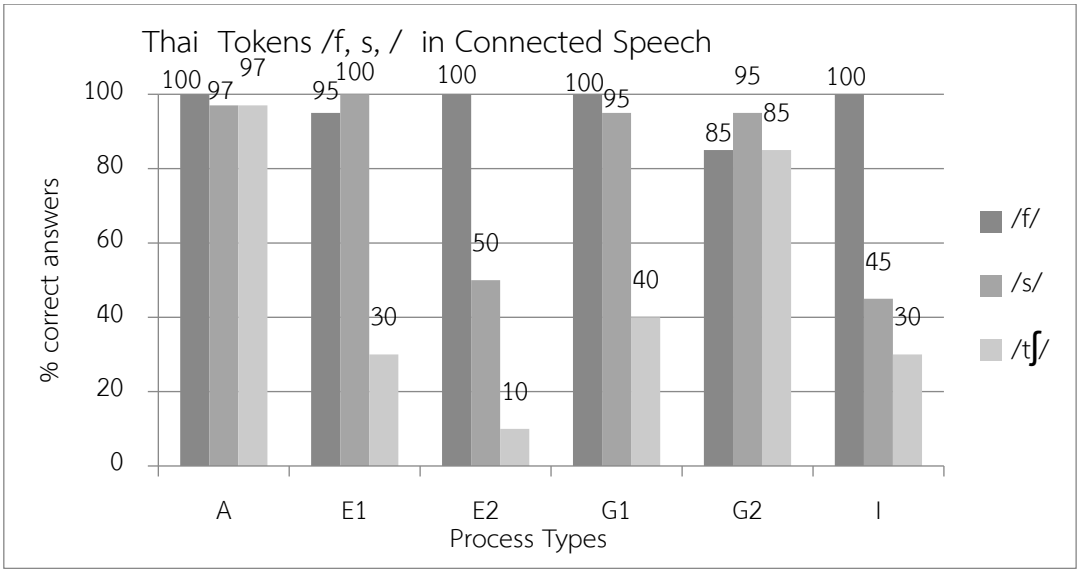

Figure 5 Thai Fricatives and Affricate in Connected Speech

The results revealed how Thai EFL learners perceived their own L1 (Thai) fricatives and affricate in citation form (Figure 4) and in connected speech (Figure 5). From the two figures, in terms of manners of articulation, Thai EFL learners can perceive both Thai fricatives /f/ and /s/ (citation form: range = 55-100%; mean = 90%; and connected speech: range = 45-100%; mean = 88.5%), while the percent correct answers for the Thai affricate /tʃ/ were much lower (citation form: range = 10-100%; mean = 53%; and connected speech: range = 10-97%; mean = 49%). Considering the different places of articulation between the two Thai fricatives /f/ and /s/, Thai EFL learners perceived the labio-dental fricative /f/ at higher percent correct answers (citation form: range = 90-100%; mean = 95%; and connected speech: range = 85-100%; mean = 97%) than those of the alveolar fricative /s/ (citation form: range = 65-100%; mean = 85%; and connected speech: range = 45-100%; mean = 80%).

Based on different process types, the percent correct answers of Thai fricatives and affricate were the highest when the tokens were totally original (Type A) (citation form: range = 96-100%; mean = 98%; and connected speech: range = 97-100%; mean = 98%), followed by tokens with the combination of ½ 2nd counterpart + ½ original portions (Type G2) (citation form: range = 85-100%; mean = 92%; and connected speech: range = 85-95%; mean = 88%), tokens with the combination of ½ original + ½ 1st counterpart portions (Type E1) (citation form:

range = 55-100%; mean = 83%; and connected speech: range = 30-100%; mean = 75%), tokens with the combination of ½ 1st counterpart + ½ original portions (Type G1) (citation form: range = 50-100%; mean = 82%; and connected speech: range = 40-100%; mean = 78%), tokens which were spliced off (Type I) (citation form: range = 10-100%; mean = 55%; and connected speech: range = 30-100%; mean = 58%), and tokens with the combination of ½ original + ½ 2nd counterpart portions (Type E2) (citation form: range = 15-85%; mean = 55%; and connected speech: range = 10-100%; mean = 53%).

To summarize, Thai EFL learners perceived the two Thai fricatives /f/ and /s/ at higher percent correct answers than the Thai affricate /tʃ/. By comparing and contrasting the percent correct answers of the two Thai fricatives /f/ and /s/ with the English equivalents, Thai EFL learners answered correctly more for Thai (L1) tokens than for the English ones. However, they can identify English fricatives and affricates correctly to a certain degree. The next section will provide the discussion and conclusion.

Discussion and Conclusion

The aims of this research were to investigate, with the new technique of the stimuli preparation, to see how Thai EFL learners perceived the English and Thai fricatives and affricates, and what the main perceptual cues are for Thai EFL learners to use when perceiving English and Thai fricatives and affricates. Previous literature has presented Thai-English fricatives in terms of articulatory phonetics with the fact that English has more voiceless-voiced fricatives and affricates, when compared to the Thai sets with only two voiceless fricatives and one voiceless affricate (Charumanee & Wongkittiporn, 2024; Chunsuwimon & Ronnakiat, 2001; Kanokpermpoon, 2007; Noobutra, 2019; Peerachachayanee, 2022; Ronnakiat, 2020; Yiamkhantithaworn, 2012). With more advanced technology, especially the Praat sound analysis program (Boersma & Weenink, 2012, 2025, the present version), current literature has explored more acoustical and perceptual studies on English fricatives of Thai learners (Kitikanan, Al-Tamimi, & Khattab, 2015; Kitikanan, 2017; Lerdpaisalwong, 2015; Roengpitya, 2011). The acoustic studies revealed the acoustic cues of English and Thai fricatives such as the shorter-longer of frication durations, the shapes and heights

of the amplitude due to different durations and positions of fricatives, the fundamental frequency (F0) of fricatives, and the voicing state (Roengpitya, 2011). Perceptually, Kitikanan (2017) tested how L2 Thai learners matched English fricatives in different vowel contexts with which Thai or English fricatives, and found, for example, that the English fricative /θ/ was mapped with the Thai fricative /f/ in the high and low vowel contexts but with the Thai fricative /s/ in the back vowel context. Additionally, Lerdpaisalwong (2015) used some English fricatives and an affricate in onset and coda positions in familiarization and nonsense words with perception trainings for Thai learners to learn American English consonants and vowels and found that full-set trainings were effective.

A research gap is the lack of a perception test on the full set of the eight English voiceless-voiced fricatives /f, v, θ, ð, s, z, ʃ, and ʒ/ and two English voiceless-voiced affricates /ʧ/ and /ʤ/, appearing in the initial, intervocalic (medial), and final positions, in authentic and natural real words, as compared to the Thai sets with the two Thai voiceless fricatives /f/ and /s/ and the Thai voiceless affricate /ʧ/, perceived by Thai EFL learners at a tertiary level, so as to find other possible essential perceptual cues for English-Thai fricatives and affricates. This research was then conducted.

However, this present perceptual test on English-Thai fricatives and affricates has extended the scope, specially designed with a novel technique (Process Types A-J) and natural meaningful English and Thai words to seek for other possible perceptual cues. Its findings revealed additional major perceptual cues for English and Thai fricatives and affricates, as in detail below.

First, focusing on Thai as L1, among the three Thai fricatives and affricate: /f/, /s/, and /ʧ/, Thai EFL learners perceived the voiceless labiodental fricative /f/ at the highest level, followed by the voiceless alveolar fricative /s/, and the least by the voiceless palatal affricate /ʧ/. Thus, places of articulation and manners of articulation serve as the perceptual cues for Thai fricatives and affricate. Voicing and positions are excluded as Thai does not have voiced counterparts, and the Thai fricatives and affricate occur in the initial

position only. In addition, the process types (E1, E2, G1, and I) in Figure 5 illustrate the lower percent correct answers for the Thai affricate /ʧ/. This can be interpreted that the Thai affricate /ʧ/ with a combination of a stop and a fricative needs both stop and fricative perceptual cues to be successfully perceived as the affricate. With only one or the other cue caused by the novel processing technique, listeners were unable to identify this affricate. Last, the other factor: being in citation form versus in connected speech did not affect the perception of Thai EFL learners.

The findings of this research further looked into the English fricatives and affricates with more complex factors served as perceptual cues such as voicing, places of articulation, manners of articulation, (initial, intervocalic, and final) positions, and process types (AB original sounds; CD original substituted by counterpart sounds; EF ½ original + ½ counterpart; GH ½ counterpart + ½ original; and IJ deleted original sounds). For voicing, English voiceless fricatives and affricate were perceived more correctly than voiced counterparts. This may correspond to the L1-L2 interlanguage (Ortega, 2013; Selinker, 1972; Tarone, 1983), as Thai has only voiceless ones, and thus Thai EFL learners better perceived English voiceless fricatives and affricate.

Places of articulation stand as another perceptual cue for English fricatives and affricates. That is Thai EFL learners can perceive palatal fricatives the best and less for interdental, labiodental, and, interestingly, the least for alveolar fricatives. This matches the Thai set in that the Thai voiceless labiodental fricative /f/ was perceived better than the Thai alveolar fricative /s/. Additionally, for manners of articulation, affricates, both in English and Thai, were more difficult to be perceived than fricatives. This can be explained that the novel processing technique, used in this perceptual study, allows us to see that an affricate, a combination of a stop and a fricative, needs more complex intrinsic perceptual cues embedded within both the stop and fricative portions of the affricate. Lacking one part or the other or deleting the entire affricate leaving only the cues on the adjacent sounds leads to listeners' problems of perceiving that affricate.

Another new finding was the positions. In an aerodynamic study (Solé, 2003), coda fricatives had a slower oral pressure build-up and a lower pressure peak. It suggested the differences of fricatives in onset versus coda positions. In this perceptual study, of all three positions (initial, intervocalic, and final), English fricatives and affricates in the intervocalic (medial) position were best perceived, less for those in the initial position, and the least for those in the final position. This finding supports the fact that fricatives differ, when in different positions, in terms of aerodynamics (Solé, 2003), acoustics (Roengpitya, 2011), and perception (this study). In addition, the result is partially matched with Lerdpaisalwong (2015) who found that, between her two positions (onsets and codas), listeners did better for the onset than the coda English tokens.

The other perceptual cue for English fricatives and affricate is the environments. This perceptual test was designed with different process types, adapted from the perceptual test on the Thai voiceless and voiced stops and the pitch perturbation on the following vowels (Roengpitya, 1998). She pointed out that the fundamental frequency (F0) was higher on the vowel onset after a voiceless stop, but lower after a voiced stop. Thus, with five different combinations (Types A-J), the findings suggested that, even an entire fricative or affricate was spliced off (Types IJ), Thai EFL listeners were still able to identify the fricative or affricate correctly at a certain level. However, the percent correct answers were not as high as those in the other process types. It can be implied that there may be extra perceptual cues for fricatives and affricates in English and Thai embedded on the adjacent sounds such as the F0 and/or amplitude (dB) levels on the neighboring vowels which were, previously, found as an acoustic cue for fricatives for Thai EFL learners (Roengpitya, 2011). Another interesting result from Types EF and GH, where half portions of the fricatives were mismatched, can be interpreted that the perceptual cues for English and Thai fricatives and affricates were embedded in both first and second halves of the consonants and were crucial for EFL learners to use for identifying L1 (Thai) – L2 (English) fricatives and affricates.

Additionally, in previous research, Kitikanan (2017) found that vowel contexts (high, low, and back) and language experience affected the perception of English fricatives by L2 Thai learners. This present research revealed further that additional perceptual cues can be from higher-lower F0 and dB on the same vowel, following and/or preceding different voiceless-voiced English fricatives and affricates in initial, intervocalic, and final positions. In other words, the results gained from this study offer a perceptual view of Thai-English fricatives and affricates by Thai EFL learners in depth.

To conclude, this perceptual study on English and Thai fricatives and affricates by Thai EFL learners yielded, by using the novel techniques of the stimuli preparation, new knowledge of how Thai EFL learners used several perceptual cues for perceiving L1 (Thai) – L2 (English) fricatives and affricates, especially the perceptual cues embedded in both half portions of Thai-English fricatives and affricates. Additional acoustic-perceptual cues can be found on adjacent sounds such as the higher-lower F0 and dB levels on neighboring vowels, and the preferred intervocalic position of English fricatives and affricates.

This perceptual study is believed to help advance more L1-L2 phonetic investigation, but its limitation was found e.g., the number of Thai EFL learners, the tertiary level of education, the English and Thai tokens and processing, and the languages chosen. More L1-FL studies should be conducted in the future to move forward not only the fields in phonetics and phonology, but also in language acquisition and psycholinguistics.

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Appendices

Table 1. English Tokens

Phonemes/ Positions	Initial		Intervocalic		Final	
	voiceless	voiced	voiceless	voiced	voiceless	voiced
/f-v/	1. fat	2. vat	13. toffee	14. saving	22. safe	23. save
/θ-ð/	3. thigh	4.thy	-	15. gather	24. teeth	25. teethe
/ʃ-ʒ/	5. shout 6. ship	7. genre	16. mission	17. vision	26. cash	27. beige
/tʃ-dʒ/	8. chip 9.cheap	10. jeep	18. richest	19. bridges	28. etch	29. edge
/ s-z/	11. sue	12. zoo	20. castle	21. puzzle	30. boss	31. dogs

The data were adapted from Ladefoged & Johnson (2015, p.46, Table 2.1) and Jotikasathira (2014, pp.83-106).

Table 2. The Thai Tokens

Phonemes/ Positions	Initial		Intervocalic		Final	
	voiceless	voiced	voiceless	voiced	voiceless	voiced
/f/ + a long vowel	1. /faǎ/ ‘cover’ 2. /faǎn/ ‘peel’ 3. /faǎk/ ‘assign, leave..with’	-	-	-	-	-
/ s/+ a long vowel	4. /saǎ/ ‘paper’ 5. /saǎn/ ‘basketry’ 6. /sàak/ ‘rough’	-	-	-	-	-
/t∫/ + a long vowel	7. /t∫aǎ/ ‘wood’ 8. /t∫aǎn/ ‘(speak) clearly’ 9. /t∫aak/ ‘curtain’	-	-	-	-	-
/f/ + a short vowel	10. /fǎn/ ‘dream’ 11. /fàk/ ‘classifier’	-	-	-	-	-
/s/ + a short vowel	12. /sǎn/ ‘ridge’ 13. /sàk/ ‘teak’	-	-	-	-	-
/t∫/ + a short vowel	14. /t∫ǎn/ ‘I’ 15. /t∫ak/ ‘noise of a train’	-	-	-	-	-