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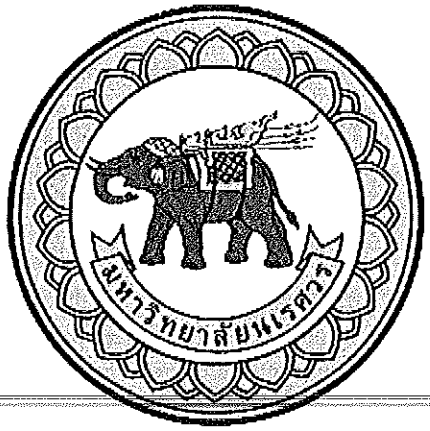

รายงานวิจัยฉบับสมบูรณ์

การรับรู้เสียงเสียดแทรกในภาษาอังกฤษโดยเด็กไทย: บทบาทของสระและประสบการณ์การเรียนภาษา

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11 ตุลาคม 2560

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บทบาทของสระและประสบการณ์ในการเรียนภาษา

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Abstract

In the field of second language (L2) speech perception, the cross-language comparison of first language (L1) and L2 sounds is commonly explored via the perceptual assimilation patterns of the two sounds by L2 learners. This was proposed by the Speech Learning Model (SLM) (Flege, 1995) and the Perceptual Assimilation Model-L2 (PAM-L2) (Best, 1995) that the ease of L2 sound learning is based on the perceived similarity between the L1 and L2 sounds. The findings from the perceptual assimilation can be used to make predictions for the sound identification task to find out if the ability to identify the L2 sounds is based on the perceptual assimilation pattern. However no previous study explores the perceptual assimilation of English fricatives in terms of Thai sounds, nor the sound identification of these sounds by L2 Thai learners. This study aims to examine the perception of English fricatives by L2 Thai learners with the effects of the vowel context and language experience. It comprises two tasks: perceptual assimilation and sound identification. The findings of the perceptual assimilation task were used to make predictions for the other task.

The fricatives were /f, s, v, θ, ð, z, ʃ/. The other sounds that might cause confusion according to previous literature were also included: /d, w, t^h, t͡ʃ/. From these sounds, only /f, s, d, w, t^h/ exist in both Thai and English sound systems. The target sounds were in initial position. These sounds were in the three vowel contexts: high, low, back. For the listeners, the perceptual assimilation task had two groups of listeners: English-major and non-English-major – all were L2 Thai learners whereas the sound identification task had three groups of listeners, i.e. the two groups in the previous task and the native speakers of English as a control group.

The findings of the perceptual assimilation task showed that for the sounds that occurred in both Thai and English sound systems (shared sounds), the majority of all shared sounds were matched with Thai sounds of the same categories, i.e. representing by the same IPA symbols, and there were no differences in the perceived similarities of these sounds and their closest L1 Thai sounds between groups of listeners in all contexts, except in the low

vowel context in English /d/ as Thai /d/. For the sounds that occurred only in English sound system (non-shared sounds), the matching of the English non-shared sounds were similar to the findings in the previous literature on the English fricative production by L2 Thai learners, except English /θ/. Regarding the perceived similarity of the English non-shared sounds and its closest Thai sounds, no influence of the two factors was found in that of English /t͡ʃ/; those of English /v, z/ were affected only by the language experience; and there were influence of both factors in those of English /θ, ð, ʃ/.

The findings of the sound identification task showed that for shared sounds, target English shared sounds were matched with the same English sounds, except in some contexts, and the degree of the perceived similarities between groups for each sound was mostly similar to that in the perceptual assimilation task. In the non-shared sounds, the matching of the sounds were various especially in /ð, θ/, and the perceived similarities of many sounds to their closest English sounds were not the reflection from the perceptual assimilation in many contexts. Hence, it can be concluded that the predictions from the perceptual assimilation were more correct on the shared-sounds than the non-shared ones.

These findings suggest positive transfer of the L1 towards the L2 shared sound perception. They also suggest the effects of the vowel context and language experience that the existence of the L2 sounds in the perception of the L2 learners is not context-independent. This implies that in the training of the L2 sounds, the vowel context and language experience of the L2 learners should be taken into account.

Keywords: L2 speech perception, Thai, English, L2 learners, perceptual assimilation, sound identification, fricative

บทคัดย่อ

ในการศึกษาด้านของการรับรู้เสียงในภาษาที่สองนั้น มักมีการเปรียบเทียบเสียงในภาษาแรกและภาษาที่สองผ่านรูปแบบการกลืนเสียงภาษาที่สองสู่ภาษาแรกโดยผู้เรียนภาษาที่สอง ดังที่ทฤษฎี Speech Learning Model (SLM) (Flege, 1995) and the Perceptual Assimilation Model-L2 (PAM-L2) (Best, 1995) ได้เสนอไว้ ว่าความยากง่ายในการเรียนรู้เสียงในภาษาที่สองนั้น ขึ้นกับการรับรู้ความเหมือนระหว่างเสียงในภาษาแรกและภาษาที่สอง โดยผลการค้นพบจากการทดสอบการกลืนเสียงจะใช้ในการสร้างสมมุติฐานสำหรับการทดสอบการระบุเสียง เพื่อที่จะดูว่าความสามารถในการระบุเสียงในภาษาที่สองนั้น ตั้งอยู่บนฐานของการกลืนเสียงหรือไม่ กระนั้นก็ตาม ก็ยังไม่มีการเปรียบเทียบการกลืนเสียงเสียดแทรกของภาษาอังกฤษกับเสียงในภาษาไทยและการทดสอบการระบุเสียงเหล่านี้โดยคนไทย งานวิจัยชิ้นนี้ จึงมีวัตถุประสงค์เพื่อศึกษาการรับรู้เสียงเสียดแทรกในภาษาอังกฤษโดยคนไทยและอิทธิพลของสระและประสบการณ์ในการเรียนภาษา โดยงานวิจัยนี้ ประกอบไปด้วยการทดลอง 2 ชิ้น ได้แก่ การกลืนเสียงและการระบุเสียง ซึ่งผลจากการทดสอบการกลืนเสียงจะใช้ในการสร้างสมมุติฐานให้กับการทดสอบการระบุเสียง

เสียงเสียดแทรกในงานวิจัยนี้ได้แก่ /f, s, v, θ, ð, z, ʃ/ นอกจากนั้น ยังมีเสียงอื่น ๆ ที่ปรากฏในงานวิจัยอื่นว่า เป็นเสียงที่ทำให้ผู้เรียนคนไทยสับสนกับเสียงเสียดแทรกด้วย คือ /d, w, t^h, $\widehat{tʃ}$/ จากเสียงเหล่านี้ เสียงที่เกิดในภาษาไทยและภาษาอังกฤษคือ /f, s, d, w, t^h/ เสียงที่ศึกษาในงานวิจัยนี้เป็นเสียงในตำแหน่งต้นคำเท่านั้น สำหรับบริบทของเสียงในงานวิจัยนี้ เสียงเหล่านี้ อยู่ใน 3 สระ คือสระสูง สระกลาง และสระต่ำ และสำหรับผู้ฟังนั้น การทดสอบการกลืนเสียง ประกอบไปด้วยกลุ่มผู้ฟังคนไทยจำนวน 2 กลุ่ม คือผู้ฟังวิชาเอกภาษาอังกฤษ และผู้ฟังวิชาเอกอื่น นอกจากนี้ การทดสอบการระบุเสียงนั้นประกอบไปด้วยกลุ่มผู้ฟัง 3 กลุ่ม คือ กลุ่มผู้ฟังคนไทย 2 กลุ่มในการทดสอบการกลืนเสียงและกลุ่มเจ้าของภาษาอังกฤษ ซึ่งเป็นกลุ่มควบคุม

สำหรับข้อค้นพบนั้น งานวิจัยนี้ พบว่า ในการทดสอบการกลืนเสียง ผู้เรียนจับคู่เสียงภาษาอังกฤษที่เกิดในภาษาไทยด้วยกับเสียงในภาษาไทยที่แทนด้วยสัญลักษณ์สัทอักษรเดียวกันและไม่มีความแตกต่างในระดับ

ความเหมือนของเสียงเป้าหมายและเสียงภาษาไทยในทุกบริบท ยกเว้นในสระต่ำในการจับคู่เสียงภาษาอังกฤษ /d/ กับเสียง /d/ ของไทย สำหรับเสียงเป้าหมายที่เกิดแต่ในภาษาอังกฤษนั้น ผู้เรียนจับคู่เสียงภาษาอังกฤษกับเสียงในภาษาไทยเหมือนที่ปรากฏในงานวิจัยอื่น ๆ ด้านการออกเสียงเสียดแทรกในภาษาอังกฤษโดยคนไทย ยกเว้นเสียง /θ/ และในด้านระดับความหมือนของเสียงเป้าหมายและเสียงภาษาไทยนั้น ไม่พบอิทธิพลของทั้งสองปัจจัยในระดับความเหมือนของเสียง /t͡ʃ/ และระดับความเหมือนของเสียง /v, z/ ได้รับอิทธิพลจากประสบการณ์ในการเรียนรู้ภาษาเท่านั้น สำหรับระดับความเหมือนของเสียง /θ, ð, ʃ/ นั้น ได้รับอิทธิพลจากปัจจัยทั้งสอง

ข้อค้นพบจากการทดสอบการระบุเสียง พบว่า สำหรับเสียงที่เกิดในทั้งสองภาษานั้น ผู้เรียนระบุเสียงเป้าหมายได้ถูกต้องในเกือบทุกบริบท และระดับความเหมือนของเสียงภาษาอังกฤษเป้าหมายกับเสียงภาษาอังกฤษที่ระบุก็แทบจะเหมือนกันกับที่พบในการทดสอบการกลืนเสียง แต่สำหรับเสียงที่เกิดเฉพาะในภาษาอังกฤษนั้น ผู้เรียนระบุเสียงเป้าหมายด้วยเสียงที่หลากหลาย โดยเฉพาะเสียง /ð, θ/ และระดับความเหมือนของเสียงเป้าหมายที่เกิดในภาษาอังกฤษเท่านั้นกับเสียงที่ระบุก็ไม่ได้เหมือนกันกับผลจากการทดสอบการกลืนเสียงในหลายบริบท ดังนั้น สรุปได้ว่า สมมุติฐานจากการทดสอบการกลืนสียงใช้ทำนายผลลัพธ์การระบุเสียงที่มีในทั้งสองภาษาได้ดีกว่าเสียงที่มีในภาษาที่สองภาษาเดียว

ข้อค้นพบจากทั้งสองการทดสอบนี้ แสดงให้เห็นถึงอิทธิพลเชิงบวกของภาษาที่หนึ่งในการรับรู้เสียงในภาษาที่สองที่มีอยู่ในทั้งสองภาษา นอกจากนี้ ข้อค้นพบเหล่านี้ ยังแสดงให้เห็นถึงอิทธิพลของสระและประสบการณ์ ซึ่งหมายถึง เสียงในภาษาที่สองที่อยู่ในการรับรู้ของผู้เรียนภาษาที่สองนั้น ไม่ได้มีอยู่อย่างอิสระ แต่อยู่ท่ามกลางบริบทที่กำหนดการรับรู้ และผลจากงานวิจัยนี้ ยังบ่งบอกว่า ในการฝึกการเรียนรู้เสียงในภาษาที่สองนั้น ปัจจัยด้านสระและประสบการณ์ในการเรียนรู้ภาษา เป็นสองปัจจัยที่ไม่สามารถละเลยได้

คำสำคัญ: การรับรู้เสียงในภาษาที่สอง, ไทย, อังกฤษ, ผู้เรียนภาษาที่สอง, การกลืนเสียง, การระบุเสียง, เสียงเสียดแทรก

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Chapter 1. Introduction

1.1 Area and topic

It has been widely accepted that the existence of an L2 sound in the L1 phonological system affects the perception at the L2 sound (Best, 1995; Best & Tyler, 2007; Flege, 1995). The 'mechanism of equivalence classification' (Flege, 1995, p. 239) which occurs when the sounds in L1 and L2 are linked to one another in perception might prevent L2 learners from discriminating specific L2 sounds. Two well-known models to explain L2 speech perception are the Perceptual Assimilation Model-L2 (PAM-L2) by Best and Tyler (2007) and the Speech Learning Model (SLM) by Flege (1995). SLM proposes that the L2 sound will be difficult to perceive when it is represented with the same IPA symbol as the one in L1 but it has different phonetic qualities. PAM-L2 stated that the L2 sound contrast will be perceived as L1 sound(s) in different degrees. The SLM bases their hypotheses on individual sound whereas the PAM-L2 bases the hypothesis on sound contrast.

The difficulty in perceiving L2 sound is not solely based on whether the L2 sound exists in L1 sound system; it also depends on many factors (Pilus, 2016). For example, experienced and inexperienced groups were used as subjects when Flege, Bohn, and Jang (1997) investigated the ability to identify four English vowels /i, ɪ, ɛ, æ/ by native German speakers. From these four vowels, only /æ/ does not exist in German. The results showed that the experienced German candidates had better perceptual ability for the identification of /æ/, similar to that of native English speakers, than the inexperienced group. This suggests that English language experience positively affects the perception of L2 listeners. This was supported in the study by Hardison (2003), investigating the perception of American English /ɹ, l/, where the subjects were Korean and Japanese learners. These two sounds do not exist in Japanese sound system whereas one of them: /l/ exists in Korean sound system. Their findings showed that both groups had their perceptual scores lowest in rounded vowels suggesting that the lip rounding might hinder the perception of the L2 sounds. Hence, it is important to take other factors into account when studying the perception of L2 sounds. The generalisation of the L2 learning should only be made when the ease or difficulty of the L2 sound perception occurs in all contexts of the research investigation. Even though research studies, as mentioned, showed the influence of the vowel context and the language experience of the L2 learners towards their L2 sound perception, none of these studies investigate the L2 sound perception with the effect of these two factors

together. It is possible that the perception of the L2 sounds might not be affected by one of these two factors alone, but one factor might be constrained by the other factor.

Regarding the numbers of fricatives in Thai and English, Thai has three fricatives: /f, s, h/ whereas English has nine: /f, v, θ, ð, s, z, ʃ, ʒ, h/. In terms of research on English fricative learning by L2 Thai learners, most studies were carried out to investigate production rather than perception (Brière & Chiachanpong, 1980; Burkardt, 2008; Chunsuvimol & Ronakiat, 2000, 2001; Kitikanan, 2016; Kitikanan, Al-Tamimi, & Khattab, 2015; Richards, 1966; Roengpitya, 2011; Sridhanyarat, 2015). Their main findings showed that L2 Thai learners had difficulty producing L2 English fricatives that do not exist in Thai sound system. The only study on English fricative perception by L2 Thai learners was explored by Pansottee (1992). In her study, English fricative contrasts were differentiated by two groups of Thai children with different age range: six and eight years old. Each group was further divided into having been exposed to English and having no English exposure. The results showed that the sound pair whereby neither L2 sounds exists in L1 was better discriminated than the sound pair with phonemes existing in both languages, or the one where one sound existed in the L2 and the other existed in both. In addition, the sound pair where one sound existed in both languages and the other existed in L2 was better discriminated than the one where both sounds existed in both languages. While the study of Pansottee (1992) is the first study to explore English fricative perception by L2 Thai learners in terms of the discriminating ability, this present study is the first study to explore the English fricative perception in terms of perceptual assimilation and sound identification by L2 Thai learners.

As this study is composed of two experiments: perceptual assimilation and sound identification, their objectives are different from one another. The perceptual assimilation investigates how the L2 Thai learners assimilate the English fricatives (/f, v, θ, ð, s, z, ʃ/) and the sounds that might cause confusion with them (/w, t^h,d, $\widehat{tʃ}$/) to the Thai sound categories. In other words, how English fricatives and relevant English sounds are represented in Thai sounds. It also presents the degree of the perceived similarity between English and Thai sounds. The sound identification explores the ability of L2 Thai learners to identify English fricatives and relevant sounds and the degree of the perceived similarity between the target English sounds that L2 Thai learners hear and the English sounds that

L2 Thai learners select. Both experiments are similar in that they explore the effects of the vowel context and language experience towards the L2 fricative perception.

1.2 Focus and aims of the study

The overall aim of this study is to investigate the perception of English fricative by L2 Thai learners. The L2 Thai learners in this study were the L2 learners of English who lived in L1 country (Thailand) and they had extensive experience learning English as a foreign language (EFL). The language used in teaching at schools was Thai in most modules. Even in many English modules, Thai was still used as a medium of instruction. These learners mainly used English only in some English classrooms. Although sometimes these learners received English input, most inputs were from teachers with the same linguistic background as them. The language used outside some English classrooms, and in their daily lives was Thai. Following Kitikanan (2016) who divided fricatives in her study into two groups, the target sounds in this study are also classified into two main types: shared and non-shared. The 'shared' sounds are sounds that occur in the L1 and L2 sound systems. The 'non-shared' sounds refers to those that occur only in the L2 sound system, but not in the L1 sound system. Three main aims are set for this study as follows.

The first aim is to explore the perceptual assimilation towards L2 fricatives of the L2 learners and the effects of the vowel context and language experience. Although there are many studies on the perceived similarity between L2 sounds and the L1 sounds as perceived by L2 learners, most of them have focused on vowels (e.g., Best, McRoberts, & Goodell, 2001; Escudero & Williams, 2011; Levy, 2009; Strange, Akahane-Yamada, Fitzgerald, & Kubo, 1996). The study of the perceived similarity of L2 fricatives and L1 sound categories is rare - only few studies were carried out (e.g., Best et al., 2001; Bohn, Best, Avesani, & Vayra, 2011; Guion, Flege, Akahane-Yamada, & Pruitt, 2000; Park, 2007). The fricatives in most studies were in the low vowel context (e.g., Guion et al., 2000; Park, 2007). The question whether the same pattern of the perceived similarity is the same across vowel contexts still remains unanswered. In addition, none of them investigated the effect of language experience on the perceived similarity. Hence this study will be the first to include these two factors in the investigation of the perceptual assimilation towards

fricatives of the L2 learners, and the first to explore the perceptual assimilation between L2 English fricatives and L2 Thai learners.

The second aim is to study the sound identification of L2 fricatives by the L2 learners and the effects of the vowel context and language experience. Even though many studies were carried out on the sound identification towards L2 sounds, most of them explored the L2 sound identification ability on vowels (e.g., Bohn & Flege, 1990; Flege, 1991; Ingram & Park, 1997). Only few studies were carried out to explore the sound identification of L2 fricatives (e.g., Lambacher, Martens, Nelson, & Berman, 2001). In addition, even though the vowel context and language experience were found to affect L2 sound perception as mentioned in the previous topic, there was no study on the sound identification of L2 sounds with the effects of these two factors together. This study will be the first study that has both the vowel context and language experience in the investigation of the sound identification of L2 sounds, and it will also be the first study on the sound identification of English fricatives by L2 Thai learners.

The last aim is to investigate to the extent the current models: SLM and PAM-L2 can explain the results of this study. The similarity of these two models is that they both accept in the influence of the L1 sounds towards the L2 sound perception; however some questions still remain: 1) To what extent is the L2 sound perception is affected by the L1 sounds?; and 2) To what extent the vowel effect and language experience affect the L2 sound perception? This study will provide some contribution for these two models in terms of the L2 sound perception.

1.3 Importance of the study

Primarily, this is the first study to investigate the perception of English fricatives and the relevant sounds in terms of perceptual assimilation by L2 Thai learners. It will not only investigate the matching of the sounds, but also the perceived similarity, i.e. L2 Thai learners will not only identify the Thai sounds they feel they are the closest to the sounds they hear, they will also rate the degree of similarity between Thai sounds they select and the sounds they hear. Hence the results of this study will present the patterns of the perceptual assimilation of English sounds and the degree of perceived similarity between

the target English and the responded Thai sounds. They will be useful to other researchers who are interested in the patterns of the perceptual assimilation of L2 sounds to L1 sounds and their perceived similarities.

Secondly, this study investigates the perception of English fricatives and relevant sounds in terms of sound identification by L2 Thai learners. It will explore the identification ability of the English sounds and the degree of similarity that L2 Thai learners feel the sounds they hear is similar to the English sounds they choose. None of the studies on the English fricative learning by L2 Thai learners were carried out to examine the sound identification of the English fricatives and the relevant sounds of L2 Thai learners. Similar to the results of the perceptual assimilation, the results of the sound identification will present the matching of the identified English sounds by L2 Thai learners and the spoken English sounds by native speakers, and their perceived similarities.

Finally, this study explores the effects of the vowel context and language experience towards the L2 sound perception by L2 learners. Many previous studies on L2 sound perception either included one of these two factors, or neither of them. However, it is possible that one factor might be constrained by the other factor. This study is thus the first study to investigate the effects of these two factors together on the perception of L2 sounds. It is hoped that this will benefit the researchers who are interested in the influence of the factors on the L2 sound learning.

1.4 Research questions

There are three main research questions for this study:

1. What are patterns of the perceived similarity of the English fricatives and related sounds, and Thai sound categories by L2 Thai learners?

    1.1 To what extent the perceived similarity of the English fricatives and related sounds, and Thai sound categories by L2 Thai learners is effected by the vowel context? (Chapter 3)

1.2 To what extent the perceived similarity of the English fricatives and related sounds, and Thai sound categories by L2 Thai learners is effected by the language experience? (Chapter 3)

2. What are patterns of the sound identification of the English fricatives and the related sounds by L2 Thai learners?

2.1 To what extent the sound identification of the English fricatives and related sounds, and Thai sound categories by L2 Thai learners is effected by the vowel context? (Chapter 4)

2.2 To what extent the sound identification of the English fricatives and related sounds, and Thai sound categories by L2 Thai learners is effected by the language experience? (Chapter 4)

3. To what extent do current models, SLM and PAM-L2 explain the results of the L2 speech perception in this study? (Chapter 5)

1.5 Organisation of the study

There are five chapters in this study. The first chapter is the introduction. It presents the area and topic of the L2 fricative perception by L2 Thai learners which is the focus of this study, followed by focus and aims of the study, importance of the study, research questions and organisation of the study.

Chapter Two is about the reviews of the current influential models of L2 phonology, i.e. PAM-L2 and SLM. It also highlights on the gaps within these two models. As this study is related to the other two factors: vowel context and language experience, the presentation of these two factors in relation to the L2 sound perception will be in this chapter. This chapter also contains the description of fricatives in Thai and English, and the studies on the perceptual assimilation and the sound identification of English fricatives by L2 learners.

Chapter Three is designed to explore the perceived similarity of the English fricatives and the related sounds, and Thai sound categories by L2 Thai learners with the effects of the vowel context and language experience (research question 1). The analyses for each target

sound in this chapter will be divided into two sections: 1) overall results; and 2) linear mixed model (LMM) results on the perceptual assimilation. While the overall results show the matching of the English sounds and their closest Thai sounds, the results from LMMs shows whether there are differences in the perceived similarity between groups of L2 Thai learners and if there is the effect of the vowel context.

Chapter Four investigates the sound identification of the English fricatives and related sounds, and Thai sound categories by L2 Thai learners with the effects of the vowel context and language experience (research question 2). Similar to Chapter Three, the analyses for each target sound in this chapter will be divided into two sections: 1) overall results; and 2) LMM results on the sound identification. The overall results present the matching of the target English sounds and their identified English sounds, and the LMM results show whether there are differences in the degree of the sound identification between groups of listeners, namely two groups of L2 Thai learners and a group of native speakers of English and if there is the effect of the vowel context.

Chapter Five presents the discussion on the extent the current models, namely PAM-L2 and SLM can explain the results of this study and the extent the results in this study can contribute to them (research question 3). This chapter also includes overall conclusions, directions for future study and limitations of the study.

Chapter 2. Review of the literature

2.1 Introduction

This chapter begins with the significant models of L2 phonology in section 2.2. In this section, the two models are presented: the Perceptual Assimilation Model-L2 (PAM-L2) and the Speech Learning Model (SLM). The end of this section (section 2.2.3) will present the evaluation of the degree to which these two models can explain the perception of English fricatives and the relevant sounds by L2 Thai learners.

Section 2.3 explores the previous studies on the factors in L2 perception. As there are two factors: the vowel context and the language experience to be investigated for their effects in this study, the previous studies on these two factors will be described in this section.

In section 2.4, as this study explores the perceptual assimilation and sound identification with English fricatives and relevant sounds as L2 sounds and Thai sounds as L1 sounds, this section shows the descriptions the English and Thai fricatives.

In section 2.5, the studies on the perceived similarity of English fricatives and L1 sound categories by L2 learners is presented to allow us to see the gap of the research in this area. As this study is composed of two experiments: perceptual assimilation and sound identification task, section 2.6 presents the previous studies on the sound identification of English fricatives by L2 learners.

2.2 Significant models of L2 phonology

In this section, two influential models on the L2 sound perception will be presented: the Perceptual Assimilation Model-L2 (PAM-L2) and the Speech Learning Model (SLM). The details of each model are as follows.

2.2.1 Perceptual Assimilation Model-L2 (PAM-L2)

The Perceptual Assimilation Model-L2 (PAM-L2) was developed from the Perceptual Assimilation Model (PAM). While PAM was developed by Best (1995), PAM-L2 was created by Best and Tyler (2007). Both of these models are based on perception rather than production. According to PAM, the naïve listeners or the learners with little or no experience in L2 are unable to distinguish nonnative sounds when the sound contrast is

produced with the same articulator as the sounds in their L1. While the target group of PAM is the naïve listeners, PAM-L2 focuses on L2 learners who learn the L2 to achieve many purposes, such as to fulfil functional and educational requirements. The L2 learners of PAM-L2 are learners in the 'natural communicative situations' (Best & Tyler, 2007, p. 17) rather than manipulated contexts as in the classroom. Both PAM and PAM-L2 based their prediction and the explanation of L2 sounds on sound contrast.

In PAM-L2, before making predictions, the L2 sounds are classified into L1 sounds by the L2 learners and the degree of the perceived similarity is rated using rating scale. The percentage of sound classification and goodness rating are used to classify L2 sound contrast into types of L2 sound contrast assimilation. However, the predictions are subjective as PAM-L2 does not provide the ranges of recommended scales to be used for goodness ratings in the L2 sound contrast classification (Almbark, 2012). According to PAM-L2, there are four types of L2 sound contrast assimilation:

1) Two-category (TC) assimilation: both L2 sounds are equally assimilated to L1 sound categories. One L2 sound is perceived as one L1 sound, and the other L2 sound is perceived as the other L1 sound.

2) Category goodness (CG) assimilation: both L2 sounds are assimilated to the same L1 sound but one is perceived as more similar to that L1 sound as the other.

3) Single-category (SC) assimilation: both L2 sounds are assimilated to the same L1 sound with the same degree.

4) Uncategorised-uncategorised (UU) assimilation: neither L2 sounds are assimilated to L1 sound as they are too different from the L1 sounds.

In terms of factors relevant to the L2 sound perception, four factors are involved in PAM-L2: word frequency, vocabulary size, amount of L2 exposure and input from L2 native speakers. Among these four factors, the amount of L2 exposure is relevant to the factor in this study as it is related to the language experience. The influence of this factor in relation to PAM-L2 is supported by the study of Fabra and Romero (2012) investigating the categorical discrimination test for the perception of English vowel contrasts by Catalan learners. The subjects in their study had various degrees of English proficiency. The English

vowel pair /ɑ/-/ʌ/ were classified as single-category assimilation as 64% of English /ɑ/ was identified as Catalan /a/ while 47% of English /ʌ/ was identified as Catalan /a/; thus the discrimination rate is predicted to be poor. Their findings showed that the overall discrimination of this contrast was poor as predicted as both sounds were assimilated to /a/. However, proficient learners had the highest score for the discrimination, followed by mid-proficient and low-proficient. This suggests that there is a positive correlation between proficiency of the L2 learners and discriminating ability.

2.2.2 Speech Learning Model (SLM)

Flege (1995) developed the Speech Learning Model (SLM) to account for changes in the L2 speech learning across the life span. This model considers the similarities between L1 and L2 sounds based on phonological and phonetic properties. The target group of this model is experienced bilinguals with many years of experience using L2. The focus of this model is on perception rather than production. However, this model proposes that L2 learners can produce L2 sound accurately when they can accurately perceive it.

Regarding types of L2 sounds in SLM, this model divided the L2 sounds into three categories: new, similar and identical (Flege, 1992). The new sound is the sound that does not occur in the L1 sound system and is phonetically different from L1 sound. The similar sound is the sound that occur in the L1 sound system as shown by similar IPA symbol, but is phonetically different from L1 sound. The identical sound is the sound that occur in the L1 sound system as shown by similar IPA symbol, and is phonetically similar to L1 sound. Hence from our target sounds (/f, v, θ, ð, s, z, ʃ, w, t^h,d, t͡ʃ/), the new sounds are /v, θ, ð, z, ʃ, t͡ʃ/ whereas the rest is either identical or similar sounds depending on their acoustic qualities. According to SLM, a different sound (a new sound) is easier to learn than a similar sound. Hence these sounds: /v, θ, ð, z, ʃ, t͡ʃ/ which do not occur in Thai sound system should be easy for L2 Thai learners. In other words, L2 Thai learners should have low degree of the perceived similarity between these sounds compared to the closest L1 Thai sounds in the perceptual assimilation task; so it follows that they should have high degree of the accurate identification of them in the sound identification task. SLM predicts the following for L2 learners:

1) The mechanisms and processes that L2 learners use for the L2 learning is the same one as the one they use for the L1 learning.

2) The unique characteristics of sounds which is phonetic categories exist in long-term memory.

3) The specific phonetic aspects of the L1 and L2 sounds develop together with the L2 learners develop their languages throughout their lives.

4) While maintaining contrasts between L1 and L2 phones, these phones exist in the same phonological space in bilinguals.

Additionally, SLM proposes the following seven hypotheses:

1) L2 learners are sensitive to differences between L1 and L2 sounds allophonically rather than phonemically, such as when they are located in specific positions in a syllable.

2) The new phonetic category of the L2 sound that is different from the L1 sound will be created when bilinguals can discern differences between L1 and L2 sounds.

3) The ease for bilinguals to acquire the L2 sounds depends on the differences between the L1 and L2 sounds as perceived by L2 learners.

4) L2 learners acquire the L2 easier when they are younger.

5) The 'mechanism of equivalence classification' (Flege, 1995, p. 239) may inhibit the ability of L2 learners to discriminate specific L2 sounds. If this happens, a diaphone which is the two sounds (one in L1 and the other in L2) that are linked to one another in perception will have similar phonetic properties in production, such as producing L1 sound with L2 sound quality.

6) The sounds produced by bilinguals and monolinguals might be different in terms of the phonetic category. L2 learners will also try to maintain the phonetic contrast between categories in a shared L1 and L2 phonological space.

7) Finally, L2 learners will achieve the ability to produce L2 sounds in a native-like manner.

2.2.3 L2 Speech models: summary and gaps

There are some differences in these two models. First, the PAM-L2 accounts for the perception of non-native sound contrasts by L2 listeners whereas the SLM explain changes in L2 speech learning across the life span. Second, while the PAM-L2 focuses on only perception, the SLM focuses on both perception and production. The similarity of these models is that they both accept the transfer of the L1 on the L2 speech learning. Although the PAM-L2 will not be used to generate specific hypothesis for this study as this study focuses on the perception of L2 sounds at individual level, i.e. one sound at a time while the PAM-L2 focuses on the sound contrasts, it can be used to generate the general hypothesis as it proposes that the learning of L2 sound is depended on the perceived similarity of L1 and L2 sounds. It is also useful in explaining the positive effect of the language experience in case that the English-major group has better ability to identify English fricatives and the relevant sounds than the non-English-major one as it proposes that high exposure to the L2 will enhance the ability to perceive the L2 sounds.

The SLM cannot generate the specific hypotheses for the perceptual assimilation task as it does not deal with the perceived similarity between L1 and L2 sounds from the perception of the L2 Thai learners. However, the hypotheses for the identification task by the SLM can be generated after the perceptual assimilation task as the SLM proposed that when the likelihood of category formation increases, the perceived cross-linguistic similarity decreases. Hence the predictions from the SLM and the PAM-L2 will be made after the results of the perceptual assimilation are out.

2.3 Factors in L2 perception

2.3.1 Vowel context

Many studies (e.g., Hardison, 2003; Schmidt, 1996) showed the effect of vowel context over language learning. For instance, the study of Schmidt (1996) showed that Korean learners had difficulty discriminating English /m, n, j, p, t, k, h/ when they were in back vowel context as compared to high and low vowel contexts. The other example is from Hardison (2003) which showed that the perceptual scores of American English /ɹ/ and /l/

as perceived by Korean and Japanese learners were lowest in rounded vowels. This difficulty in discrimination suggests the negative influence of lip rounding on these two vowels. However, it is not only vowel context that matters.

This factor is also constrained with other factors, such as the target sound. For example, in the study of Lambacher et al. (2001) exploring the identification of English fricatives /f, s, ʃ, θ, h/ by L2 Japanese learners in five vowel contexts /i, ɛ, a, o, u/. Their findings showed that the identification rates of /θ/ were lowest in /ɛ/ vowel context. /i/ was the most difficult vowel context for /ʃ, s/. /u/ was the most difficult vowel context for /f, h/ for this group of learners. Their findings suggest that the vowel context is constrained with the target sounds. As there might be some correlation of the vowel context and other factors, this study will examine the influence of the vowel context in relation to the L2 experience to see how these factors are relevant to the L2 perception.

2.3.2 Language experience

Many L2 phonological theorists (e.g., Best & Strange, 1992; Flege, 1995) claimed that L2 experience may increase the ability to discern the differences between L1 and L2 sounds. Many studies (e.g., Bohn & Flege, 1990; Flege et al., 1997; Ingram & Park, 1997) support this claim. For example, in the study of Flege et al. (1997), L2 learners of German, Spanish, Mandarin and Korean were divided into experienced and inexperienced to investigate their production and perception of English vowels /i, ɪ, ɛ, æ/. The findings showed that the experienced group had higher ability to produce and perceive the English vowels than the inexperienced one. Bohn and Flege (1990) also explored the effect of experience towards these four English vowels as perceived by L2 German learners of English. These subjects were divided into two groups: experienced German and inexperienced German. The findings showed that the way experienced German group distinguished /ɛ/ from /æ/ was similar to that of native English listeners while it was different from inexperienced German group.

However, some studies (e.g., Bohn & Flege, 1990; Flege, Munro, & Fox, 1994; Munro, 1993) did not show the support of language experience over L2 learning. For example, even though Bohn and Flege (1990) found the positive effect of the language experience

towards perceptual discrimination for /ɛ/-/æ/ as stated above, they did not find this factor useful in distinguishing /i/-/ɪ/. Similarly, Flege et al. (1994) had found no significant effect of language experience in the dissimilarity rating of stimuli of many English and Spanish vowels as perceived by L2 Spanish learners. It seems that the issue of the correlation between L2 experience and English learning is still inconclusive. This paper will explore the effect of the L2 experience in relation to the vowel contexts towards L2 English fricative perception.

2.4 Fricatives in Thai and English

While English has 24 consonant sounds, Thai has 21. The number of fricatives in English is hugely more than Thai with nine fricatives in English, /f, v, θ, ð, s, z, ʃ, ʒ, h/ and three fricatives in Thai, /f, s, h/. As all fricatives are made with two articulators close to each other, the air from the lung can go through them with difficulty. Fricatives in English can occur in all positions in a word: initial, medial and final whereas in Thai, they can occur only in initial position of the word. Only fricatives in initial position will be review in this study as fricatives in other positions are not the focus of our study. The details of fricatives in each language are presented as follows.

2.4.1 English fricatives

From all English fricatives, /h/ and /ʒ/ are excluded in this study. Hence this section is the review on seven fricatives: /f, v, θ, ð, s, z, ʃ/. Starting from /f/ and /v/ which are labiodental fricatives, according to Aslaksrud and Haarberg (1967) and Carr (1999), these two sounds are made with lower lip pressing firmly against the upper teeth. They are also produced with a bunched tongue body, a raised tongue dorsum, lowered anterior and posterior and downward pointing tip (Narayanan, Alwan, & Haker, 1995).

/θ/ and /ð/ are interdental fricatives. They are articulated with the tongue tip placing close to the upper teeth (Aslaksrud & Haarberg, 1967; Carr, 1999). In many accents, these two fricatives are stop-like. For /θ/, in Scotland, it could be pronounced as [t] (Stuart-Smith, 2004); in Liverpool, it can be a dental stop [t̪] (Watson, 2007) and in London, this sound can be [f] (Labov, 1969). For /ð/, many British speakers pronounce it as [d] (Labov, 1969) and

in Liverpool, it could be a dental stop [d̪] (Watson, 2007). In many British varieties, [f] is used for /θ/ and [v] for /ð/, such as in Newcastle (Watt & Milroy, 1999), Milton Keynes, Reading and Hull (Williams & Kerswill, 1999). The use of dental fricatives for these two fricatives are common in London working-class people (Trudgill, 1988) and other low-status urban varieties (Kerswill, 2003). In some American varieties such as Cajan English which is a dialect of Southern American English, /ð/ is pronounced like [d] (Dubois & Horvath, 1998).

/s/ and /z/ are alveolar fricatives. They are made with the blade of the tongue and the alveolar ridge with the tongue tip either raised towards the teeth ridge or resting against the lower teeth (Aslaksrud & Haarberg, 1967). According to Strevens (1960), /s/ is produced with a narrow slit and might be followed by a deep groove and pit in the tongue. Smith (1997) found that /z/ is commonly wholly or partially devoiced.

/ʃ/ is post-alveolar fricative and is articulated with the tongue blade raising towards the hard palate or the alveolar ridge, and /s, z/ is produced with articulators more forward than /ʃ/, but /ʃ/ is made with the protruded lips (Aslaksrud & Haarberg, 1967). The contraction is also slit-like and wider than /s, z/, and /ʃ/ are approximately 5-10 mm away from /s, z/ (Narayanan et al., 1995). Comparing /ʃ/ to /s/, /ʃ/ is made with a wider turbulence area (more grooved) than /s/ (Strevens, 1960).

In terms of acoustic view, voiced fricatives are found to be shorter than the voiceless ones (Crystal & House, 1988) and have shorter normalized amplitude and relative amplitude (Jongman, Wayland, & Wong, 2000). The lower value might be due to the lower volume velocity for the obstruction area (Jesus & Shadle, 2002). In English these seven fricatives are divided into two groups: sibilants (/s, z, ʃ, ʒ/) and non-sibilants (/f, v, θ, ð/). The sibilants have higher normalized and relative amplitude than non-sibilants (Hedrick & Ohde, 1993). Although findings of many studies have shown that labiodental fricatives cannot be well-distinguished from the dental ones by spectral moments (Forrest, Weismer, Milenkovic, & Dougall, 1988; Jongman et al., 2000), labiodental fricative has higher peak location but lower onset F2 frequency than interdental fricative (Jongman et al., 2000).

For /s/ and /ʃ/, /s/ has higher frequency in spectra than /ʃ/ (Hughes & Halle, 1956) resulting in higher centroid of /s/ than that of /ʃ/ (Tagliamonte, 2013). As the spectra of /ʃ/ is more positively skewed than /s/, the skewness of /ʃ/ is higher than that of /s/ while the kurtosis

of /ʃ/ is lower than that of /s/ (Nittrouer, 1995). However /s/ has lower relative amplitudes than /ʃ/ (Hedrick & Ohde, 1993) although /s/ has higher peak location than /ʃ/ (McGowan & Nittrouer, 1988). As /f/ and /s/ in English also occurs in Thai, the acoustic comparison between Thai /f/ and English /f/, and Thai /s/ and English /s/ will be in the following section.

2.4.2 Thai fricatives

As mentioned earlier, there are three fricatives in Thai /f, s, h/; however, we will review only /f, s/ as /h/ will be excluded from this study as the same reason as English /h/. For Thai /f/, it is also labiodental fricative like English /f/. According to Harris (1972), before close front vowels, this sound can be produced as voiceless labio-dental velarized fricative [fˠ]. Thai /s/ is a voiceless lamino-alveolar grooved fricative (Harris, 1972). It can also be realised as voiceless lamino-dental flat fricative or voiceless lamino-dental grooved fricative (Harris, 1972). Before close front vowels, Thai /s/ can be a voiceless denti-alveolar grooved fricative, or a voiceless lamino-alveolar velarized groove fricative (Harris, 1972). The variation of Thai fricative is speaker- and vowel-context dependent.

In terms of acoustic point of view, two studies were carried out (Kitikanan, 2016; Roengpitya, 2011). Roengpitya (2011) explored the acoustic properties of Thai and English fricatives as produced by three Thai females. The acoustic measurements in her study include amplitude, duration, *f*0 and formant frequencies. Her target sounds are Thai fricatives: /f, s/ and English fricatives /f, v, θ, ð, s, z, ʃ, ʒ/. However, no conclusion of how two groups of fricatives are different from each other was provided. Furthermore, although Harris (1972) pointed out the influence of the vowel context towards Thai fricative production and many studies showed the effect of the vowel context towards English fricatives (e.g., Jongman et al., 2000), she did not control the vowel context in her acoustic analysis.

The other acoustic study is carried out by Kitikanan (2016). Thai fricatives /f, s/ were compared with those in English. Thai and English fricatives were produced by native speakers of each language. This study controlled for gender and vowel context. The interpretation of /f/ was in level of effort whereas the interpretation of /s/ was in frontness. For /f/, it showed that in overall level, kurtosis of Thai /f/ was higher than that of English /f/

which means Thai /f/ is produced with more effort than English /f/. In female context, centroid of Thai /f/ was higher than that of English /f/ signifying that Thai /f/ are produced with more effort than English /f/ whereas SD of English /f/ was higher than that of Thai /f/ meaning the opposite. In male context, normalized amplitude of Thai /f/ was higher than that of English /f/ which means Thai /f/ is produced with more effort than English /f/. In high and low vowel contexts, centroid and normalised amplitude of Thai /f/ was higher than that of English /f/ signifying that Thai /f/ is produced with more effort than English /f/ whereas SD of English /f/ was higher than that of Thai /f/ so suggesting the opposite interpretation. In back vowel context in female production, onset F2 frequency of English /f/ was higher than that of Thai /f/ suggesting that English /f/ was produced with higher effort than Thai /f/.

In the same study (Kitikanan, 2016), for /s/, in overall level, peak location of Thai /s/ was higher than that of English /s/ suggesting that Thai /s/ is produced is more forward than English /s/. In female and male productions and back vowel context, centroid of Thai /s/ was higher than that English /s/ whereas onset F2 frequency of English /s/ was higher than that of Thai /s/. These two findings suggest that Thai /s/ is more forward than English /s/. In high vowel context, centroid of Thai /s/ was higher than that of English /s/ suggesting that Thai /s/ is more forward than English /s/. in low vowel context, centroid of Thai /s/ was higher than that of English /s/ whereas skewness of English /s/ was higher than that of Thai /s/. These two findings suggest that Thai /s/ is more forward than English /s/. The findings of Kitikanan (2016) showed that the acoustic properties of Thai and English /f, s/ are context-dependent.

2.5 Studies on the perceptual assimilation of English fricatives by L2 learners

To the best of my knowledge, only a small number of studies (e.g., Bohn et al., 2011; Guion et al., 2000; Park, 2007) were carried out on the perceived similarity between L1 and L2 sounds by L2 learners. The first example is from Guion et al. (2000) that Japanese listeners' perceptual mapping between English and Japanese consonants categories was investigated. Their target English consonants were /b, v, w, θ, t^h, s, ɹ, l/. From these sounds, /v, w, θ, ɹ, l/ did not exist in Japanese sound system. /v/ in Japanese was merely an orthographic representation that was used primarily in writing loan words. These sounds

were followed by /a/. The goodness ratings were from 1 (bad example) to 7 (very good example). Their findings showed that 1) English /v/ was mostly perceived as Japanese /v/ (goodness rating: 4.4); 2) English /w/ was mostly perceived as Japanese /ɯ/ (goodness rating: 3.5); 3) English /θ/ was mostly perceived as Japanese /s/ (goodness rating: 3.8); 4) English /t^h/ was mostly perceived as Japanese /t^h/ (goodness rating: 3.9); 5) /s/ in English was perceived as /s/ in Japanese (goodness rating: 4.5). Their findings suggest that for English fricative contrast that does not occur in Japanese sound system, i.e. /v/-/w/, they are assimilated to different Japanese sound categories whereas for English fricative contrast that one occur in L1 sound system, i.e. /θ/-/s/ and /θ/-/t^h/, both of them are assimilated to the same Japanese sound category.

The study of Park (2007) is the second example examining the perception of English stops and fricatives through the filter of Korean consonants by Korean learners of English. The target English consonants were /p^h, b, f, v, t^h, d, s, z, θ, ð/ in various positions. The sounds that do not occur in Korean are /b, f, v, d, z, θ, ð/. However, Korean has two versions of unaspirated /p, s, c, k/, i.e. lax and tense. The tense one is represented with /'/ after the symbol. These sounds were presented in nonsense words in an /a/ context. Korean listeners listened to each stimulus and were asked to choose the consonant they heard as presented in Korean orthography. The results from the onset position showed that 1) English /v/ was mostly assimilated to Korean /p/; 2) English /f/ to Korean /p^h/; 3) English /θ/ to Korean /s'/; 4) English /t^h/ to /t^h/; 5) English /f/ to /p^h/; 6) English /s/ to /s'/; 7) English /ð/ to /t/; 8) English /d/ to /t/; 9) English /z/ to Korean /c/; and 10) English /s/ to Korean /s'/. Their findings suggest that when the contrasts are English fricative sounds that do not exist in Korean sound system, Korean learners are more likely to assimilate them with two different sounds in Korean, similar to when one English sound in a contrast occur in L1 sound system. However, the author did not ask the listeners to rate the goodness of fit. In addition, Bohn et al. (2011) examined the perceptual assimilation of L2 English sounds and L1 Danish and Italian ones. In this study, Danish and Italian speakers listened to English /b, v, w, ð/ followed by an /ɑ/ vowel and were asked to identify these in terms of their L1 consonants. Both English and Italian had /b, v, w/ as phonemes, but Italian /b/ was pre-voiced as [b] whereas English /b/ in initial position was short-lag voiceless [p]. Danish did not have /w/, but had /b/ realised as [p], and /v/ as [v]. /ð/ did not occur in both Italian and

Danish. These learners were asked to write any orthographic labels including English to response to the AXB discrimination task. The results showed that: 1) English /v/ was mostly assimilated to /v/ for both groups; 2) English /w/ to /w/ for Italian speakers; 3) English /w/ to /v/ for Danish speakers; and 4) English /ð/ to /d/ for both groups. Their findings suggest that the existence of the L2 sound in the L1 sound system promotes the assimilation of the L2 sound to the L1 sound of the same category, and although the L2 sound does not exist in the L1 sound system, L2 learners will assimilate it to the L1 sound that is produced in the same or closer area of articulation to the L2 sound.

As stated that the number of studies on the perceived assimilation of L2 English fricatives and L1 sound categories are rare, and there is no study on this aspect of L2 English fricatives and Thai sound categories. Whereas some studies showed that Thai learners often replaced English sounds with Thai sounds, such as replacing /v/ with /w/ (Chunsuvimol & Ronakiat, 2000, 2001), it is interesting to investigate whether English sounds will be matched to the same L1 Thai sounds as it showed in the previous literature on the L2 fricative production by L2 Thai learners (e.g., Kanokpermpoon, 2007; Richards, 1966; Roengpitya, 2011). If yes, then this might support the idea that the relationship of perception and production in L2 sound learning is one-to-one. This study also takes the vowel context and language experience into account as these two factors might influence the perceived similarity of the L2 sound contrasts.

2.6 Studies on the sound identification of English fricatives by L2 learners

A fair number of studies on the sound identification of English fricatives by L2 learners were carried out. For example, Lambacher et al. (2001) investigated an identification ability of English voiceless fricatives /f, s, ʃ, θ, h/ by Japanese learners in five vowel contexts /i, ɛ, a, o, u/. From these five sounds, /h (realised as [ɸ, ç, h]), ç, s/ occurred in Japanese. Their findings showed that for /θ/, the identification rates were lowest in /ɛ/ vowel context. For /ʃ, s/, the most difficult vowel context was /i/. For /f, h/, /u/ was the most difficult vowel context for this group of learners. Their study suggests that in the identification of English fricatives by L2 learners, the vowel context is constrained by the perception of the target sounds.

However, the vowel context does not always affect the L2 English fricative identification. Cheon (2005) explored the English fricatives /s, ʃ/ identification by L2 Korean learners. /ʃ/ did not exist as a phoneme in Korean sound system. The target fricatives were in the initial position in /i, a, u/ contexts. In his study, the subjects were divided into three groups: beginners, advanced learners and native speakers of English. The groups of L2 learners were categorised according to the length of residence in the US, i.e. the average length of US residence in the advanced group was 5.6 years and the one in the beginning group was 0.9 years. The findings showed that all three groups had 100% of correct identification of English /s/. The scores of correct identifications of /ʃ/ of both L2 advanced group and native speakers of English were not different from one another, i.e. both groups had 100% correct identification of both sounds in all vowel contexts while the scores of both groups were better than the one of the beginners group suggesting that experience in L2 improves the L2 learning. However, the beginner group had over than 95% of correct identification of /ʃ/ in all vowel contexts although the /ʃ/ identification was more correct in the low and back vowel contexts as opposed to the high vowel context. No significant effect of the interaction between the vowel context and group of speakers was found.

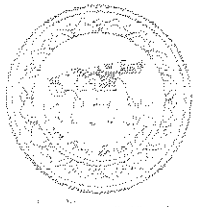
The use of L1 which is one type of language experience was also found to be correlated to the identification of L2 English fricatives. In the study of MacKay, Meador, and Flege (2001), the native speakers of Italian identified English consonants in English letters in noise to explore the effect of age of arrival (AOA), L1 use and phonological short-term memory. The Italian speakers were divided in to four groups: early-low, early, mid and late. Early-low group and early group had the same average AOA (7 years) but early-low had less used of Italian. The mid group had average AOA of 14 years, and the late group had average AOA of 19 years. For the English fricatives, /f, v, θ, s, z, ʃ/ were investigated. From these fricatives, /θ, z/ did not occur in Italian. The findings were not classified according to type of sounds. However, the findings of four groups of speakers, i.e. early, mid and late and native speakers of English showed that Italian speakers who often used L1, i.e. early, mid, and late groups, had less accurate identifications of English consonants than native speakers of English suggesting that the differences in phonological systems between L1 and L2 cause difficulty in the perception. The effect of AOA in early, mid and late groups was not found. When three groups: early-low, early, native speakers of English were compared, it was

found that early group were less accurate for consonant identification than native speakers of English while there was no significant difference between the native speakers of English and early-low group. This suggests that less use of L1 enhances the ability to identify L2 sounds.

However, the effect of the language experience does not always influence the identification ability of the L2 sounds. In the study of Reis (2006), 24 Brazilian speakers identified English /θ, f, t, s, ð, v, d, z/. /θ, ð/ existed only in English. These speakers were divided into two groups: advanced Brazilian speakers (GA) and pre-intermediate Brazilian speakers (GI). One group of native speakers of English (NS) was included as a control group. The /θ, f, t, s/ were grouped together to investigate the perception of English /θ/ - these sounds were tested in the /aɪ/ vowel context. Similarly, /ð, v, d, z/ were also grouped together to investigate the perception of English /ð/ - they were in the /iː/ vowel context. The findings showed that for the voiceless sounds /θ, f, t, s/, all groups had over than 85% overall correct identification, and there was no significant differences between groups. However /f/ and /θ/ were the most difficult sounds. For the correct identification of /f/, GI had 83%, GA had 82% and NS had 84%. For the correct identification of /θ/, GI had 67%, GA had 92% and NS had 96%. For the voiced sounds /ð, v, d, z/, all groups had over 85% overall correct identification as the voiceless ones. The /ð/ was the most difficult sounds for the learners as both groups had less than 70% correct identification for this sound while the NS had 100% correct identification. For the identification of /z/ and /v/, the GA and GI had higher scores of the correct identification than the NS. For all groups, English /ð/ was incorrectly identified as /v/ 35 out of 41 times of the total incorrect identification, and English /v/ was incorrectly identified as /ð/ 11 out of 12 times of the total incorrect identification. The findings that no significant differences were found between groups when the effect of the voicing were tested suggesting that the language experience might not always affect the L2 sound identification of the L2 learners.

The above studies showed that in the identification of the L2 English fricatives, many factors, such as vowel context, the use of L1, and language experience might play role. However, these factors do not always affect the ability to identify these sounds as shown in Reis (2006) and Cheon (2005). In addition, most previous studies did not investigate the perceived similarity between the identified English sounds with the target English sounds.

This study is the first study to carry out the exploration of the perceived similarity of these two sounds as the listeners also rated the degree of the similarity between these two sounds after they identified them. The findings of the perceived similarity between these two sounds are used to find out to what extent the predictions of the perceived similarity from the perceptual assimilation task were accurate.



Chapter 3. Perceptual assimilation of L2 English fricatives and the effects of vowel context and language experience

3.1 Introduction

This chapter presents the perceptual assimilation of English fricatives and the relevant sounds, and the closest Thai sound categories with the effects of the vowel context and language experience. The aim of this chapter is to investigate the patterns of the perceptual assimilation, and the perceived similarity between English sounds L2 Thai learners hear and Thai sounds that L2 Thai learners select. The hypotheses for this experiment are:

1) it was hypothesised that the shared sounds would be assimilated to the same Thai categories as they were represented with the same IPA symbols suggesting that they were similar in terms of target-likeness. Hence the L2 Thai learners would select the L1 Thai categories that were represented with the same IPA symbols as the L2 sounds;

2) It was expected that the /v/ would be mostly classified as Thai /w/ (Chunsuvimol & Ronakiat, 2000, 2001); /θ/ as Thai /t/ (Brière & Chiachanpong, 1980; Burkardt, 2008; Richards, 1966), /ð/ as Thai /d/ (Brière & Chiachanpong, 1980; Burkardt, 2008; Richards, 1966), /z/ as Thai /s/ (Brière & Chiachanpong, 1980; Richards, 1966), /ʃ/ as Thai /t͡ɕʰ/ (Brière & Chiachanpong, 1980) and /t͡ʃ/ as Thai /t͡ɕʰ/ (Kanokpermpoon, 2007).

3) It was hypothesised that there would be no effect of language experience nor the vowel context on the perceptual assimilation of shared English sounds by L2 Thai learners as these sounds also occur in Thai sound system, L2 Thai learners, regardless of language experience should benefit from this resulting in the selection of the same phonemic categories as L2 shared sounds across vowel contexts.

4) For the non-shared L2 sounds, it was predicted that non-English-major learners would assimilate them to the closest L1 categories with higher degree than the English-major ones and there would be the effect of the vowel contexts on these assimilations.

In addition, the results of this chapter will be used to make predictions to the sound identification task which is the next chapter.

3.2 Methodology

3.2.1 Listeners

The listeners for the experiment were 54 speakers of Thai who were divided into two groups: English-major and non-English-major. They were university students in Thailand who studied English as EFL – mainly using the L2 in classroom. Out of 54 listeners, 28 were classified as an English-major group. They were English-major students who received phonetic training in English Phonetics and Phonology module (mean = 19.04 years, range = 18-20 years). The phonetic training was approximately three months focusing on all sounds in English sound system including English fricatives without comparison to sounds in Thai sound system. The training also provides the knowledge of English sound structure, intonation and phonotactic rules. The other 26 listeners were classified as an non-English-major group. They were non-English-major students who never received training in phonetics (mean = 19.88 years, range = 19-20 years). The listeners reported no hearing problems and agreed to participate in the experiment in exchange for payment.

3.2.2 Stimuli

The target fricatives were /f, v, θ, ð, s, z, ʃ/ in onset position. The other relevant sounds were /w, t^h, d, t͡ʃ/. These sounds were produced in three vowel contexts: high, low, back by four female English native speakers. The target sounds were produced in real words in a carrier phrase and repeated for five times. The recordings took place in a sound-proof room in the Speech Sciences Section at Newcastle University using an Edirol R-44 recorder connected to a microphone with a frequency response from 15 kHz to 20 kHz. The sampling rate was at 44 kHz, mono channel (16-bit quantisation). Then to ensure the target-likeness of the sound tokens, each word was listened to by four native speakers of English who were phonetically trained. These listeners focused on the initial consonants and rated them from (1) 'bad example' to (5) 'very good example' (Guion et al., 2000). 60% of the words in each vowel context that had the rating scores higher than 4 were used in this task. The number of English stimuli was 396 ((11 consonants x 3 vowels) x 4 speakers x 3 times). The target sound and the following vowel were extracted in Praat and windowed by a parabolic function with intensity normalisation of 65 dB.

3.2.3 Procedure

Each listener heard the stimuli in a quiet room at Naresuan University, Thailand. The experiment was run with a script on Praat MFC (Boersma & Weenink, 2016) on a PC. The listeners listened to the stimuli over headphones while played through the computer. They clicked the answer using a mouse and were always presented with eight alternatives: 'ฟ, ว, ต, ท, ส, ด, ช, จ'. These letters represented that following Thai sounds /f, w, t, t^h, s, d, $\widehat{tɕ^h}$, $\widehat{tɕ}$/ respectively.

The following instructions were presented on the screen: 'You will hear a consonant-vowel sequence. Pay attention to the consonant sound and choose the Thai sound that is most similar to the sound you heard. Then rate the similarity of the Thai sound to the sound you heard on a scale from 1 (very different) to 7 (very similar). The number of trials is 684, and you can take a break every 50 trials. You can see how far you are from the end by looking at the left top corner of the screen. To continue, click the mouse'. The instruction was in the listeners' L1 in order to minimise any barrier that may be due to lack of proficiency in English. They could hear the stimuli as many times as they liked by clicking 'replay' button. After they were certain about their answer, they then clicked 'OK' button to move to the next stimulus which prevented them to redo the previous stimuli.

From the 684 stimuli, 396 consisted of English CV sequences while the other 288 were Thai tokens which were used as distraction – they were Thai stimuli with Thai consonant sounds: /f, w, t, t^h, s, d, $\widehat{tɕ^h}$, $\widehat{tɕ}$/. The stimuli were completely randomised with <PermuteBalancedNoDoublets> command in the script. The task for each participant lasted approximately 40-45 minutes.

3.2.3 Data analysis

The total number of responses was 21,384 (396 stimuli x 54 listeners). The responses were recorded on Praat and transferred to Excel for encoding. As the aim of this task was to examine the perception of English consonants through the Thai consonant sound system, the data were presented in percentage of the responses for each target English sound that were perceived as the most similar to the Thai sounds with the means of the goodness of fit. To combine the data of the identification and the goodness-of-fit the fit into a single

metric, the fit index for each English sound to an L1 consonant category was calculated by multiplying the percentage of the classification for the Thai consonant with 0.01, and then multiplying the result with the goodness of fit for each response for that L1 consonant category (Guion et al., 2000; Lengeris, 2009). The interpretation of this fit index is that the higher the fit index, the more similarity in perception between the English (L2) sound and its most-frequently-identified Thai (L1) category.

A linear mixed model (LMM) using the *lme4* package (Bates, Maechler, Bolker, & Walker, 2016) in R statistical software (R Core Team, 2016) was employed to produce the statistical results. The dependent factor was the fit index. The independent factors were vowel context (high, low, back), language experience (English-major, non-English-major) and target English sound (/v, f, w, θ, t^h, s, ð, d, z, ʃ, t͡ʃ/). The random intercept in this analysis was listener, as there was repetition in observations per listener. The optimal model was selected by comparing the model with three-way interaction with the model with two-way interaction using the *anova* function. The two models were significantly different from one another; hence the model with smaller Akaike Information Criterion (AIC) (Zhang, 2013) was selected; this was the model with three-way interaction. Then the post-hoc test was performed using the *lsmeans* package (Lenth, 2014) in R statistical software. In the table of data in the result section, the fit index is presented twice, i.e. the mean and the one from LMM analysis. The data that will be used to make a conclusion of the perceived similarity is the one from LMM analysis.

3.3 Results and discussion

3.3.1 Overall results

In terms of the classifications between L2 English /f, s, v, θ, ð, z, ʃ, w, t^h,d, t͡ʃ/ and the closest Thai categories, the results showed that all shared L2 sounds were classified to the same sounds represented with the same IPA symbols as the closest L1 Thai sounds. This supports our first hypothesis that L2 learners had no difficulty learning the L2 sounds that also occur in their L1 sound system in terms of target-likeness as shown in many studies (e.g., Chunsuvimol & Ronakiat, 2000; Kitikanan, 2016). This finding might suggest that the existence of the sounds in the L1 enhances the perception of the L2 shared sounds, and

they suggest that the relationship between production and perception of the shared L2 sounds might be one-to-one.

For the non-shared L2 sounds, the findings were as follows: 1) English /θ/ in the high and low vowel contexts and English /f/ were mostly assimilated to Thai /f/ whereas English /θ/ in the back vowel contexts, and /z/ were mostly classified as Thai /s/; 2) most English /v/ and /w/ were classified as Thai /w/; 3) most English /ð/ were classified as Thai /d/; 4) most English /ʃ/ and /t͡ʃ/ were classified as Thai /t͡ɕʰ/. The classifications of English /v, ð, z, ʃ, t͡ʃ/ support previous studies on the production of these sounds (Brière & Chiachanpong, 1980; Burkardt, 2008; Chunsuvimol & Ronakiat, 2000, 2001; Kanokpermpoon, 2007; Richards, 1966). This might suggest that the production and perception are in the same direction, and it also supports that the L2 speech production is based on perception (Flege, 1995).

The findings of English /θ/ in all vowel contexts were the only one that does not support the findings of previous production studies showing that this sound was mostly articulated as /t/ (Burkardt, 2008; Kitikanan, 2016). This might be due to different type of task between those studies and this study that those studies used the production task whereas this study used the perception task. The perceptual assimilation findings of English /θ/ showed the effect of the vowel context as English /θ/ in the back vowel context was mostly classified as Thai /s/ whereas English /θ/ in the high and low vowel contexts was mostly classified as Thai /f/. The inconsistency of the production and perception of English /θ/ by L2 Thai learners suggests that the perception and production in L2 sound might not be one-to-one relationship. The finding that English /θ/ was differently matched with Thai sounds in different vowel contexts also suggests the effect of the vowel context over the L2 sound perceptual assimilation across the learners' language experience. The assimilation of English /θ/ in the back vowel context that was different from the other two vowel contexts might be because the back vowel is produced with lip rounding and the tongue is back which might change the production of English /θ/ into slightly more backward and this articulatory feature is important cue for L2 Thai learners resulting in the selection of English /θ/ as Thai /s/ instead of Thai /f/ as in the other two vowel contexts. The classification of English /θ/ as Thai /f/ in the high and low vowel contexts is not surprising as shown in many studies on the learning of L2 English /θ/ that it is produced as /f/, such as in the L2 production of this sound by Chinese speakers (Deterding, 2006). Similarly the classification

of English /θ/ as Thai /s/ in the low vowel context is not surprising either as shown in the production of English /θ/ by L2 learners of other linguistic backgrounds, such as German and European-French learners of English that often produce /s/ for English /θ/ (Hanulikova & Weber, 2010). The /s/ and /f/ are close sounds to English /θ/ as /f/ is phonetically similar to /θ/ whereas /s/ is phonologically similar to /θ/ (Wester, Gilbers, & Lowie, 2007). Most findings of non-shared L2 sounds, except English /θ/ support our second hypothesis that non-shared English sounds would be assimilated to the closest Thai categories as shown in the previous studies of the production of English fricatives by L2 Thai learners. The details of these are presented in Table 1, and the results based on LMMs are presented after Table 1.

Table 1: Percentages of the categorisation of English fricatives into Thai consonant sounds with the mean of goodness of fit rating (1: very different, 7: very similar), the mean fit index for each English fricative and the fit index based on LMM classified according to vowel context and language experience. The number of categorisations by English-major students is 336 whereas those by non-English-major students is 312.

Target L2 sounds	Vowel	Experience	L1 closest consonant	Percentage of identification	Mean goodness of fit rating	Fit index (Mean)	Fit index (from LMM)
Eng /f/	High	Eng	/f/	78.27	4.57	3.58	3.55
		Non-Eng		79.49	4.85	3.86	3.88
	Low	Eng		84.23	4.99	4.20	4.18
		Non-Eng		86.54	5.19	4.49	4.48
	Back	Eng		95.24	4.90	4.67	4.66
		Non-Eng		96.47	5.21	5.03	5.02
Eng /s/	High	Eng	/s/	99.11	5.17	5.12	5.12
		Non-Eng		97.76	5.58	5.45	5.45
	Low	Eng		99.11	4.93	4.89	4.88
		Non-Eng		97.76	5.07	4.96	4.94
	Back	Eng		99.40	4.66	4.63	4.63
		Non-Eng		92.95	4.93	4.58	4.58
Eng /v/	High	Eng	/w/	78.57	3.57	2.81	3.54
		Non-Eng		84.94	4.43	3.76	4.45
	Low	Eng		66.96	3.92	2.63	3.84
		Non-Eng		67.31	4.67	3.14	4.60
	Back	Eng		68.45	3.25	2.22	3.23
		Non-Eng		62.18	4.37	2.72	4.30
Eng /θ/	High	Eng	/f/	68.75	4.53	3.11	3.07
		Non-Eng		70.83	4.83	3.42	3.48
	Low	Eng		72.32	4.58	3.31	3.26
		Non-Eng		77.56	4.93	3.82	3.83
	Back	Eng	/s/	73.51	3.51	2.58	2.55
		Non-Eng		81.41	4.71	3.83	3.84
	High	Eng	/d/	63.39	3.72	2.36	2.30

Target L2 sounds	Vowel	Experience	L1 closest consonant	Percentage of identification	Mean goodness of fit rating	Fit index (Mean)	Fit index (from LMM)
Eng /ð/		Non-Eng		44.55	4.25	1.89	1.67
		Eng		44.05	3.36	1.48	1.43
	Low	Non-Eng		38.14	4.71	1.80	1.83
		Eng		65.18	2.63	1.71	1.72
	Back	Non-Eng		36.22	3.81	1.38	1.21
Eng /z/		Eng	/s/	97.32	3.35	3.26	3.26
	High	Non-Eng		96.15	4.53	4.36	4.34
		Eng		91.37	3.86	3.53	3.53
	Low	Non-Eng		94.55	4.72	4.46	4.46
		Eng		96.43	3.71	3.58	3.58
	Back	Non-Eng		91.35	4.85	4.43	4.38
Eng /ʃ/		Eng	/t͡ɕʰ/	100.00	5.13	5.13	5.13
	High	Non-Eng		96.15	5.54	5.33	5.31
		Eng		98.51	4.91	4.84	4.83
	Low	Non-Eng		91.03	5.41	4.92	4.88
		Eng		98.81	4.64	4.58	4.57
	Back	Non-Eng		95.51	5.54	5.29	5.25
Eng /w/		Eng	/w/	99.70	5.20	5.18	5.19
	High	Non-Eng		99.04	5.34	5.29	5.28
		Eng		100.00	5.70	5.70	5.70
	Low	Non-Eng		99.68	5.72	5.70	5.69
		Eng		100.00	4.75	4.75	4.75
	Back	Non-Eng		99.68	5.17	5.15	5.15
Eng /tʰ/		Eng	/tʰ/	88.69	5.24	4.65	4.63
	High	Non-Eng		88.46	5.49	4.86	4.84
		Eng		80.95	4.96	4.02	4.00
	Low	Non-Eng		78.53	5.17	4.06	4.01
		Eng		97.92	4.98	4.88	4.87
	Back	Non-Eng		97.44	5.14	5.01	5.00
Eng /d/		Eng	/d/	97.62	5.22	5.10	5.09
	High	Non-Eng		94.55	5.71	5.40	5.38
		Eng		90.48	5.13	4.64	4.59
	Low	Non-Eng		76.60	5.26	4.03	3.99
		Eng		99.11	4.72	4.68	4.67
	Back	Non-Eng		96.47	5.30	5.11	5.10
Eng /t͡ʃ/		Eng		99.11	5.14	5.09	5.10
	High	Non-Eng		94.55	5.46	5.16	5.12
		Eng		98.51	5.22	5.14	5.13
	Low	Non-Eng		96.47	5.50	5.31	5.25
		Eng		100.00	4.85	4.85	4.85
	Back	Non-Eng	/t͡ɕʰ/	97.12	5.39	5.23	5.21

3.3.2 LMM results on the perceptual assimilation

Findings from pairwise comparisons show that the fit indexes were significantly higher in the English-major group than in the non-English-major group when English /d/ was perceived as Thai /d/ in the low vowel context (b = 0.59, SE = 0.26, df = 77.50, t = 2.26, p < 0.05) and when English /ð/ was perceived as Thai /d/ in the high vowel context (b = 0.62, SE = 0.28, df = 93.98, t = 2.26, p < 0.05). These findings might sound like they do not support the L2 phonological theorists (e.g., Best & Strange, 1992; Flege, 1995) proposing that L2 experience might enhance the ability to distinguish the differences between non-native and native sounds. In fact, for English /d/, it might be that Thai /d/ is very similar in terms of perceptual, acoustic and articulatory to English /d/ especially in the low vowel context as opposed to the other two vowel contexts. The reason why the English-major group identified English /ð/ as more similar to Thai /d/ in the high vowel context than the non-English-major group might be because of the similarity between these two sounds as shown in the realisation of /d/ that is often used for the production of English /ð/ in the speech of native speakers of English (Labov, 1969).

The fit indexes were significantly higher in non-English-major group as compared to English-major group when English /z/ was perceived as Thai /s/ in all vowel contexts, when English /v/ was perceived as Thai /w/ in all vowel contexts (b = -0.93, SE = 0.26, df = 74.58, t = -3.57, p < 0.01 for /z/ in the low vowel context; b = -1.08, SE = 0.26, df = 73.70, t = -4.16, p < 0.01 for /z/ in the high vowel context; b = -0.80, SE = 0.26, df = 74.40, t = -3.09, p < 0.01 for /z/ in the back vowel context; b = -0.76, SE = 0.27, df = 83.80, t = -2.85, p < 0.05 for /v/ in the low vowel context; b = -0.91, SE = 0.26, df = 77.81, t = -3.47, p < 0.01 for /v/ in the high vowel context; b = -1.07, SE = 0.27, df = 84.85, t = -3.98, p < 0.01 for /v/ in the back vowel context). The finding relating to the perceived similarity between English /z/ and Thai /s/ being higher in non-English-major rather than English-major groups supports many studies (Brière & Chiachanpong, 1980; Kitikanan, 2016; Richards, 1966) that suggest that this sound is difficult for L2 Thai learners, yet it suggests that the learning of English /z/ is possible with phonetic training. For the finding of the perceived similarity of English /v/ as Thai /w/ that was higher in non-English-major group rather than English-major one also supports many studies (Chunsuvimol & Ronakiat, 2000, 2001; Kitikanan, 2016; Richards,

1966) that this sound is difficult to learn for Thai learners, and it also suggests the improvement of the learning with phonetic training.

The same pattern was found when English /ʃ/ was perceived as Thai /t͡ɕʰ/ in the back vowel context (b = -0.67, SE = 0.26, df = 73.62, t = -2.60, $p < 0.05$), when English /θ/ was perceived as Thai /s/ in the back vowel context (b = -1.29, SE = 0.26, df = 79.34, t = -4.89, $p < 0.01$) and when English /θ/ was perceived as Thai /f/ in the low vowel context (b = -0.56, SE = 0.26, df = 80.28, t = -2.13, $p < 0.05$). The finding that the fit indexes were significantly higher in non-English-major group as compared to English-major group when English /ʃ/ was perceived as Thai /t͡ɕʰ/ in the back vowel context supports the study of Kitikanan (2016) showing the positive relationship between the back vowel context as opposed to the front low and front high vowel contexts, and the target-like realisation of English /ʃ/ produced by L2 Thai learners. This might be because the subjects in Kitikanan's study were L2 Thai learners in the L2 country who had more exposure to English and used more English in their daily lives. Hence our finding suggests the requirement of the training for English /ʃ/ in the back vowel context to be able to distinguish English /ʃ/ from Thai /t͡ɕʰ/. The findings showed that the fit indexes were significantly higher in non-English-major group as compared to English-major group when English /θ/ was perceived as Thai /s/ in the back vowel context and when English /θ/ was perceived as Thai /f/ in the low vowel context. While there were no effects of vowel context in the Kitikanan's production study, the effect of language experience was found in interaction with the vowel context in this study. These suggest that the variables that play role in production and perception might be different, and the ability of L2 Thai learners to distinguish English /θ/ from Thai /s/ in the back vowel context and Thai /f/ in the low vowel context can be improved with the phonetic training. In addition, no effects of experience and vowel contexts were found for the remaining results ($p > 0.05$ for all other contrasts).

Regarding the hypotheses, the third hypothesis predicted that there would be no effect of language experience and vowel context on the perceptual assimilation of shared English sounds. This hypothesis is supported except in the perceived similarity of English /d/ as Thai /d/ in the low vowel context. The last hypothesis predicted that non-English-major learners would assimilate non-shared English sounds to the closest L1 categories with higher degree than the English-major ones and there would be the effect of the vowel contexts on these

assimilations. This hypothesis is supported in the perceived similarities of English /z/ as Thai /s/ and English /v/ as Thai /w/ across vowel contexts, English /θ/ as Thai /f/ in the low vowel context, English /θ/ as Thai /s/ and English /ʃ/ as Thai /t͡ɕʰ/ in the back vowel context as in these contexts, the non-English-major learners assimilated non-shared English sounds to the closest L1 sounds than the English-major ones. This hypothesis is also supported in the effect of the vowel contexts which was found in English /ð/, /θ/ and /ʃ/. However, only the finding of English /t͡ʃ/ as Thai /t͡ɕʰ/ is contrastive to this hypothesis as there was no effect of both factors on its perceived similarity.

3.4 Summary

This chapter examined the perceptual assimilation of English fricatives and the relevant sounds by L2 Thai learners and the effects of the vowel contexts and language experience. The perceptual assimilation patterns of the shared sounds showed that L2 Thai learners matched all shared sounds with Thai sounds that were represented with similar IPA symbols as the closest L1 Thai sounds. They also supported that when the L2 sound also exists in the L1 sound system, the L2 sound perception will be influenced by the positive transfer that enhances their assimilation of the L2 sound with the L1 sound that falls into similar sound category.

For the non-shared sound, most non-shared sounds, except English /θ/ were matched to Thai sounds that were suggested in previous literature. This might also suggest the link between the production and perception. For English /θ/, this sound was mostly matched with Thai /f/ in the high and low vowel contexts whereas in the back vowel context, it was matched with Thai /s/. Regarding the degree of the perceived similarities of both shared and non-shared sounds, they were affected by vowel context and language experience, but the perceived similarities of the shared sounds was less affected by these two factors than those of the non-shared sounds.

In the next chapter, we will explore the identification of the L2 English fricatives and the relevant sounds to find out the extent the findings of the current chapter can accurately predict its results. The predictions from this chapter is mentioned in the introduction section in the next chapter.

Chapter 4. Sound identification of L2 English fricatives and the effects of vowel context and language experience

4.1 Introduction

In this chapter, there are three aims: 1) to explore the ability of the L2 Thai learners to identify English fricatives; 2) to explore the perceived similarity between the target English sounds and the English sounds selected by each group of listeners; and 3) to find out the effects of the language experience and the vowel context towards the L2 fricative perception. This chapter will show the sound identification of English fricatives and the relevant sounds by L2 Thai learners, the perceived similarity between the target English sounds and the English sounds selected by each group of listeners, and the effects of the two factors towards the identification and the perceived similarity.

As the results of previous chapter provide the predictions of the L2 sound identification, the results of this chapter will test whether these predictions are correct. If they are, the findings of this study will support the earlier findings that perceptual assimilation of the L2 sounds and their closest L1 sounds by the L2 learners can be used to generate predictions for the L2 sound identification. In other words, they will support that the L2 sound identification is based on the perceptual assimilation. As stated in the previous chapter, the expected results for this experiment are based on the hypothesis of SLM and PAM-L2 that the likelihood of category formation is inversely related to the perceived cross-language similarity for the non-shared L2 sounds, or the higher L1 and L2 are assimilated to one another, the less likely the L2 sounds will be correctly identified. For the shared L2 sounds, the likelihood of category formation is expected to positively correlate with the perceived similarity suggesting the ease of the perception. The predictions from the previous experiment are as follows:

1) for shared sounds

1.1) in the identification of /s, w, t^h, f/, these sounds will be identified as the same English categories as the target sounds and there will be no differences in the perceived similarity between English-major and non-English-major groups across vowel contexts;

1.2) for the identification of /d/, it will be mostly identified as /d/ and there will be no significant differences in the perceived similarity between English-major and non-English-major groups in the high and back vowel contexts. However, in the low vowel

context, the non-English-major group will perceive English /d/ as more similar to /d/ than the English-major group.

2) for non-shared sounds (The closest identified sounds cannot be predicted as the alternatives of the previous task and this current task are not the same.)

2.1) in the identification of /v, θ, ð, z, ʃ, t͡ʃ/, the sounds that will be easy for L2 Thai learners to identify are /θ, ð, v (all contexts except in the low vowel context in the non-English-major group), z/ as the perceived similarities of these sounds and their closest Thai sounds are below 4.5 out of 7. The sounds that will be difficult for them to identify are /v (in the low vowel context in the non-English-major group), ʃ, t͡ʃ/ as the perceived similarities of these sounds and their closests Thai sounds are more than 4.5 out of 7.

2.2) in the identification of /t͡ʃ/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups across vowel contexts;

2.3) in the identification of /z/ and /v/, the English-major group will have higher perceived similarities between these two sounds and the closest sounds than the non-English-major group;

2.4) in the identification of /ð/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups in the low and back vowel contexts, but in the high vowel context, the non-English-major group will have higher perceived similarity of this sound and the closest sound than the English-major group;

2.5) in the identification of /ʃ/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups in the low and high vowel contexts, but in the back vowel context, the English-major group will have higher perceived similarity of this sound and the closest sound than the non-English-major group;

2.6) in the identification of /θ/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups in the high

vowel context, but in the low and back vowel context, the English-major group will have higher perceived similarities of this sound and the closest sounds than the non-English-major group.

4.2 Methodology

4.2.1 Listeners

The L2 Thai listeners in the previous experiment also attended this current experiment. Hence there were two groups of L2 Thai learners, i.e. English-major and non-English-major. In this experiment, a control group of native English speakers was included. There were 26 native English speakers (mean = 22.96 years, range = 18-43 years). They were living in Newcastle-upon-Tyne at the time this study was carried out. 25 of them were students, and 22 speakers were never received a training in Phonetics. They were from many regions in the UK, such as London, Cumbria, Wiltshire and Dewsbury. Similar to L2 Thai learners, none of them reported having hearing problems, and they attended the experiment in exchange for payment.

4.2.2 Stimuli

The stimuli in this experiment were the same as the ones used in the previous experiment.

4.2.3 Procedure

Both L2 Thai learners and native English speakers heard the stimuli in a quiet room. L2 Thai learners used the room at Naresuan University, Thailand whereas native speakers of English used the room at Newcastle University, UK. Similar to the previous experiment, this experiment was run with a script on Praat MFC (Boersma & Weenink, 2016) on a PC computer. The listeners listened to the stimuli over headphones while played through a computer. They clicked the answer using a mouse and were always presented with relevant alternatives: 'v, f, w, t, s, ch, th 'that', th 'thief', d, z, sh'. These letters represented that following English sounds /v, f, w, t^h, s, $\widehat{tʃ}$, ð, θ, d, z, ʃ/ respectively. The letters for /ð/ and /θ/ were distinguished by the word in the quotation marks, and listeners were told by the researchers that these sounds were the first two letters of each word.

The following instructions were presented on the screen: 'You will hear a consonant-vowel sequence. Pay attention to the consonant sound and choose the English sound that is most similar to the sound you heard. Then rate the similarity of the English sound to the sound you heard on a scale from 1 (very different) to 7 (very similar). The number of trials is 684, and you can take a break every 50 trials. You can see how far you are from the end by looking at the left top corner of the screen. To continue, click the mouse'. The instruction was in the listeners' L1 in order to minimise any barrier that may be due to lack of proficiency in language. They could hear the stimuli as many times as they liked by clicking 'replay' button. After they were certain about their answer, they then clicked 'OK' button to move to the next stimulus which prevented them to redo the previous stimuli.

From the 684 stimuli, 396 consisted of English CV sequences while the other 288 were Thai tokens which were used as distraction – they were Thai stimuli with Thai consonant sounds: /f, w, t, t^h, s, d, $\widehat{tɕ^h}$, $\widehat{tɕ}$/. The stimuli were completely randomised with <PermuteBalancedNoDoublets> command in the script. The task for each participant lasted approximately 40-45 minutes.

4.2.4 Data analysis

The total number of responses was 31,680 (396 stimuli x 80 listeners). The responses were recorded on Praat and transferred to Excel for encoding. As the aim of this task was to examine the perception of English consonants through the English consonant sound system, the data were presented in percentage of the responses for each target English sound that were perceived as the most similar to the English sounds with the means of the goodness of fit. The calculation of combining the data of the identification and the goodness-of-fit the fit into a single metric was similar to the one in the perceptual assimilation task.

A linear mixed model (LMM) using the lme4 package (Bates et al., 2016) in R statistical software (R Core Team, 2016) was employed to produce the statistical results. The dependent factor was the fit index. The independent factors were vowel context (high, low, back), language experience (English-major, non-English-major, native speakers) and target English sound (/v, f, w, θ, t^h, s, ð, d, z, ʃ, $\widehat{tʃ}$/). The random intercept in this analysis was

listener, as there was repetition in observations per listener. The selection of the optimal model was the same as in the previous experiment. Then the post-hoc test was performed using the lsmeans package (Lenth, 2014) in R statistical software. In the table of data in the result section, the fit index is presented twice, i.e. the mean and the one from LMM analysis. The data that will be used to make a conclusion of the perceived similarity is the one from LMM analysis.

4.3 Results and discussion

4.3.1 Overall results

Regarding the classifications between L2 English /f, s, v, θ, ð, z, ʃ, w, t^h,d, $\widehat{tʃ}$/ and the identified English categories, the results showed that most shared L2 sounds: /f, t^h,d/ were classified into the same sounds represented with the same IPA symbols as the closest L2 English sounds. These findings are consistent with the findings in the previous experiment that these sounds were correctly matched into their sound categories. It suggests that L2 Thai learners have no difficulty perceiving these L2 sounds due to positive transfer of the L1 sounds in their L1 sound system.

The identifications of English /s/ and /w/ was unexpected. Although they were correctly identified in most contexts, /s/ was identified as /z/, and /w/ was identified as /v/ in the high vowel context in the non-English-major group. This suggests that the non-English-major group cannot perceived English /s/ and /w/ in the high vowel context. It might be that the phonetic qualities of these two sounds are different from the ones on the other two vowel contexts, and the non-English-major group can discern these qualities resulting in the classification of these two sounds in the high vowel context as different sounds. The English-major group, who had the benefit of the phonetic training, were able to identify that these two sounds in the high vowel context still belonged to the same English categories. Hence the predictions from the previous experiment for English /s/ and /w/ are accurate in all context except in the high vowel context in the non-English-major group.

For the non-shared sounds, the findings were as follows: 1) English /v/ was mostly identified as /v/ in all contexts except by the non-English-major group, who mostly

identified /v/ as /w/ across vowel contexts; 2) English /z/ was mostly correctly identified except in the low vowel context in the non-English-major group where this sound was mostly identified as /s/; 3) English /t͡ʃ/ was mostly correctly identified in most contexts. There were two exceptions. In the back vowel context in the non-English-major and the English-major groups, this sound was mostly identified as /ʃ/; 4) English /ʃ/ was mostly correctly identified in all contexts. There were two exceptions. In the high and low vowel contexts, the English-major and non-English-major groups mostly identified this sound as /t͡ʃ/; 5) English /θ/ was mostly correctly identified in high and back vowel contexts in the native group and in the back vowel context in the English-major group. However, it was mostly identified as /ð/ in the low vowel context in the native group, as /f/ in the high and low vowel contexts in the English-major and non-English-major groups, and as /s/ in the back vowel context in the non-English-major group; and 6) English /ð/ was mostly correctly identified in the low and back vowel contexts in the native group, and in the high and back vowel contexts in the English-major group. However, it was mostly identified as /θ/ in the high vowel context in the native group, as /d/ in the high vowel context in the non-English-major group, as /v/ in the low vowel context in the English-major group, and as /w/ in the low and back vowel contexts in the non-English-major group.

It was found that English /v/ was mostly correctly identified in all contexts except in the non-English-major group. This group mostly identified /v/ as /w/ across vowel contexts. This suggests that this sound was difficult for the L2 learners who had not received the phonetic training across vowel contexts. The findings that English /v/ was mostly identified as /w/ in the non-English-major group was consistent with the finding of Kitikanan (2016) that this sound was mostly produced as /w/ by L2 Thai learners. In her study, the majority of subjects did not receive phonetic training which might be the reason why most of the realisations of English /v/ was transcribed as inaccurate. The findings of our study that English-major group accurately matched most of the tokens of English /v/ across vowel contexts suggest that the phonetic training can help improve the perception of English /v/ of the L2 Thai learners. Hence the predictions from the previous experiment that /v/ would be easy to identify in all contexts except in the low vowel context in the non-English-major group are accurate in the findings of the English-major group across vowel contexts. The

other prediction for /v/ is that it would be difficult in the low vowel context in the non-English-major group is also accurate.

For the finding of the identification for English /z/ that it was mostly correctly identified except in the low vowel context in the non-English-major group, where this sound was mostly identified as /s/, this suggests that English /z/ can be accurately perceived in all contexts although the L2 learners did not receive phonetic training except in the low vowel context. The findings of English /z/ that was mostly correctly identified in most contexts are consistent with the finding in the study of Reis (2006) where English sound was mostly correctly identified by Brazilian speakers. It is possible that as /z/ is sibilant, it is not too difficult to perceive for the L2 learners except in the low vowel context in the learners who did not receive the phonetic training. The finding that in the low vowel context in the non-English-major group, English /z/ was mostly identified as /s/ is in agreement with the finding that this sound was mostly produced as /s/ by L2 Thai learners (Brière & Chiachanpong, 1980; Kitikanan, 2016; Richards, 1966) suggesting the link between the production and perception. The predictions of English /z/ that this sound would be easy to identify are accurate in all contexts except in the low vowel context in the non-English-major group.

For the finding of the identification for English /t͡ʃ/ that it was mostly correctly identified except in the back vowel context in the non-English-major and the English-major groups that this sound was mostly identified as /ʃ/, this suggests that without phonetic training, L2 learners can still accurately perceived English /t͡ʃ/ in all contexts, except in the back vowel context. The predictions that English /t͡ʃ/ would be difficult to identify in all contexts are true in the back vowel context across groups of L2 Thai learners.

For the identification of English /ʃ/, as this sound was mostly correctly identified in all contexts except in the high and low vowel contexts in the English-major and non-English-major groups that this sound was mostly identified as /t͡ʃ/, this suggests that L2 Thai learners, regardless of their language experience had difficulty perceiving /ʃ/ in the high and low vowel contexts. The findings that English /ʃ/ was mostly identified as /t͡ʃ/ is consistent with the production study of this sound by L2 Thai learners in the studies of Brière and Chiachanpong (1980) and Kitikanan (2016). The prediction that English /ʃ/ would

be difficult to identify across contexts are accurate for the low and high vowel contexts for both groups of L2 Thai learners.

For the identification of English /θ/, as this sound was mostly correctly identified in high and back vowel contexts in the native group and in the back vowel context in the English-major group, it suggests that when L2 learners receive the phonetic training, they can accurately perceive this sound in the back vowel context. It is surprising to find that native speakers of English identified this sound as /ð/ in the low vowel context. In the high and low vowel contexts in the English-major and non-English-major groups, this sound was mostly identified as /f/ which suggest that L2 Thai learners had difficulty perceiving this sound in these two vowel contexts. The misidentification of English /θ/ as /f/ is consistent with the finding in the study of Tabain (1998) that in the perception of English listeners, the pair /θ/-/f/ was rated as highly similar. In the back vowel context in the non-English-major group, this sound was mostly identified as /s/ which suggest that L2 Thai learners who did not receive the phonetic training had difficulty perceiving this sound in the back vowel context, and the phonetic training helps L2 Thai learners in perceiving it in this context. The misidentification of English /θ/ as /s/ is in agreement with the study of Weinberger (1990) that this sound is likely to be similar to one another, especially in L2 production. The misidentifications of English /θ/ as /f/ and /s/ was consistent with the production of the native speakers of English in the study of Kitikanan (2016) that 10% of their production of this sound were perceived as /f/ and /s/ by native speakers of English. Hence the predictions that English /θ/ would be easy to identify are accurate in the back vowel context in the English-major group.

For the identification of English /ð/, as this sound was mostly accurately identified in the low and back vowel contexts in the native group, and in the high and back vowel contexts in the English-major group, these suggest that when L2 learners receive the phonetic training, they can accurately perceive this sound in the high and back vowel contexts. It is surprising to find that native speakers of English identified this sound as its voiceless counterpart in the high vowel context. In the high vowel context in the non-English-major group, this sound was mostly identified as /d/. This might be due to close similarity in perception of /ð/ and /d/ as shown in the study of Dubois and Horvath (1998) that English /ð/ is sometimes produced as /d/ in Cajun English, a dialect of Southern American English.

In the low vowel context in the English-major group, this sound was mostly identified as /v/. This finding supports the fact that English /ð/ is realised as /v/ in many British varieties, such as Newcastle (Watt & Milroy, 1999). This finding is also consistent with the finding in the study of Reis (2006) that in the total incorrect identification, most English /ð/ was identified as /v/. In the back and low vowel contexts in the non-English-major group, this sound was mostly identified as /w/. As in the perceptual assimilation task, English /v/ was mostly identified as Thai /w/, and /ð/ was close to /v/ as stated above, it is possible that when L2 Thai learners did not receive the phonetic training, they assimilate English /ð/ to the L2 sound that also exists in their Thai sound system as they are produced in the front area of the mouth. The details of these are presented in Table 2, and the results based on LMMs are presented after Table 2.

Table 2: Percentages of the categorisation of English fricatives into English consonant sounds with the mean of goodness of fit rating (1: very different, 7: very similar), the mean fit index for each English fricative and the fit index based on LMM classified according to vowel context and language experience. The number of categorisations by English-major students is 336; those by non-English-major students is 312; and those by native speakers of English is 312.

Target L2 sounds	Vowel	Experience	L2 closest consonant	Percentage of identification	Mean goodness of fit rating	Fit index (Mean)	Fit index (from LMM)
Eng /f/	High	Native	/f/	66.67	4.89	3.26	3.19
		Eng		79.76	5.38	4.29	4.31
		Non-Eng		79.67	5.18	4.13	4.14
	Low	Native		79.51	5.30	4.21	4.11
		Eng		85.71	5.25	4.50	4.50
		Non-Eng		81.67	5.33	4.35	4.32
	Back	Native		74.31	5.10	3.79	3.89
		Eng		96.73	5.66	5.47	5.46
		Non-Eng		93.67	5.46	5.11	5.09
Eng /s/	High	Native	/s/	87.85	5.54	4.86	4.76
		Eng		63.10	5.63	3.55	3.55
		Non-Eng	/z/	56.67	5.92	3.36	3.31
	Low	Native	/s/	92.01	5.55	5.11	5.00
		Eng		75.60	5.54	4.18	4.16
		Non-Eng		75.33	5.48	4.13	4.16
	Back	Native		90.63	5.27	4.77	4.71
		Eng		55.36	5.42	3.00	3.00
		Non-Eng		49.67	5.54	2.75	2.78
Eng /v/	High	Native	/v/	81.94	4.91	4.02	4.03
		Eng		42.26	5.28	2.23	2.22
		Non-Eng	/w/	54.33	5.19	2.82	2.85
	Low	Native	/v/	64.58	5.06	3.27	3.28

Target L2 sounds	Vowel	Experience	L2 closest consonant	Percentage of identification	Mean goodness of fit rating	Fit index (Mean)	Fit index (from LMM)
		Eng		54.76	5.60	3.07	3.05
		Non-Eng	/w/	51.67	5.34	2.76	2.57
		Native	/v/	93.40	5.39	5.03	4.96
	Back	Eng		66.67	5.62	3.75	3.76
		Non-Eng	/w/	58.33	5.43	3.17	3.04
Eng /θ/		Native	/θ/	61.11	5.53	3.38	3.52
	High	Eng	/f/	62.20	5.31	3.30	3.28
		Non-Eng		66.67	5.39	3.59	3.55
		Native	/ð/	40.28	4.61	1.86	2.11
	Low	Eng	/f/	68.75	5.23	3.60	3.62
		Non-Eng		76.00	5.07	3.85	3.81
		Native	/θ/	57.64	5.17	2.98	2.96
	Back	Eng		37.80	5.90	2.23	2.14
		Non-Eng	/s/	43.33	5.41	2.34	2.36
Eng /ð/		Native	/θ/	35.42	4.12	1.46	1.80
	High	Eng	/ð/	29.76	5.68	1.69	1.67
		Non-Eng	/d/	30.00	5.03	1.51	1.31
		Native	/ð/	82.99	6.00	4.98	4.99
	Low	Eng	/v/	22.32	5.45	1.22	1.22
		Non-Eng	/w/	27.67	5.35	1.48	1.20
		Native	/ð/	65.28	5.87	3.83	3.72
	Back	Eng		46.73	5.98	2.79	2.79
		Non-Eng	/w/	39.67	4.91	1.95	2.05
Eng /z/		Native	/z/	97.57	5.18	5.05	5.04
	High	Eng		85.12	6.10	5.20	5.18
		Non-Eng		80.67	6.16	4.97	4.96
		Native		93.75	5.41	5.07	4.98
	Low	Eng		58.93	5.98	3.52	3.44
		Non-Eng	/s/	53.67	5.45	2.93	2.87
		Native	/z/	95.14	5.08	4.83	4.81
	Back	Eng		64.58	5.99	3.87	3.77
		Non-Eng		47.00	5.81	2.73	2.63
		Native	/ʃ/	95.83	6.00	5.75	5.72
Eng /ʃ/	High	Eng	/t͡ʃ/	50.60	5.68	2.88	2.88
		Non-Eng		45.67	5.81	2.65	2.72
		Native	/ʃ/	88.19	5.87	5.17	5.09
	Low	Eng	/t͡ʃ/	64.29	5.77	3.71	3.68
		Non-Eng		67.00	5.86	3.93	3.90
		Native	/ʃ/	96.53	5.88	5.67	5.69
	Back	Eng		73.21	6.08	4.45	4.46
		Non-Eng		58.33	6.07	3.54	3.49
Eng /w/		Native	/w/	96.53	5.47	5.28	5.24
	High	Eng		68.45	5.65	3.87	3.83
		Non-Eng	/v/	51.33	5.39	2.77	2.79
	Low	Native	/w/	95.83	5.01	4.80	4.75
		Eng		78.87	5.33	4.20	4.21

Target L2 sounds	Vowel	Experience	L2 closest consonant	Percentage of identification	Mean goodness of fit rating	Fit index (Mean)	Fit index (from LMM)
		Non-Eng		76.00	5.28	4.01	3.97
		Native		96.53	5.40	5.22	5.16
	Back	Eng		74.11	5.56	4.12	4.08
		Non-Eng		74.00	5.70	4.22	4.12
Eng /tʰ/		Native	/tʰ/	95.49	5.77	5.51	5.50
	High	Eng		86.01	5.54	4.76	4.77
		Non-Eng		88.33	5.57	4.92	4.93
		Native		90.28	4.98	4.50	4.40
	Low	Eng		74.11	5.26	3.90	3.90
		Non-Eng		78.00	5.38	4.20	4.24
		Native		97.22	5.24	5.09	5.08
	Back	Eng		92.26	5.27	4.86	4.87
		Non-Eng		89.33	5.38	4.81	4.83
Eng /d/		Native	/d/	99.31	5.77	5.73	5.71
	High	Eng		78.87	5.74	4.53	4.55
		Non-Eng		89.67	5.68	5.10	5.12
		Native		94.44	5.12	4.83	4.76
	Low	Eng		75.30	5.29	3.98	4.03
		Non-Eng		85.67	5.40	4.62	4.65
		Native		98.96	5.49	5.43	5.44
	Back	Eng		83.63	5.62	4.70	4.69
		Non-Eng		93.67	5.71	5.35	5.34
Eng /t͡ʃ/		Native	/t͡ʃ/	98.96	5.52	5.46	5.46
	High	Eng		54.76	5.84	3.20	3.18
		Non-Eng		43.00	5.91	2.54	2.55
		Native		98.96	5.83	5.77	5.75
	Low	Eng		72.32	5.58	4.04	4.04
		Non-Eng		74.00	5.74	4.25	4.24
		Native		96.53	5.68	5.48	5.49
	Back	Eng		69.35	6.01	4.17	4.15
		Non-Eng	/ʃ/	59.00	6.15	3.63	3.53

4.3.2 LMM results on the sound identification

Findings from pairwise comparisons show that, starting from shared sounds, for English /d/, in the low and back vowel contexts, the fit index of English /d/ as /d/ in English-major group was significantly lower than those in the native (b = -0.73, SE = 0.19, df = 101.74, t = -3.79, $p < 0.01$ for the low vowel context; b = -0.75, SE = 0.19, df = 99.67, t = -3.92, $p < 0.01$ for the back vowel context) and non-English-major (b = -0.62, SE = 0.19, df = 103.14, t = -3.26, $p < 0.01$ for the low vowel context; b = -0.65, SE = 0.19, df = 100.42, t = -3.46, $p < 0.01$

for the back vowel context) groups. There was no significant difference between that in the native and non-English-major groups was found ($p > 0.05$). This suggests that in the low and back vowel contexts, English /d/ as /d/ in the native group was as similar to one another as the non-English-major group, and the similarity of this in these two groups was more than that in the English-major group.

In the high vowel context, the fit index of English /d/ as /d/ in English-major group was significantly lower than those in the native (b = -1.17, SE = 0.19, df = 100.40, t = -6.11, $p <$ 0.01) and non-English-major (b = -0.57, SE = 0.19, df = 101.79, t = -3.01, $p < 0.01$) groups, but that in the native group was significantly higher than that of the non-English-major group (b = 0.59, SE = 0.20, df = 98.82, t = 3.04, $p < 0.01$). This suggests that English /d/ as /d/ was the most similar to one another in the native group, followed by non-English-major and English-major groups. Hence the prediction that in the low vowel context, the non-English-major group would perceive English /d/ as more similar to /d/ than the English-major group is true, but the prediction that in the high and back vowel contexts, there would be no difference between the perceived similarities of English /d/ as /d/ in the two groups of L2 Thai learners is not accurate.

For English /f/, there was no significant difference of the fit indexes for English /f/ as /f/ between groups in the low vowel context ($p > 0.05$), but in the high and back vowel contexts, similar patterns were found, i.e. the fit index of English /f/ as /f/ in the English-major group was significantly higher than that in the native group (b = 1.11, SE = 0.19, df = 106.50, t = 5.75, $p < 0.01$ for the high vowel context; b = 1.58, SE = 0.19, df = 102.13, t = 8.22, $p < 0.01$ for the back vowel context), but it was not significantly different from that in the non-English-major group ($p > 0.05$ for both). The fit index in the native group was significantly lower than that in the non-English-major group (b = -0.95, SE = 0.20, df = 106.34, t = -4.80, $p < 0.01$ for the high vowel context; b = -1.20, SE = 0.20, df = 102.32, t = -6.11, $p < 0.01$ for the back vowel context). This suggests that English /f/ for /f/ was equally similar to one another across listener groups in the low vowel context, but in the high and back vowel contexts, English /f/ for /f/ was more similar to one another in the English-major and non-English-major groups than the native group. The prediction that across vowel contexts, no difference in the perceived similarities for English /f/ of the two groups of L2 Thai learners would be found is true.

For English /s/, in the low and back vowel contexts, the fit index of English /s/ as /s/ in English-major group was significantly lower than that in the native group (b = -0.84, SE = 0.19, df = 102.03, t = -4.39, $p < 0.01$ for the low vowel context; b = -1.72, SE = 0.19, df = 107.52, t = -8.84, $p < 0.01$ for the back vowel context) whereas no significant difference was found between those in the English-major group and non-English-major groups ($p > 0.05$). The fit index of the native group was significantly higher than that in the non-English-major group (b = 0.84, SE = 0.20, df = 102.21, t = 4.29, $p < 0.01$ for the low vowel context; b = 1.94, SE = 0.20, df = 110.48, t = 9.64, $p < 0.01$ for the back vowel context). In the high vowel context, the fit index of English /s/ as /s/ in the English-major group was significantly lower than that in the native group (b = -1.20, SE = 0.19, df = 105.58, t = -6.23, $p < 0.01$). No significant difference was found between the fit index of English /s/ as /s/ in the English-major group and that of English /s/ as /z/ in the non-English-major group ($p > 0.05$). The fit index of English /s/ as /s/ in the native group was also significantly higher than that of English /s/ as /z/ in the non-English-major group (b = 1.45, SE = 1.20, df = 107.98, t = 7.27, $p < 0.01$). This suggests that across vowel contexts, English /s/ for /s/ was more similar to one another in the native group than the English-major and non-English-major groups. Hence the prediction that there would be no difference in the perceived similarity of English /s/ and its mostly identified sounds is true across contexts.

For English /t^h/, in the low vowel context, the fit index of English /t^h/ as /t^h/ in the English-major group was significantly lower than that in the native group (b = -0.50, SE = 0.19, df = 102.57, t = -2.59, $p < 0.01$), and no significant difference was found in those between English-major and non-English-major groups, and native and non-English-major groups ($p > 0.05$). In the high vowel context, the fit index of English /t^h/ as /t^h/ in the English-major group was significantly lower than that in the native group (b = -0.72, SE = 0.19, df = 99.76, t = -3.80, $p < 0.01$), and that in the native group was significantly higher than that in the non-English-major group (b = 0.56, SE = 0.20, df = 99.48, t = 2.87, $p < 0.05$). The significant difference between English /t^h/ as /t^h/ in the English-major and non-English-major groups was not found ($p > 0.05$). In the back vowel context, no significant difference was found for all pairs of language experience ($p > 0.05$). This suggests that in the low vowel context, English /t^h/ as /t^h/ in the English-major group was less similar to one another than that in the native group, but the degree of similarity of English /t^h/ as /t^h/ of the two groups of L2

Thai learners was in the same degree. In the high vowel context, English /t^h/ as /t^h/ was more similar to one another in the native group than the English-major and non-English-major groups. In the back vowel context, English /t^h/ was perceived as /t^h/ in the similar degree across listener groups. The prediction that there would be no difference in the perceived similarity of English /t^h/ and its mostly identified sound is true across contexts.

For English /w/, in the low vowel context, the fit index of English /w/ as /w/ in the English-major group was significantly lower than that in the native group (b = -0.53, SE = 0.19, df = 100.88, t = -2.79, $p < 0.05$), and that in the native group was significantly higher than that in the non-English-major group (b = 0.78, SE = 0.20, df = 101.57, t = 3.96, $p < 0.01$). There was no significant difference between the fit indexes of English /w/ as /w/ between English-major and non-English-major groups was found ($p > 0.05$). In the high vowel context, the fit index of English /w/ as /w/ in the English-major group was significantly lower than that in the native group (b = -1.41, SE = 0.19, df = 102.88, t = -7.34, $p < 0.01$), but significantly higher than the fit index of English /w/ as /v/ in the non-English-major group (b = 1.04, SE = 0.20, df = 114.74, t = 5.32, $p < 0.01$). The fit index of English /w/ as /w/ in the native group was significantly higher than the fit index of English /w/ as /v/ in the non-English-major group (b = 2.45, SE = 0.20, df = 108.91, t = 12.23, $p < 0.01$).

In the back vowel context, the fit index of English /w/ as /w/ in the English-major group was significantly lower than that in the native group (b = -1.08, SE = 0.19, df = 101.65, t = -5.65, $p < 0.01$), but there was no significant difference between those in the English-major and non-English-major groups ($p > 0.05$). The fit index of English /w/ as /w/ in the native group was also significantly higher than that in the non-English-major group (b = 1.05, SE = 0.20, df = 101.87, t = 5.32, $p < 0.01$). These suggest that in the low and back vowel contexts, English /w/ as /w/ was more similar to one another in the native group than the English-major and non-English-major groups. In the high vowel context, English /w/ as /w/ in the native group was the most similar, followed by that in the English-major group, and the degree of similarity of English /w/ as /w/ in these two groups was more similar to one another than English /w/ as /v/ in the non-English-major group. The prediction that there would be no difference in the perceived similarity of English /w/ and its mostly identified sound is true in the low and back vowel contexts, but not true in the high vowel context.

For non-shared sounds, for English /v/, in the low vowel context, no significant difference between the fit indexes of English /v/ for /v/ in the English-major and native groups was found ($p > 0.05$). However, the fit index of English /v/ for /v/ in the English-major group was significantly higher than the fit index of English /v/ for /w/ in the non-English-major group ($b = 0.48$, $SE = 0.20$, $df = 118.95$, $t = 2.42$, $p < 0.05$), and the fit index of English /v/ for /v/ in the native group was significantly higher than the fit index of English /v/ for /w/ in the non-English-major group ($b = 0.70$, $SE = 0.20$, $df = 115.20$, $t = 3.46$, $p < 0.01$).

In the high vowel context, the fit index of English /v/ for /v/ in the English-major group was significantly lower than that in the native ($b = -1.82$, $SE = 0.20$, $df = 115.40$, $t = ,-9.19$ $p < 0.01$) and the fit index of English /v/ for /w/ in the non-English-major groups ($b = -0.63$, $SE = 0.20$, $df = 124.00$, $t = -3.17$, $p < 0.01$), and the fit index of English /v/ for /v/ in the native group was significantly higher than the fit index of English /v/ for /w/ in the non-English-major group ($b = 1.18$, $SE = 0.20$, $df = 109.80$, $t = 5.90$, $p < 0.01$).

In the back vowel context, the fit index of English /v/ for /v/ in the English-major group was significantly lower than that in the native group ($b = -1.20$, $SE = 0.19$, $df = 103.72$, $t = -6.23$, $p < 0.01$), but it was significantly higher than the fit index of English /v/ for /w/ in the non-English-major group ($b = 0.72$, $SE = 0.19$, $df = 112.07$, $t = 3.73$, $p < 0.01$). The fit index of English /v/ for /v/ in the native group was significantly higher than the fit index of English /v/ for /w/ in the non-English-major group ($b = 1.92$, $SE = 0.20$, $df = 106.57$, $t = 9.67$, $p < 0.01$). These suggest that in the low vowel context, English /v/ for /v/ was equally similar to one another in the native and English-major groups, and this was more similar to one another than English /v/ for /w/ in the non-English-major group. In the high vowel contexts, English /v/ for /v/ in the native group was the most similar to one another followed by English /v/ for /w/ in the non-English-major group, and English /v/ for /v/ in the English-major-group. In the back vowel context, English /v/ for /v/ in the native group was the most similar to one another followed by that in the English-major group, and English /v/ for /w/ in the non-English-major group. The prediction that the English-major group would have higher perceived similarity of English /v/ and its mostly identified sounds than the non-English-major group is true in the low and back vowel contexts.

For English /z/, in the low vowel context, the fit index of English /z/ for /z/ in the English-major group was significantly lower than that in the native group (b = -1.54, SE = 0.19, df = 105.87, t = -7.95, $p < 0.01$), but it was significantly higher than the fit index of English /z/ for /s/ in the non-English-major group (b = 0.57, SE = 0.20, df = 116.37, t = 2.92, $p < 0.05$). The fit index of English /z/ for /z/ in the native group was significantly higher than the fit index of English /z/ for /s/ in the non-English-major group (b = 2.11, SE = 0.20, df = 108.28, t = 10.56, $p < 0.01$). In the high vowel context, no significant difference was found in each pairs of language experience ($p > 0.05$ for all pairs). In the back vowel context, the fit index of English /z/ for /z/ in the English-major group was significantly lower than that in the native group (b = -1.03, SE = 0.19, df = 104.05, t = -5.37, $p < 0.01$), but it was significantly higher than that in the non-English-major group (b = 1.15, SE = 0.20, df = 118.18, t = 5.84, $p < 0.01$). The fit index of English /z/ for /z/ in the native group was significantly higher than that in the non-English-major group (b = 2.18, SE = 0.20, df = 111.24, t = 10.85, $p < 0.01$). These suggest that in the high vowel context, English /z/ as /z/ was perceived to be similar to one another in the same degree across listener groups. In the low vowel context, English /z/ for /z/ was the most similar to one another in the native group, followed by English-major group, and this matching was similar to one another than English /z/ for /s/ in the non-English-major group. In the back vowel context, English /z/ for /z/ was the most similar to one another in the native group, followed by English-major group, and non-English-major groups. The prediction that the English-major group would have higher perceived similarity of English /z/ and its mostly identified sounds than the non-English-major group is true in the low and back vowel contexts.

For English /t͡ʃ/, in the low vowel context, the fit index of English /t͡ʃ/ for /t͡ʃ/ in the English-major group was significantly lower than that in the native group (b = -1.70, SE = 0.19, df = 101.71, t = -8.91, $p < 0.01$) whereas no significant difference was found between that in the English-major and non-English-major groups ($p > 0.05$). The fit index of English /t͡ʃ/ for /t͡ʃ/ was also found to be significantly higher in the native group as opposed to the non-English-major group (b = 1.50, SE = 0.20, df = 101.57, t = 7.65, $p < 0.01$). In the high vowel context, the fit index of English /t͡ʃ/ for /t͡ʃ/ in the English-major group was significantly lower than that in the native group (b = -2.28, SE = 0.19, df = 106.53, t = -11.75, $p < 0.01$), but it was significantly higher than that in the non-English-major group (b = 0.63, SE = 0.20, df =

124.04, t = 3.19, p < 0.01). The fit index of English /t͡ʃ/ for /t͡ʃ/ in the native group was significantly higher than that in the non-English-major group (b = 2.91, SE = 0.20, df = 113.01, t = 14.41, p < 0.01).

In the back vowel context, the fit index of English /t͡ʃ/ for /ʃ/ in the English-major group was significantly lower than the fit index of English /t͡ʃ/ for /t͡ʃ/ in the native group (b = -1.34, SE = 0.19, df = 102.64, t = -6.98, p < 0.01), but it was significantly higher than the fit index of English /t͡ʃ/ for /ʃ/ in the non-English-major group (b = 0.62, SE = 0.19, df = 111.17, t = 3.20, p < 0.01). The fit index of English /t͡ʃ/ for /t͡ʃ/ in the native group was significantly higher than the fit index of English /t͡ʃ/ for /ʃ/ in the non-English-major group (b = 1.96, SE = 1.20, df = 105.90, t = 9.86, p < 0.01). These suggest that in the low vowel context, English /t͡ʃ/ for /t͡ʃ/ was more similar to one another in the native group than the English-major and non-English-major groups. In the high vowel context, English /t͡ʃ/ for /t͡ʃ/ was the most similar to one another in the native group, followed by English-major group and non-English-major groups. In the back vowel context, English /t͡ʃ/ for /t͡ʃ/ in the native group was the most similar to one another, followed by English /t͡ʃ/ for /ʃ/ in the English-major group and English /t͡ʃ/ for /ʃ/ in the non-English-major group. The prediction that no difference in the perceived similarity of English /t͡ʃ/ and its mostly identified sounds between the English-major and the non-English-major groups is true in the low vowel context.

For English /ð/, in the low vowel context, the fit index of English /ð/ for /v/ in the English-major group was significantly lower than the fit index of English /ð/ for /ð/ in the native group (b = -3.77, SE = 0.21, df = 140.71, t = -18.15, p < 0.01) while no significant difference between the fit index of English /ð/ for /v/ in the English-major and the fit index of English /ð/ for /w/ in the non-English-major groups (p > 0.05). The fit index of English /ð/ for /ð/ in the native group was also significantly higher than the fit index of English /ð/ for /w/ in the non-English-major group (b = 3.79, SE = 0.20, df = 131.73, t = 18.05, p < 0.01). In the high vowel context, no significant difference was found for all pairs of language experience: 1) the fit index of English /ð/ for /ð/ in the English-major group and the fit index of English /ð/ for /θ/ in the native group, 2) the fit index of English /ð/ for /ð/ in the English-major group and the fit index of English /ð/ for /d/ in the non-English-major group, and 3) the fit index of English /ð/ for /θ/ in the native group and the fit index of English /ð/ for /d/ in the non-English-major group (p > 0.05 for all pairs).

In the back vowel context, the fit index of English /ð/ for /ð/ in the English-major group was significantly lower than that in the native group (b = -0.93, SE = 0.20, df = 117.17, t = -4.67, p < 0.01), but it was significantly higher than the fit index of English /ð/ for /w/ in the non-English-major group (b = 0.74, SE = 0.20, df = 130.71, t = 3.68, p < 0.01). The fit index of English /ð/ for /ð/ in the native group was significantly higher than the fit index of English /ð/ for /w/ in the non-English-major group (b = 1.67, SE = 0.21, df = 122.17, t = 8.10, p < 0.01). These suggest that in the low vowel context, English /ð/ for /ð/ in the native group was more similar to one another than English /ð/ for /v/ in the English-major group and English /ð/ for /w/ in the non-English-major group. In the high vowel contexts, English /ð/ for /ð/ in the English-major group, English /ð/ for /θ/ in the native group, and English /ð/ for /θ/ in the non-English-major group were similar to one another in the same degree. In the back vowel context, English /ð/ for /ð/ in the native group was more similar to one another than that in the English-major group, and the similarity of this matching was more than English /ð/ for /w/ in the non-English-major group. From the prediction for the identification of English /ð/, only the perceived similarity in the low vowel context is true as no difference between the two groups of L2 Thai learners was found.

For English /ʃ/, in the low vowel context, the fit index of English /ʃ/ for /t͡ʃ/ in the English-major group was significantly lower than the fit index of English /ʃ/ for /ʃ/ in the native group (b = -1.41, SE = 0.19, df = 105.14, t = -7.28, p < 0.01) whereas no significant difference was found between the fit indexes of English /ʃ/ for /t͡ʃ/ in the English-major and non-English-major groups (p > 0.05). The fit index of English /ʃ/ for /ʃ/ in the native group was significantly higher than the fit index of English /ʃ/ for /t͡ʃ/ in the non-English-major group (b = 1.19, SE = 0.20, df = 104.70, t = 6.01, p < 0.01). In the high vowel context, the fit index of English /ʃ/ for /t͡ʃ/ in the English-major group was significantly lower than the fit index of English /ʃ/ for /ʃ/ in the native group (b = -2.84, SE = 0.19, df = 108.58, t = -14.58, p < 0.01) whereas no significant difference was found between the fit indexes of English /ʃ/ for /t͡ʃ/ in the English-major and non-English-major groups (p > 0.05). The fit index of English /ʃ/ for /ʃ/ in the native group was significantly higher than the fit index of English /ʃ/ for /t͡ʃ/ in the non-English-major group (b = 3.00, SE = 0.20, df = 111.81, t = 14.91, p < 0.01).

In the back vowel context, the fit index of English /ʃ/ for /ʃ/ in the English-major group was significantly lower than that in the native group (b = -1.22, SE = 0.19, df = 101.82, t = -6.39,

$p < 0.01$), but it was significantly higher than that in the non-English-major group ($b = 0.97$, $SE = 0.19$, $df = 110.52$, $t = 5.04$, $p < 0.01$). The fit index of English /ʃ/ for /ʃ/ in the native group was also significantly higher than that in the non-English-major group ($b = 2.20$, $SE = 0.20$, $df = 106.11$, $t = 11.05$, $p < 0.01$). These suggest that in the low and high vowel contexts, English /ʃ/ for /ʃ/ in the native group was more similar to one another than English /ʃ/ for /t͡ʃ/ in the English-major and non-English-major groups. In the back vowel context, English /ʃ/ for /ʃ/ was the most similar to one another in the native group, followed by English-major group and non-English-major group. The prediction of English /ʃ/ regarding its perceived similarities between the two groups of L2 Thai learners is true in all vowel contexts.

For English /θ/, in the low vowel context, the fit index of English /θ/ for /f/ in the English-major group was significantly higher than the fit index of English /θ/ for /ð/ in the native group ($b = 1.51$, $SE = 0.20$, $df = 122.09$, $t = 7.53$, $p < 0.01$) whereas there was no significant difference between the fit indexes of English /θ/ for /f/ of English-major and non-English-major groups ($p > 0.05$). The fit index of English /θ/ for /ð/ in the native group was significantly lower than the fit index of English /θ/ for /f/ in the non-English-major group ($b = -1.70$, $SE = 0.20$, $df = 119.57$, $t = -8.30$, $p < 0.01$). In the high vowel context, no significant difference was found for all pairs of language experience: 1) the fit index of English /θ/ for /f/ in the English-major group and the fit index of English /θ/ for /ð/ in the native group, 2) the fit index of English /θ/ for /f/ in the English-major group and the fit index of English /θ/ for /f/ in the non-English-major group, and 3) the fit index of English /θ/ for /ð/ in the native group and the fit index of English /θ/ for /f/ in the non-English-major group ($p > 0.05$ for all pairs).

In the back vowel context, the fit index of English /θ/ for /θ/ in the English-major group was significantly lower than that in the native group ($b = -0.82$, $SE = 0.20$, $df = 126.04$, $t = -4.06$, $p < 0.01$) whereas no significant difference between the fit index of English /θ/ for /θ in the English-major and the fit index of English /θ/ for /s/ in the non-English-major groups ($p > 0.05$). The fit index of English /θ/ for /θ/ in the native group was also significantly higher than the fit index of English /θ/ for /s/ in the non-English-major group ($b = 0.59$, $SE = 0.21$, $df = 122.17$, $t = 2.89$, $p < 0.01$). These suggest that in the low vowel context, English /θ/ for /f/ in the English-major and non-English-major groups were equally similar to one another

and this similarity was more than English /θ/ for /ð/ in the native group. In the high vowel context, English /θ/ for /f/ in the English-major and non-English-major groups, and English /θ/ for /θ/ in the native group were similar to one another with the same degree. In the back vowel context, English /θ/ for /θ/ in the native group was more similar to one another than that in the English-major group and English /θ/ for /s/ in the non-English-major group. Hence the prediction for the identification for English /θ/ is true only in the high vowel context as no difference in the perceived similarities of the two groups of L2 Thai learners was found.

4.4 Summary

In this chapter, the ability to identify English fricatives and the relevant sounds by L2 Thai learners were explored. Regarding the predictions from the perceptual assimilation task, the results showed that for the L2 shared sounds, the findings from this chapter showed as follows:

1) for shared sounds

1.1) in the identification of /s, w, t^h, f/, these sounds will be identified as the same English categories as the target sounds and there will be no differences in the perceived similarity between English-major and non-English-major groups across vowel contexts.

This prediction is true for the identification of /t^h/ and /f/ as both sounds were correctly identified and there were no differences in the perceived similarity between English-major and non-English-major groups across vowel contexts. For the prediction of the identification of /s/, it is accurate for all contexts, except in the high vowel context where the non-English-major group's perception of /s/ was most closely associated to the sound /z/. For the identification of /w/, this prediction is true for the low and back vowel contexts where English /w/ was correctly identified. However, for the high vowel context, the non-English-major group mostly identified /w/ as /v/ and the perceived similarity of English /w/ and its closest sounds was higher in the English-major group than the non-English-major group. To sum up, this prediction is partially true.

1.2) for the identification of /d/, it will be mostly identified as /d/ and there will be no significant differences in the perceived similarity between English-major and non-English-major groups in the high and back vowel contexts. However, in the low vowel context, the non-English-major group will perceive English /d/ as more similar to /d/ than the English-major group.

This prediction is partially true. It is accurate that English /d/ was identified as /d/, and in the low vowel context, the non-English-major group perceived English /d/ as more similar to /d/ than the English-major group. However, in the other two vowel contexts, the non-English-major group perceived English /d/ as more similar to /d/ than the English-major group resulting in a deviation from the prediction.

2) for non-shared sounds

2.1) in the identification of /v, ʋ, ð, z, ʃ, t͡ʃ/, the sounds that will be easy for L2 Thai learners to identify are /ʋ, ð, v (in all contexts except in the low vowel context by the non-English-major group), z/ as the perceived similarities of these sounds and their closest Thai sounds are below 4.5 out of 7. The sounds that will be difficult for them to identify are /v (in the low vowel context in the non-English-major group), ʃ, t͡ʃ/ as the perceived similarities of these sounds and their closests Thai sounds are greater than 4.5 out of 7.

Regarding the identifications of /θ, ð, v (in all contexts except in the low vowel context by the non-English-major group), z/, these sounds are predicted to be easy. The findings showed that for English /v/, only the identification of /v/ by English-major group that followed the prediction of the perceptual assimilation as this group of listeners accurately identified English /v/ in most tokens. For English /θ/, the prediction of the perceptual assimilation is correct in the back vowel context in the English-major group. Although this sound in the other contexts showed that it is not an easy sound, the matching of the sound to the other sounds were consistent with the perceptual assimilation. For English /ð/, the prediction is accurate for the English-major group in the high and back vowel contexts, but this prediction is inaccurate in the English-major group in the low vowel context and in the non-English-major group across vowel contexts. It is surprising that the non-English-major group selected only the sounds occurring in Thai sound system instead of nonnative sounds. For English /z/, this prediction is true in all contexts except in the low vowel context

in the non-English-major group. However, the degree of the perceived similarity of English /z/ and Thai /s/ was almost 4.5 which suggests that this sound in the low vowel context in the non-English-major group has potential to be difficult, and it is the most difficult comparing to the other contexts.

For the identifications of /v (in the low vowel context in the non-English-major group), ʃ, t͡ʃ/, these sounds are predicted to be difficult. The findings showed that for English /v/ in that context, the identifications were as predicted as the non-English-major group in the low vowel context mostly identified this sound as /w/. For English /ʃ/, the prediction of the perceptual assimilation is correct in the high and low vowel contexts as English /ʃ/ was mostly identified as /t͡ʃ/ whereas in the back vowel context, this prediction is wrong as this sound was mostly correctly identified. For English /t͡ʃ/, the prediction is correct in the back vowel context as this sound was mostly identified as /ʃ/ while in the high and low vowel contexts, this prediction is wrong as this sound was mostly correctly identified.

2.2) in the identification of /t͡ʃ/, there will be no significant difference in the perceived similarity between /t͡ʃ/ and its closest sound for the English-major and for the non-English-major groups across vowel contexts;

This prediction is true in the low vowel context, but in the high and back vowel contexts, the perceived similarity between English /t͡ʃ/ and its closest sound was higher in the English-major than the non-English-major groups.

2.3) in the identification of /z/ and /v/, the English-major group will have higher perceived similarities between these two sounds and the closest sounds than the non-English-major group across vowel contexts;

This prediction is true in the identification of these two sounds in the low and back vowel contexts. It is not true in the identification of /z/ in the high vowel context when no significant difference in the perceived similarity between the English-major and non-English-major was found, and in the identification of /v/ in the high vowel context when the perceived similarity was higher in the non-English-major group than in the English-major group.

2.4) in the identification of /ð/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups in the low and back vowel contexts, but in the high vowel context, the non-English-major group will have higher perceived similarity of this sound and the closest sound than the English-major group;

This prediction was true in only the identification of /ð/ in the low vowel context. In the back vowel context, the perceived similarities between English /ð/ and the closest sound was higher in the English-major group than the non-English-major group, and in the high vowel context, there was no significant difference in the perceived similarity between English-major and non-English-major groups resulting in the contrast to the prediction.

2.5) in the identification of /ʃ/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups in the low and high vowel contexts, but in the back vowel context, the English-major group will have higher perceived similarity of this sound and the closest sound than the non-English-major group;

This prediction is completely true as there was no significant difference in the perceived similarity between English-major and non-English-major groups in the low and high vowel contexts, but in the back vowel context, the English-major group had higher perceived similarity of this sound and the closest sound than the non-English-major group.

2.6) in the identification of /θ/, there will be no significant difference in the perceived similarity between English-major and non-English-major groups in the high vowel context, but in the low and back vowel context, the English-major group will have higher perceived similarities of this sound and the closest sounds than the non-English-major group.

This prediction is partially true. It is true that in the high vowel context, there was no significant difference in the perceived similarities between English-major and non-English-major groups. However, in the low and back vowel contexts, there was also no significant differences in the perceived similarities of the English /θ/ and their closest sounds between English-major and non-English-major groups. In the next chapter, all the results from the two experiments are discussed in relation to SLM and PAM-L2 followed by the implications of the study.

Chapter 5. Discussion and conclusion

5.1 Introduction

This study aims at investigating the perception of English fricatives by L2 Thai learners and the effects of the language experience and vowel context. It is composed of two experiments: perceptual assimilation and sound identification task. The aim of this chapter is to discuss the results of this study and to explore the degree to which the two models, namely the Perceptual Assimilation Model-L2 (PAM-L2) and the Speech Learning Model (SLM) can explain the results of this study. The discussion and implications of the study are in the following section.

5.2 Discussion and implications of the study

Regarding the finding from the perceptual assimilation task, all shared sounds, namely /f, s, d, t^h, w/ were assimilated to Thai sounds with the same IPA symbols, and there was no differences in the perceived similarities between the target shared English and the closest Thai sounds, except English /d/ for Thai /d/ in the low vowel context as the perceived similarity between these two sounds was higher in the English-major than the non-English-major one.

As the hypotheses for the sound identification is based on the findings of the perceptual assimilation task, it is predicted that L2 Thai learners would not have difficulty identify English shared sounds /f, s, t^h, w, d/ and there would not be differences in the perceived similarities of English /f, s, t^h, w/ and their closest Thai sounds in the two groups of Thai listeners. For the perceived similarity of English /d/, in high and back vowel contexts, although there would be no difference between groups of Thai listeners, in the low vowel context, the non-English-major group would have higher perceived similarity of English /d/ for /d/ than the English-major group.

The findings from the sound identification task for shared sounds supported the following hypotheses: 1) the identification of English /d/ for /d/; 2) in low vowel context of English /d/ for /d/ as the non-English-major group perceived English /d/ as /d/ and perceived that these two sounds were similar to one another than the English-major group; 3) the identification and perceived similarities of English /t^h/ for /t^h/; 4) the identification and perceived similarities of English /f/ for /f/; 5) the identification and perceived similarities of

English /s/ for /s/, except in the high vowel context in the non-English-major group as this group mostly identified English /s/ with /z/; and 7) the identification and perceived similarities of English /w/ as /w/ in the low and back vowel contexts – for the high vowel context, only the identification in the English-major group was accurate, but not the perceived similarity. Hence, for shared sounds, the proposals of the PAM-L2 and SLM that the L2 perception is based on the perceived similarity between L1 and L2 sounds by the L2 learners are confirmed in these context. On the other hand, the findings of some contexts are against the hypotheses for shared sounds, such as for English /d/, the findings showed that in the back and high vowel contexts, the perceived similarity of the non-English-major group was higher than the English-major group whereas the hypothesis proposed that there would be no difference in the perceived similarities between the two groups in these vowel contexts.

In the non-shared sounds, most sounds were mostly matched with the same sounds that L2 Thai learners commonly produced as substituted sounds, i.e. English /v/ as /w/ (Chunsuvimol & Ronakiat, 2000, 2001), English /z/ as /s/ (Brière & Chiachanpong, 1980; Kitikanan, 2016; Richards, 1966), English /ð/ as /d/ (Burkardt, 2008; Kitikanan, 2016), and English /ʃ/ and /t͡ʃ/ as /t͡ɕʰ/ (Richards, 1966). However, for English /θ/, instead of being mostly matched with /t/ (Burkardt, 2008; Kitikanan, 2016), it was mostly matched with /f/ in the high and low vowel context whereas in the back vowel context, it was mostly matched with /s/. In terms of the perceived similarity, for English /z/ and /v/, the perceived similarities of the target English sounds to their Thai sounds were higher in the non-English-major group than the English-major group suggesting that there is no influence of the vowel context in the assimilation of English /z/ and /v/ for the L2 Thai learners – only the language experience that matters. For the perceived similarities of English /ð, ʃ, θ/, the findings showed influences of both vowel context and language experience, i.e. for English /ð/, the perceived similarity of the English-major group was higher than that of the non-English-major group in the high vowel context; for English /ʃ/, in the back vowel context, the opposite direction was found; and for English /θ/, in the low and back vowel contexts, the perceived similarities was higher in the non-English-major group than the English-major group. For English /t͡ʃ/, no difference in the perceived similarities between groups was found.

The hypotheses from the perceptual assimilation task for the non-shared sounds were used to make predictions regarding the perceived similarities between the target sound and the identified sound. They were as follows: 1) the sounds that would be easy were /θ, ð, v (all contexts except in the low vowel context in the non-English-major group), z/ and the sounds that would be difficult to identify were /v (in the low vowel context in the non-English-major group), ʃ, t͡ʃ/; 2) the perceived similarities of English /t͡ʃ/ between the English-major and the non-English-major groups would not be found to be different from one another; 3) the perceived similarities of English /z/ and /v/ would be higher in the English-major than the non-English-major group; 4) for English /ð/, no differences in the perceived similarities between the English-major and the non-English-major groups would be found in the low and back vowel contexts, but that in the non-English-major group would be higher than that in the English-major group in the high vowel context; 5) for English /ʃ/, no differences in the perceived similarities between the English-major and the non-English-major groups would be found in the high and low vowel contexts, but that in the English-major group would be higher than that in the non-English-major group in the back vowel context; 6) for English /θ/, no difference in the perceived similarities between the English-major and the non-English-major groups would be found in the high vowel context, but in the low and back vowel contexts, those in the English-major group would be higher those that in the non-English-major group.

Regarding the confirmations of the hypotheses for the non-shared sounds, they were confirmed in the following contexts: 1) the identifications of the non-shared sounds were confirmed in English /θ/ in the back vowel context in the English-major group, English /ð/ in the English-major group in the high and back vowel contexts, English /v/ in the English-major group across vowel contexts, English /z/ in all contexts except in the low context in the non-English-major group, English /ʃ/ in the high and low vowel contexts, English /t͡ʃ/ in the back vowel context and English /v/ in the non-English-major in the low vowel contexts; 2) the perceived similarities of English /t͡ʃ/ between the English-major and the non-English-major groups were found no difference in the low vowel context; 3) the perceived similarities of English /z/ and /v/ were higher in the English-major group than the non-English-major group in the low and back vowel contexts; 4) there was no difference between the two groups of L2 Thai learners in the low vowel context for English /ð/; 5) the

perceived similarities of English /ʃ/ were true in all contexts; and 6) in the high vowel context, no difference in the perceived similarities of English /θ/ in the two groups. Thus, for non-shared sounds, the proposals of the PAM-L2 and SLM that the L2 perception that are based on the perceived similarity between L1 and L2 sounds by the L2 learners are confirmed in these contexts. However, the number of the hypotheses of the non-shared sounds that are not confirmed are higher than the ones of the shared sounds. This suggests that in some contexts, the predictions that are based on the perceived similarities between L1 and L2 sounds by L2 learners might be insufficient. In other words, the proposals of PAM-L2 and SLM that the L2 sound perception is based on the perceived similarity between the L1 and L2 sounds by L2 learners are partially true. Other ways of comparing the similarities between the L1 and L2 sounds might be needed such as measuring phonetic qualities of these sounds with acoustic characteristics. However, the predictions for the L2 sound perception are better for shared sounds than non-shared sounds.

The PAM-L2 also proposed that the L2 exposure will enhance the ability to perceive the L2 sounds. This is confirmed in many findings for both shared and non-shared sounds, such as when the English-major correctly identified English /v/ as /v/ whereas the non-English-major group mostly identified this sound as /w/. However, in some contexts, it seems that higher experience in the L2 does not always encourage the L2 sound perception, such as in the back vowel context when both groups of the learners identified English /t͡ʃ/ as /ʃ/, and the perceived similarities between these sounds were even higher in the English-major group than the non-English-major group. It is possible that for some target sounds, the ability to identify L2 sounds might require more than merely L2 exposure. The other possibility might be that this hypothesis from the PAM-L2 is based on the L2 exposure in the L2 natural setting whereas the L2 experience of the L2 Thai learners in this study is from the phonetic training which might not be effective to improve the perception of this sound.

In terms of the implication for teaching the L2 sounds, the findings of this study suggest that L2 Thai learners have more difficulty learning non-shared sounds than the shared ones. They also show that not all L2 learners have difficulty perceiving in the same extent, such as when English /v/ was identified as /v/ in the English-major group, but as /w/ in the non-English-major group. This suggests the influence of the language experience in the learning. In some contexts, the influence of the vowel context was found, such as when

English /θ/ was assimilated to Thai /f/ in the high and low vowel contexts, but to Thai /s/ in the back vowel context for both groups of L2 Thai learners which is consistent to the identification of this sound for the English sounds in all contexts of the L2 Thai learners, except in the back vowel context in the English-major group. In addition, we also found the influences of the vowel context and language experience together in many contexts, such as for English /ð/, it was identified correctly in the high and back vowel contexts by the English-major group, but it was identified as /d/ in the high vowel context and as /w/ in the back vowel context by the non-English-major group. These suggestions show that in the teaching of the L2 sounds, both language experience and vowel context should be taken into consideration.

5.3 Contribution

This study has contributed to the field of the L2 speech learning as follows. First, while there are a fair number of studies on English fricative learning by L2 Thai learners (Brière & Chiachanpong, 1980; Burkardt, 2008; Chunsuvimol & Ronakiat, 2000, 2001; Kitikanan, 2016; Kitikanan et al., 2015; Pansottee, 1992; Richards, 1966; Roengpitya, 2011; Sridhanyarat, 2015), most of them are on the production of English fricatives. The study of Pansottee (1992) is the only study on the English fricative perception by L2 Thai learners. To the best of my knowledge, this study is the first one to explore the perceived similarity of the English and Thai sounds, i.e. it is the study investigating the perceptual assimilation of the English sounds to the closest Thai categories. In addition to finding the matching of the L2 sounds with the L1 sounds, we also investigate the degree of the perceived similarity between these sounds. Hence this study not only provides the matching of the sounds, but also the extent of these L1 and L2 sounds are perceived as similar to one another in the perception of L2 Thai learners.

Second, this study is the first study to investigate the ability to identify the English fricatives by L2 Thai learners. Although Pansottee (1992) carried out the study on the perception of English fricatives by L2 Thai learners, her study was on the discrimination task, i.e. asking the subjects to distinguish the sounds rather than identify the sound categories. This study explores the identification of the English sounds to find out the matching of the English sounds to the target English sounds. It provides the frequency of the correct identification

and the comparison to the native speakers of English. Additionally, it also shows the extent of the perceived similarity of the target English sounds and the identified sounds in three groups of speakers: native speakers of English, English-major and non-English-major group. The identification of the native speakers is used as a base line for the identification. This allows us to see the sounds that might not be as intended even for the group of native speakers of English, such as when native speakers perceived English /ð/ as /θ/ in the high vowel context which might be because the voicing of English /ð/ in this context was not sufficiently salient.

The last contribution of this study is the exploration of the effects of the vowel context and the language experience in the perception of the L2 sounds. Although many studies on the L2 sound perception included one of these two factors in their studies, none of the studies involves these two factors together. The results of this study, such as when the perceived similarity of English /ʃ/ as Thai /t͡ɕʰ/ was significantly higher in the non-English-major group than English-major group only in the back vowel context, rather than in the other two vowel contexts, or when English /s/ was identified as /z/ in the non-English-major group in the high vowel context, but not in the other contexts, suggest that the matching of the sounds either between L2 and L1 sounds, or between L2 and L2 sounds and the degree of the perceived similarity is not in the context-independent manner. This supports the PAM-L2 and SLM that the comparisons of the similarity of the L2 and L1 sounds should be carried out in the phonetic rather than phonological level.

5.4 Limitations of the study

In this study, there are three limitations to be mentioned. First, the fricatives and the relevant sounds were only in the initial position. The study of the perception in this study thus might not represent the whole area of English fricative perception by L2 Thai learners. However, with the limitation in time and budget, the production of the stimuli is also limited.

Second, the stimuli in this study were only produced by female speakers. The findings of the perception in this study might be influenced by sex of the speakers. When the stimuli are produced with male speakers, or multi-talkers with both sexes, the results might be

different. However, the sex of the speakers was limited into only female as to control the sex of the speakers.

Last, the L2 Thai learners in this study were learners in the EFL (English as a Foreign Language) context, i.e. learners in the L1 country. The language experience factor in this study thus refers to the training in phonetics that L2 Thai learners in Thailand received. It is interesting to explore the English fricative perception of the L2 Thai learners in the other contexts, such as ESL (English as a Second Language) context where Thai learners are using English in their daily lives. This will allow us to see whether the positive influence of the language experience in the findings in this study is due to the phonetic training, or the results might still be the same with L2 Thai learners exposing to L2 in the L2 country.

5.5 Future directions

Three directions are proposed for the future research. First, the analysis of the perceptual assimilation can be from the sound contrast angle, i.e. comparing the sounds in pair with the consideration of the language experience and the vowel context. For example, the previous studies showed that English /z/ is often produced as /s/ in the production of L2 Thai learners (e.g., Brière & Chiachanpong, 1980; Kanokpermpoon, 2007); thus it is likely that English /s/ and /z/ are confusable sound contrast for L2 Thai learners. Then in the analysis of the perceived similarity between English /z/ and /s/, the degree of the perceived similarity of these sounds and their closest Thai sounds might be compared from when they are in the same vowel contexts and language experience group. This will allow us to make the prediction for the discrimination task to find out if the predictions support the PAM-L2 as this model makes the prediction from the perceived similarity of the L2 sound contrast, and the way to prove its prediction is via the discrimination task.

Second, in addition to the perceptual assimilation and the sound identification, the other task that could be explored is the discrimination task. The purpose of this task is to investigate if the L2 learners can see the difference between sounds provided in the task. At this current study, we cannot investigate the extent that the PAM-L2 can account for the L2 sound perception as this study dealt with individual sounds, rather than the sound contrasts. In the discrimination task, the stimuli will be in the sound contrasts and this will

allow us to explore if the discrimination of the sound contrasts of the L2 learners will be based on the findings of the perceptual assimilation task. If it is, then it suggests that the ability to discriminate the sound in the L2 sound contrast s based on the perceptual assimilation of the L1 and L2 sounds.

Last, apart from using the perceptual assimilation task to investigate the degree of the cross-language similarity between L1 and L2 sounds, there might be the comparison of the two sounds using acoustic measurements. From the target sounds in this study, /f, s/ in English and Thai were acoustically compared in the study of Kitikanan (2016). However the acoustic comparison for the other shared sounds is still needed. The acoustic characteristics of the sounds can be measured by many acoustic angles which provide us the fine-grained phonetic details that might be beyond the perception of humans. The acoustic findings can also be used to make the predictions to the sound identification and discrimination tasks. Then the findings from the acoustic and perceptual assimilation views could be compared in terms of which view provides better predictions for the L2 sound perception based on both tasks.

6. References

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