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The Impact of L1 Negative Phonological Transfer on L2 Word Identification and Production

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Abstract

30 intermediate Chinese English learners participated in two experiments which address the issue of first language negative phonological transfer on second language word identification and production. In Experiment 1, the subjects performed an auditory priming task. In Experiment 2, the subjects completed a pronunciation task, in which they were asked to read words containing "th" and some filler words. Results showed that the subjects assimilated the English phonemes /s/, /θ/ and /d/, /ð/ into the Chinese phonemic categories of (s) and (d) respectively and used (s) and (d) to substitute /s/, /θ/ and /d/, /ð/ in word identification and production. The result partly confirmed the Speech Learning Model and the abstractionist model of speech perception and the researchers argued that the negative phonological transfer resulted in false phonological representations of L2 words in the learners' mental lexicon.

Keywords: Phonological negative transfer, L2 word identification, Phonemic substitution, Phonological representation

1. Introduction

When acquiring the L1 (first language), children identify phonemes and extract phonotactic regularities from the speech signals they are exposed to. To L2[1] (second language) learners, the learning of the L2 sounds is likely to be influenced by the L1 phonetic system, and especially when some L2 phonemes do not exist in learners' L1, the L1 phonological system would function like a sieve subjecting the L2 phonemes to adapting to its structure (Sebastian-Galles *et al*, 2005). Therefore, L2 learners tend to assimilate those L2 phonemes into their L1 phonemic categories (Pallier *et al*, 2001). For example, it is well documented that Japanese English learners substitute the English /r/ and /l/ with the Japanese /l/ (Hattori & Iverson, 2009). This phenomenon, termed as negative phonological transfer, may not only cause L2 learners to have difficulties in L2 word identification and production, but also result in foreign accent as well.

To L2 learners, or even to those who have sufficient exposure to the L2, correct identification and production of L2 phonemes constantly prove to be a problem (Flege *et al*, 1999). For example, the English phonemes /θ/ and /ð/ are not existent in many languages. Consequently they pose a great difficulty for L2 English learners. The two sounds are usually replaced by different phonemes by L2 learners with distinctive L1 backgrounds. For instance, German and French English learners usually replace /θ/ with /s/ (Brannen, 2002). Lambacher *et al* (1997) found that Japanese learners of English had considerable difficulty distinguishing /θ/ and /s/ and they constantly assimilated /θ/ into the phonetic category of /s/. Brown (2000) compared the acquisition of /θ/ and /ð/ by Chinese and Korean learners of English and found that they both substitute /θ/ and /ð/ with their L1 phonemes (s)[2] and (d). Other studies also provide support for this finding (*e.g.* Rau *et al*, 2009).

Previous studies mainly investigated whether negative L1 phonological transfer occurs in L2 acquisition (e.g. Bohn & Best, 2012). The impact of L1 negative phonological transfer on L2 word identification and production has received only limited attention, though the issue is of significance both theoretically and pedagogically. Theoretically, the study could provide experimental evidence to verify models of spoken word recognition and speech learning and contribute to our knowledge of the cognitive underpinnings of the negative phonological transfer. Pedagogically, the results could bear direct implications and suggestions for L2 phonetic and phonological teaching and learning so that L2 teachers could prioritize particular pronunciation activities to help the learners avoid the negative phonological transfer if they know whether negative phonological transfer merely results in articulatory simplification or a more serious problem, *i.e.* the construction of false phonological mental representations.

For the current study, we wish to determine if negative phonological transfer only results in a simple sound substitution strategy or it leads to a more serious problem that L2 learners construct false phonological representations for similar and novel L2 sounds and use them for

[1] L2 in the article refers to a language other than one's native language.

[2] The Chinese phonemes are put into parentheses in order to be distinguished from the English phonemes which are put between slashes.

word identification and production.

To address this objective, we tested a group of college freshmen who had entered college for only one month in Northeastern China. We targeted them because they had just graduated from senior high school, where they paid far much attention to the grammatical knowledge of English. Hence, we assume that the subjects have relatively low phonological awareness[3]. In Experiment 1, a priming paradigm and a repetition task (*e.g.* Jiang & Liu, 2014) are used to gauge the impact of L1 negative phonological transfer on L2 word identification, because a priming paradigm is well suited for examining the subjects' unconscious use of phonological processes. Specifically, we examined whether the subjects assimilated similar and novel L2 sounds into the L1 phonetic category, as predicated by the Speech Learning Model (Flege, 1987; 1995). Flege (1987) classified L2 sounds mainly into three types in terms of their relation to L1 sounds, *i.e.* same sounds, similar sounds and novel sounds. He predicted that the ease with which the contrasts between L2 sounds are perceived varies with the perceived phonetic similarity between an L1 sound and an L2 sound (Flege, 1995). He also holds that when an L1 sound and an L2 sound bear a large number of similarities, the L1 sound will interfere with the construction of the phonetic category of the L2 sound. However, when the similarities between an L1 sound and an L2 sound are not conspicuous, L2 learners may be able to construct a new L2 phonetic category, because the bigger the gap is between an L1 sound and an L2 sound, the easier it will be for L2 learners to perceive the differences.

As predicated by the speech learning model, Chinese English learners may have difficulty constructing new phonetic categories for the English /s/ and /d/ sounds, because they share a number of phonetic features with the Chinese (s) and (d). However, they may have no such difficulty with the construction of phonetic categories for /θ/ and /ð/ as they are nonexistent in Chinese. On the other hand, English teaching and learning in China has long been grammar-based, where teachers and students pay far more attention to the grammatical accuracy than pronunciation (Macdonald, 2003). This could result in low phonological awareness, which could prevent leaners from noticing the differences between similar sounds in the L1 and L2. It may also prompt them to neglect the novel L2 sounds, which will be replaced by similar L1 sounds. In Experiment 1, we hypothesize that the subjects will substitute /s/ and θ/ with their L1 phoneme (s) and replace /d/ and /ð/ with their L1 phoneme (d), and that they would regard the minimal pairs with /θ/ and /ð/ (*e.g. sink- think*) or /d/ and /ð/ (*e.g. den-then*) as homophones, as the shared representational hypothesis of homophones assumes that homophones are represented with the same phonological representation. If the reaction time (RT) for the target words is significantly faster than that for the filler words, the hypothesis could be verified.

In Experiment 2, a pronunciation task is administered to investigate the influence of L1 negative transfer on L2 word production. The hypothesis is that the subjects will substitute /θ/ and /ð/ with their L1 phonemes (s) and (d) respectively when they read visually presented words involving the "th" cluster.

[3] Phonological awareness refers to a person's awareness of the phonological structure of spoken words (Gillon, 2004).

2. Research Methods

2.1 Subjects

30 intermediate[4] Chinese English learners (5 male and 25 female) from Northeast Normal University participated in the experiments. They had been in college for only one month at the time of the tests. The mean age of the subjects is 18.27 (*SD*=0.45) and they had been learning English for an average of 6.5 years (*SD*=0.50). No subject had vision, hearing or pronunciation problems. They were awarded with a little gift at the end of the experiments.

2.2 Materials

1) Experiment 1

The stimuli in Experiment 1 include 60 English words which are classified into two groups: 16 minimal pairs with the /s/ and /θ/ or /d/ and /ð/ phonemes (*e.g. sank-thank; dough-though*) and 28 filler words. All the /θ/ and /ð/ phonemes appear in the word initial position. According to the Corpus of Contemporary American English, the average word frequency of the minimal pairs and the filler words are 200447.56 (*SD*=4.41) and 127433.61 (*SD*=1.65), respectively.

16 words appear in the study phrase, which include 5 words with an initial /s/, 4 words with an initial /θ/, 4 words with an initial /d/ and 3 words with an initial /ð/. The other 44 words appear in the test phrase, which include 16 words that constitute minimal pairs with the 16 words in the study phrase and 28 filler words. The mean syllable number of the minimal pairs and the filler words are 1.13 (*SD*=0.34) and 2.18 (*SD*=0.55), respectively.

All the words were digitally recorded in a soundproof lab by a male Chinese English teacher at a sampling rate of 44,100 Hz to produce 16-bit digital sound files by using Cool Edit Pro (Syntrillium Software Corporation, 2002).

2) Experiment 2

The materials in Experiment 2 include the same 16 minimal pairs as those in Experiment 1 and a new set of 18 filler words. The same 16 minimal pairs are used due to two reasons. First, the number of English words containing “th” is limited; hence it seems difficult to include a different set of words with “th”, especially when we have to match the two sets of words on frequency. Secondly, there might be a possibility that the subjects may have correct phonological representations in the mental lexicon for the very words they are asked to read. In that case, it would be impossible to examine the relationship between the impact of negative phonological transfer on word identification and that on word production.

2.3 Experiment Design

Both experiments adopt a within-subject design. In Experiment 1, the independent variable is word identity, which has two levels: minimal pairs and filler words. The dependent variable is the reaction time. In Experiment 2, the independent variable is word type, which has two

[4] The subjects have formally received English instruction in junior and senior high schools but they have not reached an advanced level of English proficiency. Consequently, we consider them at an intermediate level.

levels: words with "th" and words without them. The dependent variable is the pronunciation accuracy.

2.4 Equipment

The experimental program was created on E-prime 2.0 professional (Psychological Software Tools, 2012). A serial-response box, a microphone and a headphone (Sony DR-ZX102DPV) were attached to a Dell desktop computer with a 17-inch monitor (CPU: Intel (R) Core (TM) i3 550; ROM: 2 G). In addition, a Sony video camera was used in Experiment 2.

2.5 Procedures

1) Experiment 1

All the subjects were individually tested for approximately 10 minutes. First, in the study phrase, the subjects heard 16 target words individually presented at an interval of 3000 milliseconds (ms) and they did not have to make any response. However, they were asked to think about how many syllables the word they heard has. Then in the distracter phase, they worked out ten arithmetic questions so as to eliminate recency effect. Finally in the test phrase, the subjects heard 44 words individually presented at an interval of 4000ms and were asked to repeat each word aloud as promptly and accurately as possible. A schematic illustration of the process is demonstrated below.

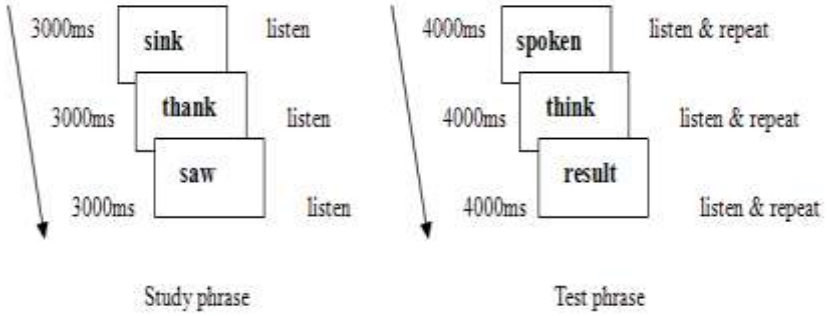


Fig. 1 A schematic illustration of the study phase and test phase

2) Experiment 2

The subjects were asked to read aloud the words presented to them on the computer monitor at an interval of 4000ms. They could only read each word once. If they failed to read a word within 4000ms, the program would automatically jump to the next page and the trial would become invalid.

3. Results and Discussion

Before subjecting the data to SPSS analysis, we checked the subjects' RT for outliers[5]. Outliers in the present study refer to the RT that is less than 300ms or more than 1300ms. The total outliers accounted for 1.27% of all and they were removed from the final data analysis.

[5] Outliers refer to the RT that is either too fast or too slow. The removal of the outlines could guarantee that RT could faithfully reflect the processing time of the words and processing benefit on the second rendition of the words.

In addition, we watched the video and found 19 invalid trials, which accounted for 1.44% of total trails.

Then, the data from Experiment 1 and Experiment 2 were subject to a paired sample *t*-test and a single sample *t*-test on SPSS 17.0, respectively. First, the RT for the target words and filler words were compared. If the mean RT for the target words is significantly faster than that for the filler words, it will mean that the subjects indeed regard the minimal pairs as homophones, because only under such a circumstance can priming effects be obtained.

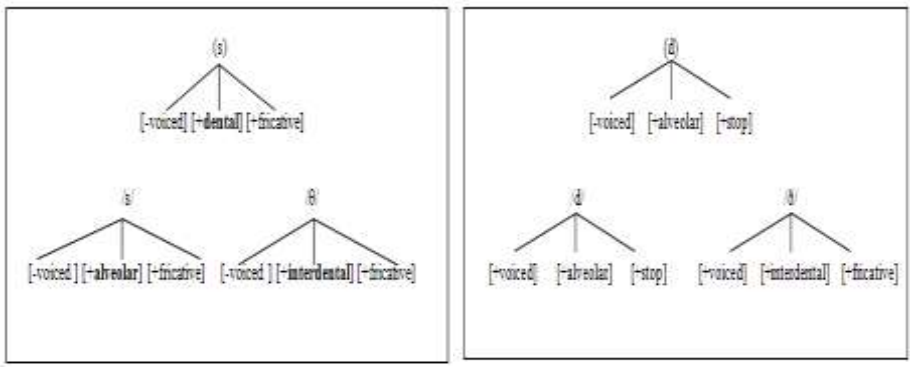
3.1 Results of Experiment 1 and discussion

Table 1. Reaction time for words in the test phrase

Word identity	**RT *Mean***	***SD***
Target words	661.87	21.36
Filler words	692.14	16.32

From Table 1 it could be seen that the RT for the target words is significantly faster than that for the filler words. t (29)=-12.85, p=0.00. This suggests that the subjects indeed treated the 16 words they heard in the test phase as the same words they heard in the study phrase. As single word repetition does not involve the retrieval of word meaning (Gupta & MacWhinney, 1997), the subjects did not need to consider whether they heard “sick” or “thick”. Moreover, when the subjects heard the words in the study phase, we manipulated the subjects’ attentional orientation to focus on the formal features of the words, *i.e.* to count the syllable(s) a word has, it is highly probably that the subjects had no additional time or cognitive capability to retrieve the meaning of the words. It seems that the subjects failed to notice the distinctive phonemes in the minimal pairs. Instead, they treated them as the same words, or homophones to be more exact. According to the Logogen Model (Morton, 1982), the target words were activated when the subjects heard them for the first time. Before the activation returned to a resting level, the subjects heard the same word again. Consequently, the retrieval process was accelerated. The result confirmed the hypothesis that the subjects substitute the English phonemes /s/, /θ/ and /d/, /ð/ with the Chinese phonemes (s) and (d) and represented minimal pairs involving /s/ and /θ/ or /d/ and /ð/ as homophones in their mental lexicon.

Then why did the subjects substitute the English phonemes /θ/ and /ð/ with the Chinese phonemes (s) and (d) in word identification and production? An examination of the similarities and differences among the L1 Chinese (s), the L2 /s/ and /θ/ and those among the L1 Chinese (d), the L2 /d/ and /ð/ might offer some clue, as shown in Figure 2.



(1) (2)

Fig. 2. (1) Similarities and differences among L1 Chinese (s), the L2 /s/ and /θ/

(2) Similarities and differences among L1 Chinese (d), the L2 /d/ and /ð/

From Figure 2, it could be seen that the L2 /s/ and /d/ bear a lot of similarities with the L1 (s) and (d), while /θ/ and /ð/ do not resemble any sound in Chinese, as there are no interdental sounds in Chinese. According to the equivalence classification hypothesis (Flege, 1987), L2 learners may not acquire those L2 sounds that bear similarity to L1 sounds, but may be able to acquire novel L2 sounds. However, in the present study, it seems that the learners have not established phonetic categories for the novel L2 sounds /θ/ and /ð/ yet. In English, the phonemes /θ/ and /ð/, as interdental fricatives, are quite distinctive in their articulatory gestures. Consequently the feature [+interdental] is marked, while in Chinese, (s) and (d) are unmarked, as alveolar sounds, fricative sounds and stops are common in the Chinese phonetic inventory. According to the markedness theory, the marked aspects of an L1 would not transfer to the target L2. However, if linguistic features are unmarked in the L1 and are marked in the L2, then language transfer is likely to occur (Ellis, 2000).

The reason why the subjects in the present study failed to acquire /θ/ and /ð/ successfully may be two fold. First, to L2 learners of English, the interdental phonemes /θ/ and /ð/ are so difficult to pronounce that it naturally takes a long time for the L2 speakers to reach automaticity in producing them. Second, the fact that English words containing /θ/ and /ð/ are also quite limited in number again aggravates the difficulty (Smith, 2009). Thus, L2 speakers encounter considerate challenges when they encode them (Ota *et al*, 2009). Though the subjects in the present study have learnt English for about averagely 6.5 years, they received far more instructions in the formal aspect of the language, *i.e.* English teaching is mainly grammatically orientated in China and students rarely receive phonetic or phonological instructions (Macdonald, 2003). This lack of phonological awareness prevents the learners to construct accurate phonological representations for /θ/ and /ð/, which are assimilated into the L1 (s) and (d) phonetic category as a result. In addition, as pointed out by Dresher & van der Hulst (1995), phoneme acquisition requires learners to take both the local phonetics of individual segments and the phonological processes into consideration. In Chinese, (d) is often produced as (də), which sounds quite similar to the English word "the" (/ðə/). As "the" is perhaps one of the most frequent words in English ("the" occurs for 25,065,276 times in the Corpus of Contemporary American English, a 450-million-word corpus.), Chinese

students encounter this word in the very early phase of English learning, when their phonological awareness is only beginning to develop. Naturally, when they heard "/ðə/" for the first time, they would consider it the same with the Chinese (də).

In order to account for the impact of negative phonological transfer, we create a model as shown in Figure 3.

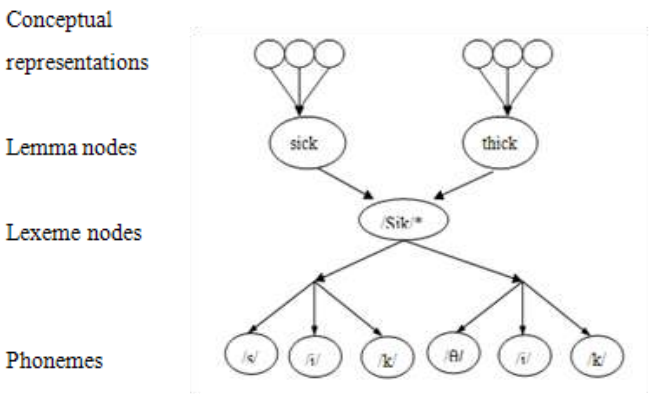


Fig. 3. Phonological negative transfer and its impact on phonological mental presentation

As demonstrated in Figure 3, when the subjects falsely represented the minimal pairs /sik/ and /θik/ as the same /Sik/*[6] in their mental lexicon, they treated /sik/ and /θik/ as homophones.

The results of Experiment 1 are consistent with the abstractionist model of speech perception, which asserts that words are not represented in detailed acoustic traces in the mental lexicon; instead they are represented in abstract forms (Norris, 1994). According to the abstractionist model, the acoustic speech stream is coded as a normalized, language specific phonological representation. The prelexical phonological representation is utilized for matching with lexical representations. When two L2 sounds are assimilated into one L1 phonetic category, their representations become identical at the prelexical level, as the L1 phoneme is used to code the two L2 phonemes. As a result, two L2 words (or a minimal pair) that only differ in such a contrast will share identical lexical representation. In the study, the subjects heard /θ/ and /ð/, however, they failed to retain the phonetic feature [+interdental] and encode it for subsequent word identification. Instead, they assimilated /θ/ and /ð/ into the similar L1 phonemic categories, which causes the minimal pairs like /sik/ and /θik/ to share the same prelexical presentation in the mental lexicon. The result is also in line with the study done by Trofimovich & John (2011), who found that the L2 learners did not distinguish words like "three" and "tree" or "they" and "day" at the level of lexicon.

However, is the problem that the subjects have in identifying words with /θ/ and /ð/ caused by the sound quality of the recording? To probe this possibility, we asked two English native speakers to complete a dictation task. The results showed that the native speakers' dictation accuracy reached 95.3%. A common problem was caused by the word "thy" and this may be

[6] /Sik/* is a false phonological representation resulting from negative L1 phonological transfer.

attributed to its low frequency in language use. The dictation test proved that the problem the subjects have identifying /θ/ and /ð/ does not originate from perceptual difficulty, but instead it was triggered by the negative phonological transfer, *i.e.* the /θ/ and /ð/ sounds are represented incorrectly in the subjects' mental lexicon.

3.2 Results of Experiment 2 and Discussion

There are two types of words in Experiment 2, i.e. words with "th" and those without them. First, we watched each subject's video to judge the accuracy of the pronunciation of "th" and the filler words. Only when subjects pronounce /θ/ and /ð/ as voiceless or voiced interdental fricatives do we consider them correct. Each of the 16 target words is credited with a point of 0.625 and each of the 18 filler words is given a point of 0.55, which approximately makes up 10 points for each type of words in total. The subjects' performance on the target words and filler words is shown in Figure 4.

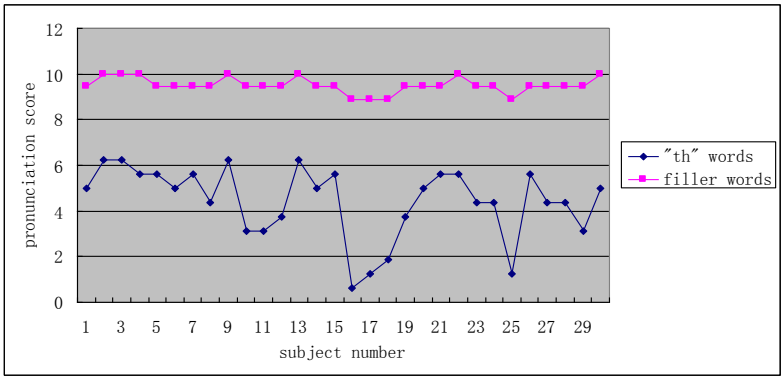


Fig. 4. Subjects' pronunciation performance in Experiment 2

As shown in Figure 4, the subjects score much higher on the filler words than the target words (M=95.01, SD=3.37), which suggests that they are quite familiar with the filler words and that they have few if any problems with their pronunciation of English words. However, what is of real interest here is their performance on the target words. A majority of the subjects scored under 5 points (M=4.44, SD=1.58). The differences among the subjects' performance are significant. $t(29)$=15.42，p=0.00. When they pronounce words with the "th" cluster, they usually pronounce "th" as (s) or (d), especially for words like "though", "theory", "southern" and etc. Apart from this, we did not find any other substitutes for /θ/ and /ð/ in these subjects. The result confirmed what Brown has found in his study (Brown, 2000). The result also shows that the subjects could pronounce some "th" words correctly while have problems with others. This can be accounted for by at least two reasons. First, this may be pertinent to the subjects' differential phonological awareness. Those with higher phonological awareness may have attached more importance to their pronunciation in their L2 learning, so consequently they could produce more "th" words accurately than those subjects with low phonological awareness. More importantly, as studies show that some L2 speakers are able to produce L2 contrasts that they cannot distinguish perceptually (Baker & Trofimovich, 2006), so even if some subjects could pronounce some "th" words correctly, they may still have created false phonological mental representations for these correctly

produced words.

However, a related question still remains unaddressed, *i.e.* what is the relationship between negative phonological transfer in L2 word identification and that in L2 production? Does it mean the stronger impact negative phonological transfer has on L2 word identification, the stronger impact it will have on L2 word production? To unravel this question, we subject the RT for the target words in Experiment 1 and the pronunciation scores of the "th" words in Experiment 2 to a correlation analysis and found that the two are significantly correlated, as shown in Figure 5.

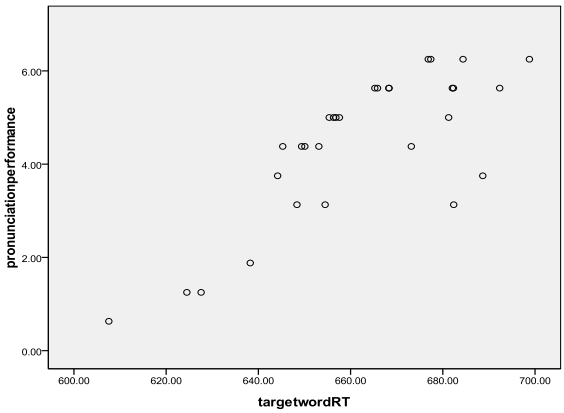


Fig. 5. Correlation between target word RT and the "th" pronunciation performance

Figure 5 reveals that the target word RT and the pronunciation performance are positively correlated. r=0.78， p=0.00. The result indicates that the stronger impact negative phonological transfer has on L2 word identification, the stronger impact it has on L2 word production. As the subjects constructed the wrong phonological representation for the /θ/ and /ð/ sounds, it is natural that they would retrieve incorrect phonological representations and encode them for production.

What deserves further attention is that in Experiment 2 the subjects usually failed to utilize the typographical information, *i.e.* the "th" cluster to assist their pronunciation, though "th" cluster usually makes the /θ/ and /ð/ sounds. The subjects in the present study have learnt English for averagely 6.5 years, but why are they unable to make use of the typographical information to assist their pronunciation? Again, we would argue that the problem is deeply rooted in the long negligence of developing phonological awareness in secondary schools in China (Macdonald, 2003). Focusing exclusively on grammar and tests, where pronunciation is not examined prevents the learners from noticing the important relationship between typography and pronunciation.

One pedagogical implication from the study is that in L2 teaching, especially in the early phase, teachers should design phonological awareness raising tasks in order to prevent the negative phonological transfer and enable learners to construct accurate, robust and stable phonological representations of L2 words. It has been demonstrated that phonetic and phonological instruction could enhance learners' accuracy of L2 vowel and consonant

production (Derwing & Rossiter, 2003). In addition, teachers could also train L2 learners to utilize the typographic information to assist their production (Escudero *et al*, 2008). For example, Hazan *et al.* (2005) showed that audiovisual training could benefit L2 learners in their production of words with difficult L2 contrasts. The speech learning model assumes that the basic speech learning mechanism, involving the ability to create long-term phonetic representations remains intact throughout one's whole life (Flege, 1987). Therefore, with experience and enhanced phonological awareness, it is conceivable that the L2 learners will eventually construct correct, robust and solid long-term phonological presentations.

4. Conclusion

We investigated the impact of L1 negative phonological transfer by examining Chinese L2 learners' identification and production of English words with /θ/ and /ð/ and found that there was a strong tendency for them to substitute the L2 /s/, /θ/ and /d/, /ð/ phonemes with (s) and (d) from their L1 phonetic inventory in both word identification and production. We argued that the phenomenon is due to the false phonological representations these learners constructed for the /s/, /θ/ and /d/, /ð/ sounds. The results support the abstractionists' view and partly confirmed the Speech Learning Model. It is suggested that L2 teaching practitioners should incorporate a focus on phonetic and phonological instruction to enhance L2 learners' phonological awareness so that they could construct accurate and stable L2 phonological representations that will assist them in the correct identification and production of L2 words.

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Appendix

Appendix A. Materials of Experiment 1

I. Study phase

1. sink[7]	**2. thank**	**3. saw**	**4. theme**	**5. serie**	**6. thick**
7. sin	**8. thing**	**9. dare**	**10. thy**	**11. dough**	**12. then**
13. day	**14. those**	**15. sudden**	**16. sigh**		

II. Test phrase

1. think	**2. sank**	**3. thaw**	**4. seem**	**5. theory**	**6. sick**
7. thin	**8. sing**	**9. their**	**10. die**	**11. though**	**12. den**
13. they	**14. doze**	**15. southern**	**16. thigh**	17. spoken	18. bicycle
19. result	20. indicate	21. consider	22. argue	23. perform	24. different

[7] The 32 bold words are target words and they make up 16 minimal pairs.

25. student 26. broadcast 27. address 28. speed 29. pattern 30. perfect

31. regard 32. depend 33. finger 34. agreement 35.correct 36. result

37. forget 38. account 39. expect 40. smoker 41. number 42.company

43. popular 44. follow

Appendix B. Materials of Experiment 2

I. target words

1. sink 2. thank 3. saw 4. theme 5. serie 6. thick

7. sin 8. thing 9. dare 10. thy 11. dough 12. then

13. day 14. those 15. sudden 16. sigh 17.think 18. sank

19. thaw 20. seem 21. theory 22. sick 23. thin 24. sing

25. their 26. die 27. though 28. den 29. they 30. doze

31. southern 32. thigh

II. Filler words

1. wonder 2. uniform 3. trust 4. surprise 5.rocket 6. quality

7. protect 8. necessary 9. monument 10. lifetime 11. ability 12. judgment

13. instrument 14. freedom 15.expense 16. calm 17. contrast 18. influence