A Corpus-based Study on Speech Errors in Pronouncing the Fricative /θ/ by Chinese Learners of English

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Abstract: There were quite a few studies investigating English pronunciation errors of Chinese learners of English. However, studies focusing on one typical sound and its detailed features are still inadequate. Besides, limited studies used speech corpora to investigate this topic due to a lack of available speech corpora. To fill such a research gap, this study uses the corpus L2-ARCTIC to investigate the speech errors of voiceless dental fricative /θ/ among four Chinese learners of English, and analyzes the possible reasons for the speech errors. Data are collected by analyzing the speech recordings from the corpus L2-ARCTIC, and the pronunciation errors of speakers are classified into different types. Results show that, in this corpus, the types of speech errors of the fricative /θ/ are the substitution and deletion. The sounds that have very close manners and places of articulation are easier to become the error sounds to replace the /θ/ sound.

Keywords: Speech Errors, Fricative /θ/, EFL, L2-ARCTIC Corpus.

1. Introduction

Pronunciation plays an important role when communicating. In China, traditional pronunciation teaching methods failed to pay enough attention to the L1 effects so that some potential difficulties of pronunciation are hard to predict when teaching and learning. Yiing claimed that phonetically, Chinese English learners are hard to pronounce certain sounds in English since some sounds do not exist in their mother tongue [1]. Besides, some researchers held that manners and places of articulation are relatively different in language systems of English and Chinese [4]. As an example, the /θ/ sound, a voiceless dental fricative, does not exist in Chinese sounds. Some research reflected that Chinese speakers of English pronounce the /θ/ sound as the voiceless /s/ sound.

This study aims to explore and classify the pronunciation errors of voiceless dental fricative /θ/ sound in English through studying four Chinese speakers from the corpus L2-ARCTIC. Considering the idea of interference and the L1 effect, this paper studies the normal qualities in pronunciation mistakes of the four subjects. A corpus-based method of analysis is applied. The results of the present research and the research method with corpus can help English learners better understand the qualities of articulation mistakes as well as the impedance of special English sound frameworks.

2.   Literature Review

Previous researchers held that, for Chinese learners of English, it is phonetically hard to pronounce the sounds that are absent in their mother tongue or, more specifically, local dialects. Take the fricatives /θ/ and /ð/ as examples, they are difficult for Chinese English learners to pronounce since they do not exist in Chinese [2]. When a non-native English speaker utters a specific English sound, the way of pronouncing depends a lot on the speaker's background. In most cases, their first language affects the pronunciation of their second language, known as the L1 effect. Previous research showed that the first language interference results in most of the speech errors of Chinese English learners [3]. Interference means that learners make errors due to the effect of their native language when speaking target languages [2]. It happens to Chinese learners of English in the same way. Since Chinese greatly differs from English, it is not easy for Chinese learners of English to pronounce a sound not belonging to Chinese sound system. By conducting a contrastive analysis, some studies made a summary of the pronunciation problems of Chinese learners of English and predicted their difficulties in pronunciation [5]. Additionally, some research narrowed down to the segmental and suprasegmental levels. Chen, Sun, and Zhang investigated the developmental patterns of 14 students of English major and their phonological ability through a method of experimental phonetics [6]. It turns out that, compared to the errors on the segmental level, Chinese learners of English make more speech errors on the suprasegmental level, particularly in rhythm, pause, and sentence stress [7]. Some studies attempted to research the main factors related to the intelligibility of spoken English among Chinese university students, and made suggestions on English teaching priorities for Chinese learners in the level of pronunciation. Existing research sheds light on a comprehensive picture of the characteristics of speech spoken by Chinese English learners. Nevertheless, previous studies are limited in two aspects. First, few studies focus on one typical sound and its detailed features. Second, limited studies on this topic apply the method of corpus. To fill such a gap, this study explores the pronunciation errors of the mentioned voiceless dental fricative /θ/ spoken by Chinese speakers with the method of corpus.

3.   Research Methodology

Through mixed-method research of the qualitative and quantitative methods, a comprehensive analysis is used to research the error features of the sound. First, a corpus-based approach will be adopted to collect the data of frequency. The corpus is combined with both compulsory speech and spontaneous speech. Also, it has already been annotated at the word and phone level. Besides, the data is recorded in a quiet room without background noise, so the quality of the record is good. Second, discussions on the speech errors of the /θ/ sound with native speakers or sophisticated Chinese English pronunciation teachers are applied to see the possible reasons for such errors.

3.1.   Participants

Four Chinese EFL learners (two males, two females) are selected from the L2-ARCTIC Corpus. Speakers are recruited from Iowa State University. Table 1 summaries the information of speakers.

Table 1: Information of the speakers.

Speaker	Gender	Native Language	#Wav Files	#Annotations
BWC	M	Chinese	1130	150
TXHC	M	Chinese	1132	150
LXC	F	Chinese	1131	150
NCC	F	Chinese	1131	150

3.2. Annotation

The developers of the corpus use the Montreal forced-aligner [8] to produce phonetic transcriptions in PRAAT's TextGrid format containing word and phone boundaries (Figure 1) and perform manual annotations on a subset of sentences for each speaker [9]. Finally, about 150 selected phonetic transcriptions per speaker are included in the corpus. These transcriptions contain manually-adjusted word and phone boundaries, correct phoneme labels, mispronunciation error tags (phone additions, phone deletions, and phone substitutions), and annotators' comments in IPA formats. In addition, the phonetic transcriptions as well as the error tags use the ARPAbet phoneme set in order to facilitate computer processing. In the comment part of the transcriptions, annotators use IPA symbols [10]. Automated scripts are also developed to check the high-quality annotations.
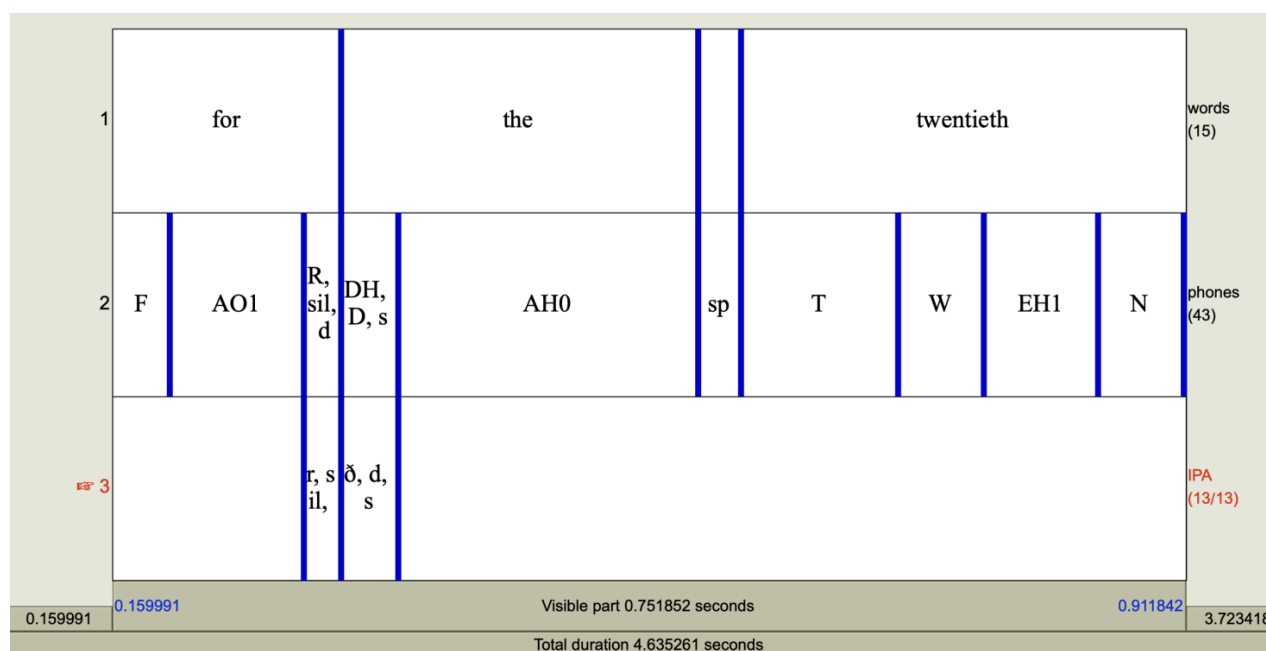

Figure 1: A manually annotated TextGrid file. Top to bottom: words, phonemes and error tags, comments from the annotator with IPA symbols.

3.3. Data Collection and Data Analysis

L2-ARCTIC corpus is a non-native English Speech Corpus. Four Chinese speakers' data are annotated by PRAAT and calculated by Python. Each speaker recorded about one hour's reading speech from the Carnegie Mellon University ARCTIC prompts. The 150 utterances of each speaker are annotated and identified as 3 types of pronunciation mistakes: substitutions, deletions, and additions.

The L2-ARCTIC corpus contains 26,867 utterances in total from 24 non-native speakers with a balanced distribution of gender and L1. Most speakers record the full CMU ARCTIC set. The total duration of the corpus is 27.1 hours, with an average of 67.7 minutes (std: 8.6 minutes) of speech per L2 speaker. Each utterance is at the average of 3.6 seconds in duration. The pause before and after each utterance is shorter than 100 ms in most cases. A speech to silence ratio of 7:1 is estimated across the whole dataset after applying the forced alignment results. The dataset contains over 238,702 word segments, giving an average of about nine words per utterance, and over 851,830 phone segments (excluding silence).

The data of the 4 subjects are from the corpus. In total, there are 4477 utterances from the four Chinese speakers of English, around nine words per utterance, and over 35496 phone segments on average. First, Python is used to erect the speech errors and calculate the frequency. Second, Excel is applied to classify these speech errors.

4. Results

4.1. Error Classifications

Results show that speech errors of the fricative /θ/ are in the form of substitutions and deletions. Statistic information of the results is illustrated in Table 2. Take "/θ/, /t/, /s/" in Table 2 as an example. It means that the correct sound in this place should be "/θ/", but the speaker mistakenly makes this sound as "/t/". The "/s/" at the last position refers to the error type "substitution" and "/d/" means "deletion". By the way, in this research, the author considers "/θ/, /t/, /s/" and "/ð/, /θ/, /s/" as a substitution error of "/θ/" as well.

Table 2: Statistic information of the results.

Subject Error	substitution							deletion
	/ð/ /θ/ /s/	/θ/ /s/ /s/	/θ/ /t/ /s/; /t/ /θ/ /s/	/θ/ /z/ /s/	/θ/ /ʃ/ /s/	/d/ /θ/ /s/	/θ/ err /s/	/θ/ sil /d/
BWC (Male)	4	2	2					1
TXHC (Male)		25	1		1	1	1	1
LXC (Female)		27						
NCC (Female)	1	10	11	1				2
Total	5	64	14	1	1	1	1	4

4.1.1. Sound Substitution

According to Table 2, substitutions of /θ/ by /s/ happened 64 times in total. BWC (M) made 2 substitution errors of /θ/ by /s/ and TXHC (M) had 25 substitution errors. As for the female speakers, LXC (F) made 27 substitutions of /θ/ by /s/ and NCC (F) made 10. Substitutions between /θ/ and /t/ happened 14 times in total as /θ/ and /t/ are substituted by each other. The number of substitutions between /θ/ and /t/ done by BWC is 2 and TXHC had 1 substitution errors. Regarding the female speakers' substitutions between /θ/ and /t/, NCC made 11 substitutions and LXC did not make any.

Substitutions of /ð/ by /θ/ happened 5 times in total. BWC had 4 substitution errors, and NCC had 1. Substitutions of /θ/ by /z/ happened once by NCC. Substitutions of /θ/ by /ʃ/ happened once by TXHC. Substitutions of /θ/ by a non-IPA sound happened once by TXHC.

Four classifications of the sound substitution can be summarized as follows:

A. The substitution by the sounds of the same place and manner of articulation.

In this case, the only sound as the substitution of the /θ/ sound is /ð/. The only difference between these two sounds is voicing. /θ/ is voiceless and /ð/ is voiced.

B. The substitution by the sounds of the same manner but different places of articulation.

/θ/ is a fricative dental voiceless sound. Its substitution sounds /s/ and /ʃ/ are both fricatives and voiceless, but in terms of the place of the articulation, /s/ is an alveolar and /ʃ/ is a palatal. Both of the alveolar and palatal is close to the dental sound.

C. The substitution by the sounds of the same place but different manners of articulation.

This kind of situation does not appear in this study but the author thinks it is possible to happen with more data from speakers.

D. The substitution by the sounds of both different places and different manners of articulation.

The sounds /d/ and /t/, which are close to the aim sound both in place and the manner but are stop and alveolar sounds, can be listed as examples in this case.

4.1.2. Sound Deletion

The sound deletion means that the aim sound does not show in the place where it should be. In this study, the deletion of /θ/ happened 4 times in total, once by the male BWC, once by the male TXHC, and twice by the female NCC.

4.2. Reasons for the Errors

Possible reasons that cause the pronunciation problems of English dental fricative /θ/ sound among Chinese learners of English are given below.

First of all, these error sounds are very close in terms of both the manner and place of articulation. These tiny differences may be difficult for EFL learners to tell the differences due to a lack of professional guidance or correction suggestions.

Second, their native language interferes with the English language (the target language) considering the limited linguistic knowledge of phonology and phonetics. Particular sounds that do not belong to the native language can pose difficulties for the second language learners. Therefore, the learners have difficulties perceiving these sounds, and instead, they substitute them with similar sounds that exist in their native language systems.

5. Conclusion

To conclude, the speech errors of the fricative /θ/ are substitutions and deletions. The sounds that have a very close manner and place of articulation are easier to become the error sounds to replace the /θ/ sound. Substitutions of /θ/ by /s/ happened 64 times in total with the highest frequency. In this study, the author summarizes two reasons that cause errors when pronouncing the voiceless dental fricative /θ/ sound by Chinese learners of English. First of all, the closeness in manner and place of articulation may cause such errors. For example, /s/ is close to /θ/ in the place of articulation as /s/ is an alveolar, while they are the same in the manner of articulation since both of them are fricatives. Second, due to the L1 effect, their mother tongue language interferes with the the target language. A particular sound which does not exist in the native language can consequently cause problems for the second language learners. For example, in the Chinese sound system, there is no /θ/ sound but a /s/

sound. Therefore, learners have trouble with perceiving the sound /θ/ and they substitute it with similar ones in their mother tongue or delete the target sound.

One of the limitations of this study is that the size of the corpus is too small that the findings are not evident if generalized to a wide range of learners. Another limitation is that the data are limited to the error sounds appearing in /θ/ sound. However, this study is still able to identify the participants' mispronunciation of specific sounds, and help English language teachers better comprehend the qualities of articulation mistakes and enhance students' understanding of the impedance of distinctive sound pronunciations.

Acknowledgements

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