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# English Consonant Pronunciation Errors Research among Chinese K-9 Learners

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## ABSTRACT

When native Chinese speakers learn English pronunciation, learners of different ages have different pronunciation characteristics. Previous studies on the English consonant pronunciation of Chinese children mainly focus on learners at one stage, and there is a lack of comparative studies on different ages, and research on early childhood is relatively scarce. We study English consonant pronunciation errors among Chinese learners in kindergarten through 9th Grade (K-9). We divided K-9 learners into three age groups: Kindergarten Children (KC), Primary-school Students (PS), and Middle-school students (MS). The results show: (1) The overall English consonant acquisition error ratio of the MS group is lower than that of the PS group, and the PS group is lower than that of the KC group. (2) It is easier for learners to master the phonemes that have the same pronunciation in English and Chinese, and difficult to accurately distinguish the phonemes that have similar pronunciation in English and Chinese, and difficult to master the phonemes that exist in English but do not exist in Chinese. (3) With the growth of age, learners' English consonant errors tend to be diversified and dispersed. Understanding the English consonant pronunciation errors in learners of different ages can be more targeted to correct learners' pronunciation errors. Combining the English consonant pronunciation errors with the Chinese pronunciation influence of different aged learners, we explore and summarize the characteristics and causes of K-9 learners' English consonant errors, trying to provide some references for oral English teaching.

***Keywords:*** L2 Acquisition; Mispronunciation Patterns; Consonant Contrast; Learner Age Differences

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# 1. Introduction

## 1.1. Research Background

In the era of globalization, English has become an international language, playing a vital role in business communication, tourism, academic research, and other fields. English learners pay more and more attention to clear, natural, and accurate pronunciation to better communicate with native speakers and the international community. English oral learners want to weaken their foreign language accent and make their pronunciation more similar to native speakers. For Chinese students learning English, young bilingual children have attracted wide attention [1–3]. Finding and correcting English consonant pronunciation errors in Chinese children is essential. For learners of different ages, they have differences in the specific performance of pronunciation errors [4]. Therefore, exploring the characteristics of consonant pronunciation errors in learners of various ages is a link that cannot ignored in the study of second language pronunciation acquisition.

In the field of acquisition of English pronunciation, consonant pronunciation in young Chinese students is studied a lot [5–8]. Previous studies have shown that due to the influence of the second language learning experience and native phonology of learners, learners with the same native language have differences in the acquisition difficulty and pronunciation error patterns at different learning stages [9–12]. Understanding the pronunciation error characteristics in learners of different ages can help learners correct consonant pronunciation errors more pertinently. By using the audio of the intermediate corpus, we analyze the English pronunciation data of Chinese K-9 learners and summarize error characteristics.

This paper studies the consonant acquisition of Chinese K-9 (Kindergarten to 9th Grade) English learners in three groups: Kindergarten Children (KC), Primary-school Students (PS), and Middle-school students (MS). We use the intermediate corpus to summarize the characteristics of pronunciation errors and combine the pronunciation characteristics of learners' mother tongues of different age groups to analyze the causes of mispronunciation.

## 1.2. Research Status

Many studies have been conducted on English consonant mispronunciation by Chinese learners [13–15]. For childhood English learners, Zou [16] finds that fricative /θ/ and /ð/, /s/ and /z/, nasal /n/ and border /l/, semi-vowel /w/ and fricative /v/ are easily confused. Hong [17] believes that Chinese middle school students have insufficient cognition and practice in oral English learning, and students need long-term practice in pronunciation, intonation, and rhythm. Cheng and He [18] show that substitution errors are the most common in consonant pronunciation of Chinese students. Xin [19] puts forward the problems of consonant pronunciation: inaccurate pronunciation, poor grasp of stress, and poor intonation for Chinese students. Liu [20] summarizes that Chinese students are prone to adding vowels after consonants, confusing consonants, /l/ being ignored or mispronounced, insufficient turbidity when pronouncing /b/, /d/, /g/, /r/, poor mastery of the pronunciation of /ʃ/, /ʒ/, /r/, etc. Li [21] believes that the negative transfer of the Chinese mother tongue would impact English phonetic learning. Guo [22] and Wang [23] believe that the mother tongue has both positive and negative influences on foreign language acquisition. Zheng [24] suggests learners understand the similarities and differences between two language systems to promote positive transfer while avoiding negative transfer in second language learning.

Some studies have shown that the younger the learner, the easier it is to acquire a language [25–27]. Therefore, it is necessary to study the English consonant pronunciation of young Chinese children. The studies on the English consonant pronunciation of Chinese children mainly focus on the learners at one stage, so there is a lack of comparative studies on different ages, and research on early childhood is relatively scarce. Therefore, we conduct a systematic analysis and research on English consonant errors of K-9 learners in three adjacent age groups. In this paper, we summarize the tendency and characteristics of English consonant pronunciation errors in different aged learners. Based on the characteristics of learners' English consonant mispronunciation and their native Chinese pronunciation, we analyze the causes of learners' English consonant pronunciation errors at different ages and try to provide references for oral English teaching.

# 2. Materials and Methods

## 2.1. Data Sources

We collected all the data used in this study from the online English learning app English Jun. The learners in this study are native Chinese speakers in Beijing. According to the age, grade, and other information filled in by the learners during online registration, about 500 learners were divided into three groups: Kindergarten Children (KC), Primary-school Students (PS), and Middle-school Students (MS). The number of learners in the three groups is relatively balanced. Learners in the KC group are 3–6 years old, learners in the PS group are 6–12 years old, and learners in the MS group are 12–15 years old. The number of learners in the three groups was relatively balanced. Since the APP can only record the registration time of learners, and the information of the starting learning age and learning duration of learners is not recorded, this study only analyzes the pronunciation error characteristics of the three groups of learners from the perspective of the age. Considering the privacy of app users, our data is currently not public.

The English Jun mainly collected data from learners reading aloud or reading followed them online. The reading contents are words, texts, and exercises in the textbooks used by the corresponding grade. Learners mainly used smartphones to record. The data sampling frequency is 16000Hz, and the bit rate is 16bit. The audios of the experiment selected the actual recording of learners in the low-noise environment. The experimental data is the full coverage of phonemes and has the balance of learners' gender and grade as much as possible, to ensure that the data reflected the real pronunciation level of learners of all ages as far as possible. After the manual screening, 1074 pieces of audio in the KC group, 1066 pieces of audio in the PS group, and 936 pieces of audio in the MS group were finally selected.

## 2.2. Data Annotation

In this study, The CMU Dictionary [28] is selected as the reference dictionary for English pronunciation data annotation. In terms of segments, the dictionary is divided into two parts: English vowel phonemes and consonant phonemes. Consonant phonemes include B, CH, D, DH, F, G, HH, JH, K, L, M, N, NG, P, R, S, SH, T, TH, V, W, Y, Z, ZH. Chinese learners are easily influenced by their native language in English oral learning, and consonant pronunciation is no exception. There are 22 consonants in the Chinese family, including b, p, m, f, d, t, n, l, g, k, h, j, q, x, zh, ch, sh, r, z, c, s, ng. Many consonants in English and Chinese sound similar, but there are also differences. In English, the number of voiceless consonants is less than that of voiced consonants, but most Chinese consonants are voiceless consonants. There are differences in the place of articulation and pronunciation methods of English and Chinese consonants [29].

We use Praat software to annotate pronunciation errors [30]. Each piece of audio is presented in five layers in Praat (see **Figure 1**). The first layer is the word regularization layer, the second layer uses the Montreal-force-Aligner tool [31] to force the phoneme level to align, the third layer is the phoneme error annotation layer, the fourth layer is graded for pronunciation accuracy, the fifth layer is the comment layer. The third layer is the core because the third layer is the phoneme error layer. We divide pronunciation errors into three types: substitution, insertion, and deletion [32, 33]. For substitution errors, the annotator will mark the correct pronunciation below the wrong phoneme. For example, the vowel AY was pronounced AE, so the annotator marked "AE(/æ/)" below "AY(/ai/)" in **Figure 1**. For insertion errors, the symbol "+" and the inserted phoneme are marked at the third layer where the error occurred. For example, the "+H" in **Figure 1** indicates that the speaker inserted the phoneme HH(/h/). For deletion errors, the symbol "-" and the deleted phoneme are marked at the third layer of the corresponding position. For example, the "-T" in **Figure 1** indicates that the speaker has lost the sound of the T(/t/) phoneme.

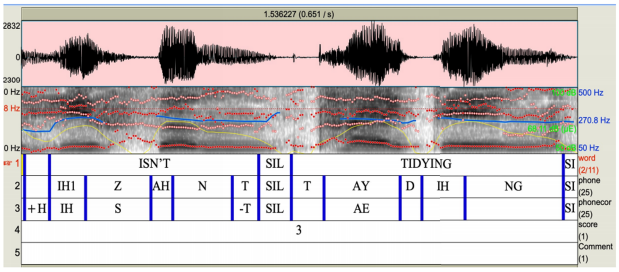


**Figure 1.** Example of the marking interface.

The data annotation in the experiment was completed by five graduate students majoring in English from Beijing Language and Culture University. A native English speaker from the United States conducted a random check on all the

annotated data according to the proportion of 20%, and the accuracy of the annotation was more than 90%. Data annotators and the sample checker are familiar with the English phonological structures and phonetic alphabet. Before tagging, the project leader conducted CMU dictionary and Praat software training and tests for all the researchers involved in the project tagging.

# 3. Results

## 3.1. Consonant Errors in The KC Group

The KC group in this paper mainly refers to English learners aged 3–6 in Chinese children. At this stage, learners' phonological awareness in English and Chinese has begun to develop[34]. Studies have shown that the Chinese syllable awareness of small children aged 3 to 4 develops rapidly, and the English syllable and phonemic awareness of small children aged 3 to 5 also begins to develop[35].

The researchers collected the English pronunciation error data of the KC group and used the error ratio to evaluate the error probability of each phoneme. The target phoneme error ratio is the ratio of the number of the target phoneme mispronounced to the total number of target phoneme samples. **Figure 2** shows the consonant phoneme error ratios in the KC group. The average error ratio in the KC group is 19.6% (variance 0.0148). According to **Figure 2**, the phonemes with a higher consonant pronunciation error ratio of the KC group are SH, DH, NG, Z, and P, and the error ratios are about 40.5%, 40.0%, 34.0%, 32.9%, and 30.8%.

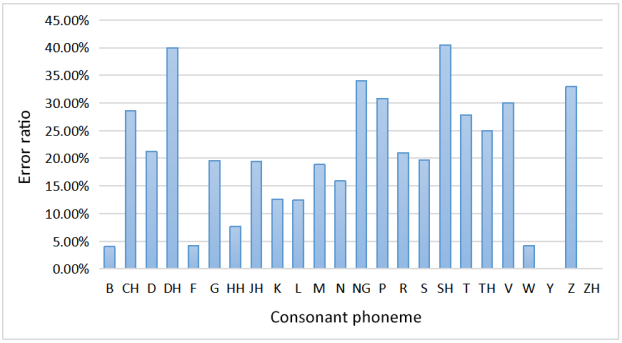


**Figure 2.** Consonant phoneme error ratios in KC.

From the perspective of the error pattern, we analyze the phonemes SH, DH, NG, Z, and P with high error ratios. For the phoneme SH, the KC group tends to mistake SH(/ʃ/) for S(/s/). For example, they read "fish" as /fɪs/ and read "she" as /si:/. For the phoneme DH, the KC group is prone to misread DH(/ð/) to D(/d/). For example, they read "the" as /də/ and read "this" as /dɪs/. For the phoneme NG, the KC group is prone to misread NG(/N/) into N(/n/). For example, they read "sing" as /sɪn/ and read "living" as /lɪvɪn/. For the phoneme Z, the KC group is prone to misread Z(/z/) to S(/s/). For example: they read "is(/ɪz/)" into /ɪs/ and read "nose(/nəʊz/)" as /nəʊs/. For the phoneme P, the KC group is prone to misread P(/p/) into B(/b/). For example: they read "apple" as /'æbl/ and read "happy" as /ˈhæbi/.

From the perspective of the error types, the proportion of substitution, deletion, and insertion in the PS group is 49.5%, 29.0%, and 21.5%. Among them, phoneme DH is the most prone to substitution errors, and all DH errors in the KC group in the database are substitution errors. Phoneme D has the highest rate of deletion errors, accounting for 48% of D errors; And phoneme NG is the most prone to insertion error, accounting for 65% of the errors in phoneme NG. In addition, the error types of phonemes B, D, and L are mainly deletion, the error types of phonemes G and NG are mainly insertion, and the main error types of other consonant phonemes are substitution.

## 3.2. Consonant Errors in the PS Group

The PS group in this paper mainly refers to Chinese children aged 6–12. Learners at this stage are good at imitation, have begun to use daily speech to express themselves, and are sensitive to English pronunciation and intonation[2]. The consonant phoneme error ratios in the PS group are in **Figure 3**. The average error ratio of consonant phonemes in the PS group is about 18.1% (variance 0.0355). Phoneme Z has the highest error ratio, with a 37.9% error ratio, followed by phonemes TH, V, and DH, with 35.3%, 29.8%, and 29.5% error ratios.

From the perspective of the error pattern, we analyze the phonemes Z, TH, V, and DH with high error ratios. The PS group tends to misread the phoneme Z(/z/) into S(/s/). For example, they read "is(/ɪz/)" as /ɪs/, read "has(/hæz/)" as /hæs/. They prone to misread the phoneme TH(/θ/) into F(/f/), S(/s/), and Z(/z/). For example, they read "three" as /fri:/, read "thanks" as /sæŋks/, and read "with" as /wɪz/ or /wɪf/. The PS group is prone to misreading the phoneme V(/v/) into F(/f/). For example, they read "have" as /hæf/ and read "of" as /əf/. The PS group is prone to misread the

phoneme DH(/ð/) into D(/d/). For example, they read "the" as /də/ and read "mother" as /ˈmʌdər/.

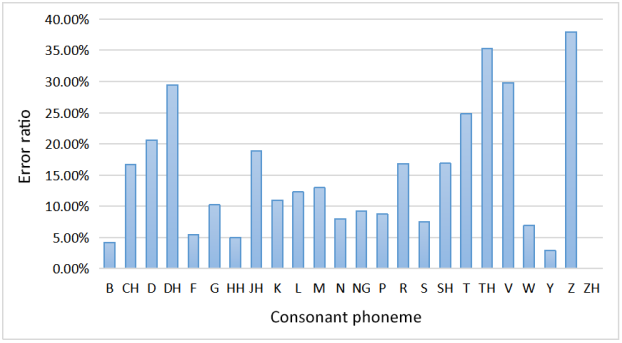


**Figure 3.** Consonant phoneme error ratios in PS.

From the perspective of the error types, the proportion of substitution, deletion, and insertion in the PS group is 50.2%, 41.9%, and 7.9%. Among substitution errors, the most common phoneme is Z. The phoneme Z mispronounced as the phoneme S accounts for 95% of Z substitution errors. The letter "s" in some English words should be pronounced as /z/, and the PS group is not sufficiently familiar with this kind of situation, so when they see the letter "s" in a word, they are likely to pronounce it as /s/. For both deletion and insertion errors, the phoneme T appears most frequently, indicating that the PS group tends to ignore /t/ and tends to mix /t/ in English pronunciation.

### 3.3. Consonant Errors in the MS Group

The MS group in this paper mainly refers to teenagers aged 12–15. Although MS have learned English for many years, they are generally unable to use spoken English flexibly, and there are still problems with pronunciation. The consonant phoneme error ratios in the MS group are in **Figure 4**. The average error ratio of consonant phonemes for the MS group is 10.7% (variance 0.0120). According to **Figure 4**, phoneme ZH has the highest error frequency with an error ratio of 41.7%, followed by phonemes Z, DH, and TH with a higher error ratio of 37.9%, 26.6%, and 24.9%.

From the perspective of the error pattern, we analyze the phonemes ZH, Z, DH, and TH with high error ratios. The MS group tends to misread ZH(/ʒ/) into SH(/ʃ/). For example, they read "pleasure(/ˈpleʒər/)" as /ˈpleʃər/, read "usually(/ˈjuːʒʊəlɪ/)" as /ˈjuːʃʊəlɪ/. For the phoneme Z, the MS group is prone to misread Z(/z/) into S(/s/). For example: they read "is(/ɪz/)" as /ɪs/, read "always(/ˈɔːl.weɪz/)" as /ˈɔːl.weɪs/. For the phoneme DH, the MS group is prone to misread DH(/ð/) into D(/d/) or Z(/z/). For example, they read "the" as /də/ or /zə/ and read "them" as /dem/ or /zem/. For the phoneme TH, the MS group is prone to misread TH(/θ/) into S(/s/). For example, they read "with" as /wɪs/ and read "something" as /ˈsʌmsɪŋ/.

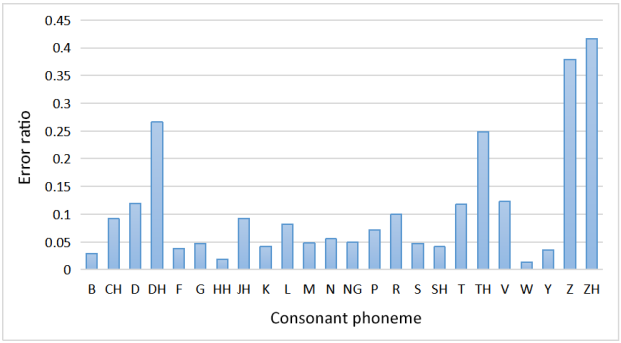


**Figure 4.** Consonant phoneme error ratios in MS.

From the perspective of the error types, the proportion of substitution, deletion, and insertion in the MS group is 55.2%, 33.3%, and 11.5%. Among substitution errors, the three phonemes with the highest error ratio are Z, DH, and T. Among insertion errors, the three phonemes with the highest error ratio are T, DH, and D. Among deletion errors, the three phonemes with the highest error ratio are T, R, and D. We find that the MS group has a poor grasp of T, DH, and D, they tend to make multiple types of errors with these three phonemes.

## 4. Discussion

### 4.1. Comparison of Consonant Errors

The comparison of consonant phoneme error ratios in the three groups is in **Figure 5**. The error ratios in the KC group are mostly higher than those in the PS group, and the error ratios in the PS group are mostly higher than those in the MS group. With the growth of age, the accumulation of learning time can improve learners' ability to pronounce correctly.

We find that the error ratios of phonemes DH, TH, and Z are high in each stage, indicating that learners of three groups are prone to mispronounce DH(/ð/), TH(/θ/), and Z(/z/). The error ratios of phonemes B, F, HH, W, and Y are low at each stage, and we speculate that the pronunciations of these five phonemes in Chinese can be positively trans-

ferred to English and easily mastered by learners. The error cases of phonemes TH and ZH are relatively particular. The error ratio of TH phonemes is the highest in the PS group among the three stages. The PS group tends to mispronounce TH(/θ/) as S(/s/). The error ratio of the phoneme ZH is low in the KC and PS group but high in the MS group, and the MS group easily mispronounces ZH(/θ/) into SH(/ʃ/). Most consonant phoneme error ratios in the MS group are around 10%, and only a few phonemes have higher error ratios, such as 41.7% for phoneme ZH, 37.9% for phoneme Z, 26.6% for phoneme DH, and 24.9% for phoneme TH. The total frequency of ZH, Z, DH, and TH in the corpus is 12, 912, 556, 165. Among these phoneme substitution errors, ZH has a particular case of error, and all the wrong pronunciation of ZH is SH. The frequency of Z, DH, and TH being errored into other phonemes is in **Tables 1–3**.

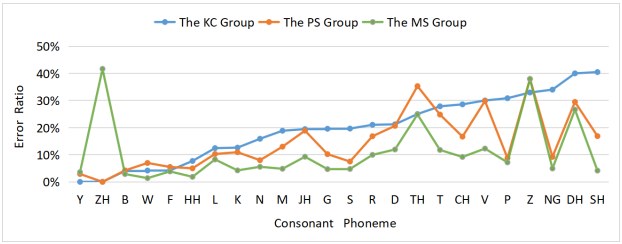


**Figure 5.** Consonant phoneme error ratios in learners.

**Table 1.** Consonant phoneme Z error distribution.

| Phoneme | Frequency |
|---|---|
| S | 295 |
| D | 2 |
| SH | 2 |
| IH | 2 |
| EY | 1 |
| T | 1 |
| IY | 1 |
| CH | 1 |

**Table 2.** Consonant phoneme DH error distribution.

| Phoneme | Frequency |
|---|---|
| D | 69 |
| Z | 29 |
| S | 6 |
| L | 4 |
| N | 2 |
| Y | 2 |
| EY | 1 |
| ZH | 1 |
| P | 1 |
| T | 1 |

**Table 3.** Consonant phoneme TH error distribution.

| Phoneme | Frequency |
|---|---|
| S | 32 |
| D | 1 |
| Z | 1 |
| T | 1 |
| IY | 1 |

Through the data, we find that phoneme Z and phoneme TH are easily mispronounced as phoneme S by the MS group, and the phoneme DH is easily mispronounced as phoneme D or phoneme Z by the MS group. In addition, the MS group tends to confuse the /s/ and /z/ because they may not place the tip of the tongue between the upper and lower teeth when pronouncing /ð/ and /θ/[36]. The distribution of error types in the three stages should also be of concern (**Table 4**).

**Table 4.** Proportion of error types in three groups.

| Error Type | KC Group | PS Group | MS Group |
|---|---|---|---|
| Substitution | 49.5% | 50.2% | 55.2% |
| Deletion | 29.0% | 41.9% | 33.3% |
| Insertion | 21.5% | 7.9% | 11.5% |

It is not difficult to find that the proportion of substitution error increases with age. It speculated that learners tend to negatively transfer Chinese pronunciation into second language pronunciation acquisition with the continuous maturity of their native language system, resulting in more substitution errors. The proportion of deletion error in the PS or MS group is higher than that in the KC group, and we speculate that it is caused by the inconsistency of learning materials. The KC group's reading materials are words so that they are not prone to substitution errors, but the PS and MS group's reading materials are sentences so that they may create more deletion errors.

We counted the number of wrong phonemes that learners at different stages pronounced the same consonant phoneme into wrong phonemes (see **Figure 6**). If learners mispronounce the same consonant phoneme into more wrong phonemes as they grow, it indicates that learners' mispronunciation of this consonant tends to be dispersed and diversified. For example, according to our statistics, for the phoneme DH, the KC group mispronounces the phoneme DH into four wrong phonemes, the PS group mispronounces the phoneme DH into eight wrong phonemes, the MS group mispronounces the phoneme DH into ten wrong phonemes.

Therefore, learners tend to have diversified pronunciation errors in the phoneme DH with age. As can be seen from Figure 6, the number of mispronunciation phonemes of the same consonant phoneme shows an overall increasing trend with age. Learners may have more wrong objects for the same consonant phoneme, and the errors tend to be diversified and dispersed.

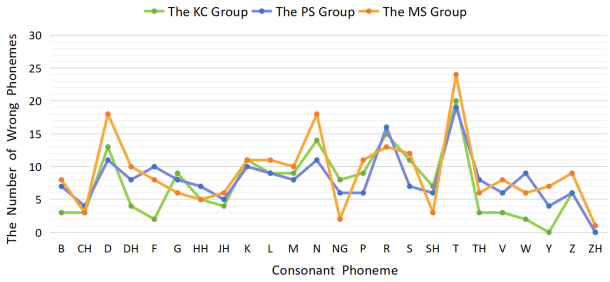


**Figure 6.** The number of wrong phonemes in learners.

## 4.2. Characteristics of Consonant Errors

The Chinese mother tongue system of the KC group is not mature, so they are prone to errors when learning English consonants, and the reasons for errors are complex. The English consonant pronunciation of the PS group is likely affected by the negative transfer of the mother tongue. In Chinese, the vocal cords of pronouncing consonants vibrate. In English, the vocal cords of pronouncing voiceless consonants do not vibrate, while the vocal cords of pronouncing voiced consonants vibrate[37]. The PS group generally has difficulty distinguishing these differences, resulting in more errors. It is easier for the MS group to master phonemes with similar pronunciation in English and Chinese[38]. For the phonemes absent in Chinese but existing in English, it is difficult for the MS group to master pronunciation skills.

For consonants with the same symbols in English and Chinese languages, learners generally make fewer mistakes if they have the same pronunciation, while learners are likely to be confused or misread if there are differences in pronunciation. For example, consonant b has the same symbol and pronunciation in English and Chinese, which is easier to master. Consonant z has the same symbol in English and Chinese languages, and it is pronounced as the phonetic symbol /z/ in English but pronounced as the unaspirated /ts/ in Chinese pinyin, which is difficult for learners to distinguish.

For Chinese K-9 learners, when the English consonant pronunciation is the same as the Chinese consonant pronunciation, the learning speed is faster[39]. When English consonant pronunciations are similar to Chinese consonant pronunciations, refer to the "Native Language Magnet Model (NLMM)" proposed by Kuhl, and the magnetic effect of Chinese phonetic prototypes will interfere with second language learning[40]. Therefore, it is difficult to distinguish similar pronunciations between English and Chinese. When English consonant pronunciation is missing in the Chinese language family, second-language learners of native Chinese lack relevant pronunciation experience[41], which makes it more difficult and slower to learn.

Influenced by the pronunciation of the native Chinese language, Chinese learners generally have more errors in English consonant pronunciation. We found some rules by analyzing the data, which can be roughly divided into the following situations:

1. Both English and Chinese languages exist, indicating the same symbols and pronunciation, and learners generally make fewer mistakes;
2. Both English and Chinese languages exist, indicating the same symbols, but there are differences in pronunciation, and learners are easy to be confused or misread;
3. In the English language, there is no Chinese language family, and learners have more errors.

In the first situation, the phonemes exist in both English and Chinese, they have the same symbols and pronunciation in the two language families, and learners generally make fewer mistakes. For example, the symbol "b" corresponds to the phoneme B, and the pronunciation is /b/ in both English and Chinese; the symbol "f" corresponds to the phoneme F, and the pronunciation is /f/ in both English and Chinese. The pronunciation of these phonemes is easier for the learners to master. In the second situation, the phonemes exist in both English and Chinese, they have the same symbols, but there are differences in pronunciation, and learners easily confuse or misread. For example, the symbol "z" corresponds to /z/ in the English phonetic alphabet, the phoneme is Z, and the pronunciation in Chinese pinyin corresponds to the unaspirated /ts/, which is difficult for learners to distinguish. In the third situation, the phonemes are in the English language family, but there is no Chinese language family, and learners have more errors. For example, the English phonemes V and DH have neither the same symbol nor the same pronunciation in Chinese families, and learners will try to transfer learning

with the help of similar pronunciation in their mother tongue, such as V(/v/) errored to W(/w/), DH(/ð/) errored to D(/d/).

# 5. Conclusions

With the help of the speech data of the intermediate corpus, this paper analyzes the English consonant errors in the three adjacent stages of the KC group, PS group, and MS group. With the increase of age, the consonant error ratio of learners generally shows a downward trend, and the cases of consonant errors tend to be dispersed and diversified. Among the different types of mistakes, learners of various ages are most likely to make substitute consonant pronunciation mistakes. In the process of learners' growth, the construction of bilingual space and the characteristics of native speech will affect the pronunciation of English consonants. Based on the influence of mother tongue and English consonant mispronunciations, this paper discusses the causes of English consonant errors and summarizes the characteristics of Chinese K-9 students' English consonant errors. According to the above analysis, the characteristics of English consonant pronunciation errors of learners in three age groups are summarized:

1. The overall English consonant acquisition error ratio of the MS group is lower than that of the PS group, and the PS group is lower than that of the KC group;
2. It is easier to master phonemes that have the same pronunciation in English and Chinese, difficult to accurately distinguish phonemes that have similar pronunciation in English and Chinese, and difficult to master phonemes that exist in English but do not exist in Chinese;
3. With the increase of age, English learners tend to have more scattered and diversified consonant pronunciation errors overall.

Based on the characteristics of learners' English consonant pronunciation errors, oral English teachers can focus on the pronunciation that does not exist in the Chinese language family or is similar to but different from Chinese consonant pronunciation. For learners in the KC group, teachers should pay attention to each consonant pronunciation to lay a good foundation for learners' English consonant learning. For learners in the PS group, teachers should pay attention to the confusing phonemes of English consonant pronunciation with Chinese pronunciation. For learners in the MS group, teachers could guide learners to correct phonemes with high error ratios in a targeted way, such as listening to correct recordings repeatedly and imitating reading to improve accuracy.

In the future, we plan to use the research data to train English consonant automatic detection models, which will provide a more intelligent and accurate platform for Chinese K-9 learners to learn English consonants. Further research may consider using various methods to assist in the analysis and comparison of English consonant pronunciation errors at different ages, such as integrating text analysis methods [42]. We hope that our future research can provide reference information for the theory and practice of multilingual education and contribute to the field of applied linguistics and language education.

# Author Contributions

All authors have made a substantial, direct, and intellectual contribution to the work. Conceptualization, Y.X. and X.F.; methodology, Y.X. and X.F.; software, X.F., Y.T., X.G., X.H., and Z.W.; validation, Y.T., X.G., X.H., and Z.Q.; formal analysis, Y.T., X.G., X.H., and Z.W.; investigation, Y.T., X.G., X.H., and Z.W.; resources, Y.X. and L.W.; data curation, X.F., Y.T., X.G., X.H., and Z.W.; writing—original draft preparation, Y.T., X.G., X.H., and Z.W.; writing—review and editing, Y.X. and Y.T.; visualization, Y.T.; supervision, Y.X. and Y.T.; project administration, Y.X.; funding acquisition, Y.X. All authors have read and agreed to the published version of the manuscript.

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# Institutional Review Board Statement

Not applicable.

## Informed Consent Statement

All participants provided informed consent before participating in the study. The anonymity and confidentiality of the participants were guaranteed, and participation was completely voluntary.

## Data Availability Statement

Data can be given upon a reasonable request.

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## Conflicts of Interest

The authors declare no conflict of interest.

## References

[1] Jiang, Y.W., 2024. A study of English pronunciation teaching strategies in primary schools. Primary School Teaching Research. 2024(24), 67–68.

[2] Feng, L., 2023. The present situation and improvement strategies of English pronunciation teaching in primary schools under the new curriculum standard. Jilin Education. 2023(12), 88–90.

[3] Yang, Y., 2023. Phonetics teaching in primary school English teaching. Academy Education. 2023(15), 19–21.

[4] Llanes, À., 2018. Reading in English as a foreign language: Examining differences in reading speed, comprehension, efficacy and L1 cross-linguistic influence across grades. Investigaciones Sobre Lectura. 2018(9), 1–49.

[5] Wewalaarachchi, T.D., Singh, L., 2020. Vowel, consonant, and tone variation exert asymmetrical effects on spoken word recognition: Evidence from 6-year-old monolingual and bilingual learners of Mandarin. Journal of Experimental Child Psychology. 189(1), 104698.

[6] Han, F.F., 2013. Pronunciation Problems of Chinese Learners of English. ORTESOL Journal. 2013(30), 26–30.

[7] Deterding, D., 2006. The pronunciation of English by speakers from China. English World-Wide. 27(2), 175–198.

[8] Liang, D.X., 2015. Chinese Learners' Pronunciation Problems and Listening Difficulties in English Connected Speech. Asian Social Science. 2015(11), 98.

[9] Zhang, F.C., Yin, P.P., 2009. A Study of Pronunciation Problems of English Learners in China. Asian Social Science. 5(6), 141–146.

[10] Best, C.T., Tyler, M.D., 2007. Nonnative and second-language speech perception: Commonalities and complementarities. Language experience in second language speech learning: In honor of James Emil Flege. John Benjamins: Amsterdam, The Netherlands. pp. 13–44.

[11] Flege, J.E., 1995. Second-language speech learning: Theory, findings, and problems. Speech perception and linguistic experience: Issue in cross-language research. York Press: London, UK. pp. 229–273.

[12] Jia, G., Strange, W., Collado, J., et al., 2006. Perception and production of English vowels by Mandarin speakers: Age-related differences vary with amount of L2 exposure. Journal of the Acoustical Society of America. 119(2), 1118–1130.

[13] Kirkova-Naskova, A., Henderson, A., Fouz-González, J., 2021. English Pronunciation Instruction: Research-Based Insights. John Benjamins: Amsterdam, The Netherlands. pp. 165–189.

[14] Lin, Y.H., 2001. A constraint-based approach to Chinese speakers' acquisition of English consonant clusters1. Concentric Studies in Lingus. 27(2), 1–35.

[15] Wu, Y., 2019. Review of Chinese English Learners' Prosodic Acquisition. English Language Teaching. 12(8), 89.

[16] Zou, L.L., 2021. A Study on Common Errors in Phonological Acquisition of Lower grade Children English Learners. Yan Bian College of Education. 35(5), 160–163.

[17] Hong, M., 2004. The negative transfer effect of English and Chinese phonological Differences on English phonological acquisition. Journal of Zhejiang Normal University. 29(2), 108–111.

[18] Cheng, C.M., He, A.P., 2008. Analysis of speech segment errors in Advanced English learners: a corpus-based study. Journal of Foreign Languages Institute of PLA. 31(1), 38–42.

[19] Xin, Y., 2010. On Common pronunciation Problems in English Pronunciation Teaching and their Countermeasures. Business Culture (Science and Technology Edition). 2010(2), 174–175.

[20] Liu, Y.Y., 2013. Analysis of Common Mistakes in Consonant Pronunciation of English Majors. Journal of Linguistics and Literature (Foreign Language Education and Education). 2013(5), 132–133.

[21] Li, L., 2006. The influence of Chinese on English Pronunciation Teaching and its Countermeasures. Journal of Foreign Languages College of Shandong Normal University (Basic English Education). 8(2), 3–7.

[22] Guo, M.H., 2002. On the role of mother tongue in foreign language class. Foreign Languages and Foreign Language Teaching. 2002(4), 24–27.

[23] Wang, J., 2011. A study on English Phonetics Teaching in Chinese Environment: Based on the influence of Chinese phonemes on English phonetics. Modern commercial trade industry. 23(18), 215–216.

[24] Zheng, G.F., 2011. The effect of mother tongue transfer on English Phonetics Acquisition and its countermeasures. Journal of Jilin Radio and Television University. 2011(2), 122–123.

[25] Tikofsky, R.S., 1967. Eric H. Lenneberg, Biological Foundations of Language.Wiley and Sons: New York, NY, USA. DOI: https://doi.org/10.1002/bs.3830130610

[26] Penfield, W., Roberts, L., 1959. Speech and Brain Mechanism. Atheneum Press: Cambridge, MA, USA. pp. 120–125.

[27] Lantolf, J.L., 1990. A Time to Speak: A Psycholinguistic Inquiry into the Critical Period for Human Speech. Studies in Second Language Acquisition. 12(1), 84–85. DOI: https://doi.org/10.1017/S0272263100008779

[28] The CMU pronouncing dictionary. Available from: http://www.speech.cs.cmu.edu/cgi-bin/cmudict/ (cited 1 November 2024).

[29] Sun, Y., 2008. A contrastive analysis of English and Chinese consonants. Journal of Changchun Normal University (Humanities and Social Sciences Edition). 27(4), 111–114.

[30] Boersma, P., Weenink, D., 2019. Praat: Doing phonetics by computer (version 6.0.49). Available from: http://www.praat.org/ (cited 1 November 2024).

[31] McAuliffe, M., Socolof, M., Mihuc, S., et al., 2017. Montreal Forced Aligner: trainable text-speech alignment using Kaldi. In Proceedings of the Annual Conference of the International Speech Communication Association; Stockholm, Sweden, 20–24 August 2017; pp. 498–502. DOI: https://doi.org/10.21437/Interspeech.2017-1386

[32] Zhao, G.L., Sonsaat, S., Silpachai, A., et al., 2018. L2-ARCTIC: A Non-Native English Speech Corpus. In Proceedings of the Conference of the International Speech Communication Association; Hyderabad, India, 2–6 September 2018; pp. 2783–2787.

[33] Li, K., Qian, X.J., Meng, H.M., 2017. Mispronunciation detection and diagnosis in L2 English speech using multi-distribution deep neural networks. IEEE/ACM Transactions on Audio, Speech, and Language Processing. 25(1), 193–207. DOI: https://doi.org/10.1109/TASLP.2016.2621675

[34] Wang, B.R., Wang, P.R., Han, M.L., 2017. Age of Onset and
China's English Learners' Foreign Language Proficiency-An Interpretation Based on Language Input. Journal of Northeastern University (Social Science). 19(2), 208–214.

[35] Yang, J., Xu, F., Ren, P., et al., 2007. The development of Chinese phonological awareness and English phonological awareness in early childhood. Psychological Science. 30(6), 1418–1421.

[36] Dong, Y.P., 2015. A brief analysis of common pronunciation problems in Middle school students' English learning. English for Middle School Students. 2015(22), 35.

[37] Wu, C.N., 2014. An analysis of the causes of Chinese students' English pronunciation errors. Overseas English. 2014(8), 266–267.

[38] Luo, T.F., 2020. Common problems and coping strategies of Chinese students' English pronunciation. Overseas English. 2020(17), 22–23.

[39] Major, R.C., Kim, E., 2002. The similarity differential rate hypothesis. Language Learning. 49(s1), 151–183.

[40] Kuhl, P.K., 1991. Human adults and human infants show a 'perceptual magnet effect' for the prototypes of speech categories, monkeys do not. Perception and Psychophysics. 50(2), 93–107.

[41] Li, L., Li, Y.X., Kang, Y., et al., 2020. The role of tonal language experience in Mandarin tone perception among Chinese second speakers. Journal of South China Normal University (Social Science Edition). 2020(01), 83–91.

[42] Uludag, K., 2024. Exploring the Association Between Textual Parameters and Psychological and Cognitive Factors. Psychology Research and Behavior Management. 2024(17), 1139–1150. DOI: https://doi.org/10.2147/PRBM.S460503