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# EVIDENCE-BASED INTERVENTION OF CHINESE CHILDREN WITH SPEECH SOUND DISORDER IN AFFRICATE CONSONANTS

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**Abstract**

*This paper aims to design an effective intervention program for Chinese children with speech sound disorder (SSD). Firstly, 40 children with SSD in affricate consonants were selected. Next, the subjects were trained intensively based on empirical strategies, such as the training based on nonlinear phonology and linguistic principles (model 1), and the training based on motor learning (model 2). After that, the training results of different strategies were compared. The comparison shows that the speech articulation of the subjects was greatly improved through the intensive trainings; model 1 achieved better intervention effects than model 2. The excellent effects demonstrate that SSD treatment requires both clinical knowledge and linguistic treatment skills; intensive training is an effective way to improve affricate consonants acquisition; motor learning, linguistic principles and phonological knowledge are all important tools for speech-language pathologists.*

***Key words:*** *Speech Sound Disorders, Affricates, Chinese, Intervention.*

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## INTRODUCTION

Communication disorders are one of the most common developmental disorders in children, with reported prevalence rates of 3%-20% (Tomblin, Records, Buckwalter et al., 1997; Baker & McLeod, 2011). Children with speech sound disorders (SSDs) form a large part of Speech and Language Pathologist's caseloads (Joffe & Pring, 2008; Cook & Odom, 2013) SSD is an umbrella term covering both articulatory and phonological deficits. SSD patients' hearing and intelligence are at normal level. In some definitions the symptomatology is considered to be primary (idiopathic) and distinct from language impairment (Eadie, Morgan, Ukoumunne et al., 2015). In others, the full range of speech difficulties, both primary and secondary is included.

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Developmental language disorder is the most frequent communication disorder in children, with a prevalence of approximately 5.95% (Shriberg, Kent, McAllister et al., 2019; Shriberg & Wren, 2019). However, speech disorders in children also have similar prevalence rate, and it was reported that 7.5% of children from age 3-11 years require speech therapy due to articulation and phonological disorders. Children with SSD can have any combination of difficulties with perception, articulation/motor production, and/or phonological representation of speech segments (consonants and vowels), phonotactics (syllable and word shapes), and prosody (lexical and grammatical tones, rhythm, stress, and intonation) that may impact speech intelligibility and acceptability (Mullen & Schooling, 2010). In this paper, the term SSD encompasses speech, articulation and/or phonological impairment, delay, or disorder. In a survey of 489 pediatric SLPs in the US, 52% indicated that children with SSD constituted half or more of their caseloads (Brumbaugh & Smit, 2013). A similar story is told in other countries around the world (Coplan &

Gleason, 1988). At present, there are no official statistics on the number of Chinese SSD children. But from the data provided by major medical rehabilitation institutions, we estimate that SSD children in China approximately is 8-10% of children. This number of children with SSD in China is increasing (Zhu, 2006). The incidence of behavioral problems of children with SSD is significantly higher than that of typical children, affecting their physical and mental health (Wren, Roulstone, & Miller, 2012).

Affricate pronunciation is a very common problem in SSD children, especially in Chinese, affricate pronunciation is relatively more serious. There are 21 consonants in Chinese Mandarin, of which there are 3 pairs of affricates with aspiration/non-aspiration distinctive features. Affricate is an important category of obstructive consonant. In the International Phonetic Alphabet (IPA), the affricate is regarded as the combination of the affricate (burst) and the affricate, but it is not listed separately. In fact, however, the affricate is often regarded as a single segment (Trask, 1996). Clements (1999) discusses the issue of affricate as a single segment from the perspective of phonology. Affricates have important distinctive meanings in the phonological characteristics of East Asian languages (Crystal, 1987; Dodd, Zhu, Crosbie et al., 2002), so they have received widespread attention in the academic circles. There are abundant affricates in Chinese dialects. All these show the special attributes of affricate and its important position in Chinese. According to the manners of pronunciation, Chinese affricates can be divided into cornal-alveolar [ts, tsh], cornal post-alveolar retroflex [tʂ], tʂh] and lingua-hard palate [tɕ, tɕh]. Each group of affricates can be divided into aspiration [tsh, tʂh, tɕh]and non-aspiration [ts, tʂ, tɕ], according to the pronunciation method. There are also three fricatives corresponding to the three groups of affricates in Chinese, whose pronunciation methods are identical and their pronunciation parts are distinguished from each other.

These six affricates are relatively late in children's language development. We tracked the speech treatment process of SSD children, and found that the intervention of these six affricates is relatively difficult. As some researchers documented affricates in Chinese children may be well developed almost after 6 even 7 years old. From the perspective of the type of SSD, articulation of Chinese affricates is a very significant problem. This study sought to find a more effective intervention method in affricates.

## METHODS

### Participants

We selected 40 Chinese children with SSD (22 boys and 18 girls). According to the speech intelligibility test of PCC (PCC=Number of correct consonants/total consonants) (Shriberg & Kwiatkowski, 1982), there were 14 severe children, 18 moderate children and 8 moderate and mild children, aged from 6.0 to 7.5 years old (mean age: 6.6 years; standard deviation: 1.1years). They are mainly from kindergartens and primary schools in Beijing, China. Volunteers were recruited in the form of online questionnaires. Selected children with SSD received intensive intervention. There were 10 children in the control group, five boys and five girls, aged 6.5-7 years, with good speech clarity (PCC>95%).

### Materials and methods

In the larger study, single-word picture-based elicitation was used. The word list included 50 Monosyllabic or disyllabic words (affricates consonants appeared in the first syllable of disyllabic word) and it was designed to cover the consonant segmental phonology of Chinese. Each affricate consonants occurred twice. There are totally 80 words of each affricate consonant (1 affricate*2 words*40 children with SSD=80 samples).480 samples were recorded in total. The majority of the eliciting items were selected from a list that contained the most frequent words occurring in the reader books for first graders.

*Table 1.* **Chinese affricate consonants**

| | | **place of articulation** | |
|---|---|---|---|
| **manner of articulation** | coronal alveolar | cornal post alveolar retroflex | lingua palate |
| **non-aspirations** | [ts] | [tʂ] | [tɕ] |
| **aspiration** | [tsh] | [tʂh] | [tɕh] |

**Procedure**

Firstly, according to the PCC evaluation reports, we analyzed the test results of all SSD children, observed the pronunciation of affricate, and compared it with typical children. Secondly, the children with SSD were divided into two groups on average. One group (Group A) was treated with speech therapy, which mainly focused on motor-learning pronunciation and motor movement. The other group (Group B) was treated with the combination of motor-learning, phonology and linguistic-phonetics-based intervention. Then, 8 weeks of intervention were given. We did intensive training for 8 weeks, 5 days a week, 2 sections each day (take a break of 30 minutes between the two parts). All interventions were performed by the same therapists in group. Finally, the intervention effects of the two groups were compared. After 8-week intervention, and one-week interval, we re-evaluated the articulation of all patients and compared the results of affricates.

**RESULTS**

Before the speech intervention, we assessed all SSD children's language intelligibility. After that, based on the results of the PCC evaluation, we divided the children into three groups for comparison, those are mild, moderate and severe. And then we focus on the accuracy of all affricate consonants. The results are shown in the table below.

As the data shows that there are many problems in pronunciation of the affricates by SSD children. The percentage of each group is very low, all affricates are below 30%. Especially in the severe group (PCC<50%), the correct percentage was less than 20%. We analyzed the error types of all the affricates. Substitution and distortion are the main types of affricate errors.

Children with SSD substituted affricates [ts, tʂ, tɕ] predominantly for lingua-alveolar stops [t, th] or fricatives [s, ɕ]. The number of substitutes with these four phonemes is more than 50. We make statistics on the error frequency of affricates and find that substitution is the main problem. The alternative types are stops, fricatives and a small number of affricates. The specific distribution is shown in the Table 3. Generally speaking, there are more cases of pronouncing affricates into fricatives and stops.

Traditional therapies mainly take perception training as the premise. First, they induce children to send out or imitate individually, then in syllables, and then in words and sentences, in order to achieve the goal of categorization. That is a liner training procedure. Among linguistic-based treatments, minimal pair contrast therapy is the typical one.

*Table 2.* **Percentage of correct pronunciation of affricates by Pre-intervention assessment**

| | Pre-intervention assessment | | | |
|---|---|---|---|---|
| | Children with SSD | | | Typical children |
| Affricate consonants | mild (n=15) | moderate (n=10) | severe (n=15) | |
| ts | 20% | 15% | 17% | 95% |
| tsh | 17% | 15% | 13% | 95% |
| tʂ | 20% | 13% | 3% | 90% |
| tʂh | 13% | 13% | 3% | 90% |
| tɕ | 27% | 25% | 20% | 100% |
| tɕh | 20% | 8% | 13% | 95% |
| Average | 19% | 15% | 12% | 94% |

**mild: 65≤PCC<85% moderate:50%≤ PCC <65 severe: PCC <50%.**

*Table 3.* **Error type and frequency of affricate consonants (Children with SSD)**

| Affricates | Substitution | | | | | | | | | | Distortion | Total number | Number of types |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | /t/ | /th/ | /k/ | /kh/ | /s/ | /ʂ/ | /f/ | /ɕ/ | /ts/ | /tsh/ | | | |
| [ts] | 30 | | | | 20 | | 7 | | | | 6 | 63 | 3 |
| [tsh] | 10 | 28 | | | 22 | | | | | | 5 | 65 | 3 |
| [tʂ] | 24 | 6 | | | 20 | 10 | 8 | | | | | 68 | 5 |
| [tʂh] | 8 | 30 | | | | 12 | 7 | 5 | | | 8 | 70 | 5 |
| [tɕ] | 8 | | 6 | | 10 | | | 24 | 4 | | 4 | 56 | 5 |
| [tɕh] | | 10 | | 4 | 16 | | | 26 | 2 | 2 | 7 | 67 | 5 |
| Total number | 80 | 74 | 6 | 4 | 88 | 22 | 22 | 55 | 6 | 2 | 30 | 389 | |

Through the comparison of the smallest words, let the SSD children understand the difference of different pronunciation in meaning. For example, the difference in pronunciation between [ɕie$^{35}$ʈʂɿ$^{0}$] (*shoes*) and [tɕ$^{h}$ie$^{35}$ʈʂɿ$^{0}$] (*eggplant*), [tʂu$^{55}$] (*pig*) and [ʂu$^{55}$] (*book*) is different. In the linguistic-based treatment, we also introduce the contents of non-linear phonology such as 4 tones and intonation, and teach different language units at the same time.

According to the statistics of the intervention results (Table 4), whether in group A or group B, the articulation of affricate was significantly improved after intensive intervention. However, through the comparison of the two groups, we can find that the group B which are treated on the combination of motor and linguistics-learning are much better than Group A.

*Figure 1.* **Percentage map of affricate consonants error type**

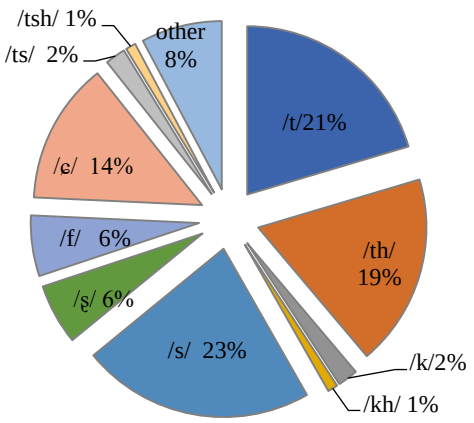
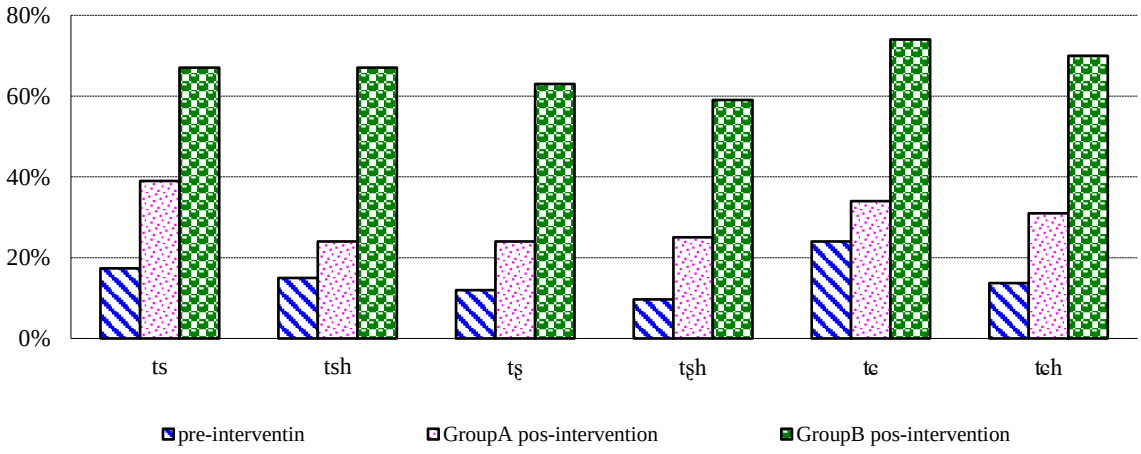



*Table 4.* **Results of the correct percentage of the two groups by post-therapy assessment**

| Affricate consonants | Group A | | | Group B | | |
|---|---|---|---|---|---|---|
| | mild | moderate | severe | mild | moderate | severe |
| ts | 44% | 40% | 33% | 80% | 65% | 55% |
| tsh | 38% | 18% | 16% | 83% | 68% | 50% |
| tʂ | 28% | 30% | 13% | 65% | 65% | 59% |
| tʂh | 30% | 25% | 20% | 63% | 60% | 55% |
| tɕ | 49% | 34% | 18% | 80% | 78% | 65% |
| tɕh | 40% | 33% | 20% | 78% | 68% | 63% |
| Average | 38% | 30% | 20% | 75% | 67% | 58% |

*Figure 2*. **Correct percentage by post-therapy assessment of affricates**



We observed that the training effects of the six consonants are significantly improved, especially in group B. Group A are raised 10% at least, while Group B are raised more obviously. From the assessment results of Group B, it can be seen that after the intensive intervention, the evaluation results of each consonant except [tʂ] are more than 50%.

In short, the results show that the combination of traditional methods and linguistic-based treatment methods has a better effect. Children with three different language levels were significantly improved in accuracy.

## DISCUSSION

In this study, we found that the error frequency of the retroflex affricates is the highest, followed by the cornal alveolar affricates, lingua-palate affricates are the lowest. This result is basically consistent with previous studies on the order of consonants in children's language acquisition. The error rate of retroflex affricates is very high. It may be related to the factors that is late acquisition of apical retroflex. In the order of acquisition of consonants in normal children, the acquisition of apical retroflex is the latest. Studies have found that the later the consonants are acquired, the higher the incidence of articulation errors.

In typical children, the earliest lip sound is acquired, and the lowest error frequency is found in SSD children. And the later apical retroflex sound is the last stage in children. It is suggested that in the process of SSD children's articulation training, we can try to draw up articulation training plan according to the sequence of typical children's phonetic acquisition. It is an efficient method for SSD children to master the consonant articulation.

Firstly, the results show that high intensity intervention based on exercise has a certain effect on children with SSD, and the correct rate of affricate has been improved. This is inseparable from intensive training. Intensive training works better than non-intensive training. As a whole, the clarity and intelligibility of affricates have been improved.

Secondly, motor-based intervention is necessary. Explaining the gesture and manner of articulation, or displaying the phonetic tongue bitmap to the clients in the form of pictures, can achieve twice the result with half the effort in teaching. There are two main methods to be adopted in specific teaching. The first one is exaggerating the pronunciation position of the tongue tip, emphasizing that the obstruction position of the tongue tip is not on the back of the upper teeth or the silver of the upper teeth, and must have wings and tongues to guide the clients to complete the action of the wings and tongues. The second is to highlight the difficulties, repeated practice. During the process of training, therapist can draw simple tongue bitmap to help students grasp the pronunciation part of the post-apical pronunciation of the tongue, after clients understand and master the tongue position, repeated practice, pay attention to the ear, eyes, mouth training at the same time, strengthen signal stimulation, and finally achieve the goal. In addition, the method of "biting the tip of the tongue" can be used to explain the pronunciation position. We know that the pronunciation of the phoneme [ts], the tip of the tongue in Chinese is the tip of the tongue and the back of the upper teeth. In order to use this pronunciation part, we can try to explain the pronunciation part of the back of the tip of the tongue, and guide the children to put the tip of the tongue between the teeth but not to spit out. This practice is conducive to children's more intuitive understanding of the articulation place. Let the children pay attention to the appropriate force when sending out the pneumatic sound, expand the gap between the tongue and teeth, and strengthen the air flow, while in the pronunciation of the non-aspiration sound.

*Table 5.* **Studies on the Development of Chinese Affricates (adopted from Tong Baojuan, 2014)**

| Affricate Consonants | Wang (1984) | Zheng (2003) | Zhu and Dodd (2000) | Zhuo (2008) |
|---|---|---|---|---|
| **ts** | 3 | 5 | 4.5 | 4.5 |
| **tsh** | 3.5 | 5 | 4.5 | 4.5 |
| **tʂ** | 6 | 6 | 4.5 | 6 |
| **tʂh** | 6 | 6 | 4.5 | 4 |
| **tɕ** | 4 | 3 | 4.5 | 3.5 |
| **tɕh** | 3 | 4 | 4.5 | 4.5 |

It is necessary to increase the obstruction, strengthen the friction, and then break through the obstruction to produce the non-aspiration affricate consonants sound.

Thirdly, nonlinear phonological and linguistic treatments are our primary treatments. While focusing on vocal organ movements, the main objective is to establish a standard phonological system, including phoneme and phonological combination rules. Pay attention to the contrast of words in different tones, the different combinations of words and phrases, to help children master the pronunciation and to form a phonological system as soon as possible. The motor-based approach is a behavioral approach, and language-based therapy and treatment have an important relationship in the treatment process. Here we use intensive stimuli to describe and demonstrate the method of training single phonemes, while also using the minimum phrase comparison, constructing the squeaks into different syllables and vocabulary, directly combining the use of language with language therapy. For example, 机器 (machine) vs. 记起 (remember), 茄子 (eggplant) vs 鞋子 (shoes), 炸鸡 (fried chicken) vs. 烧鸡 (roast chicken), etc., we make use of the substitution and omission of children in the previous pronunciation appraisers (the affricate is replaced by the fricative), and the two minimum differences are targeted. Mineral contrastive features are entered into the treatment. This can quickly increase the phoneme contrast combination in the case voice system. Each class has a large amount of training, but the target sound is relatively small. It constantly circulates the phoneme-syllable-word-phrase-sentence training, and each material has an affricate target. This training process is not boring, and more importantly, the effect is very good. This method is repeated every day throughout the whole process of speech therapy. The results show that the combination of behavioral therapy and linguistic therapy can better promote the intervention process of affricate. Affricates is the consonants which are acquired late in speech system, and Chinese itself is a tone speech system. The combination of linguistic method and non-linear phonological method can accelerate the classification of case speech therapy process.

The main goal of linguistic-based speech therapy is to establish a standard phonological system for the clients, including complete phonemes (with contrast-based speech), phoneme variants, and phoneme combination rules. There are two basic rules. The first rule is related to the target behavior, and the second is related to the treatment process. In the intervention process, two methods are mainly used. One is to establish a comparison of phoneme and pronunciation features, the other is to replace the wrong phonemes. In the intervention, it is necessary to eliminate those same pronunciation but different meaning words, to establish new syllables and syllable combinations, and establish new phoneme types.

Of course, phonological awareness is also very important. Through continuous reinforcement of interventions for SSD children, this is also intensifying language abilities and phonological awareness. Integrating linguistic knowledge into intervention training can better inform children of the phonological structure of syllables, words, and sentences. We already know that the phonological awareness is gradually developing, and the development of the children's phonological awareness is a gradual progress. (Stanovich & Jordan, 2000). By strengthening the training method combining motor-based and linguistic theory, children's sensitivity to phonemes in words will also develop rapidly, and then they will develop phonological awareness. This is consistent with the research by Burgess & Lonigan (1998) and Lonigan, Burgess, Anthony et al. (1998).

## CONCLUSION

Recently, there has been an increasing number of children visiting the outpatient clinic with complaints of inaccurate pronunciation and delayed language development. One of the reasons could be the establishment of the referral system of the National Health Program for Infants and Children. The data from this study show that for children with SSD, most of the false consonant pronunciation will not improve with older-age. Many parents believe that voice problems improve with age. This idea is unscientific. The subjects we selected are basically over 6 years old. Intelligence is a diagnostic criterion for SSD. Children need timely intervention treatment. In addition to behavioral-based phoneme pronunciation training, linguistic-based therapy should be combined in order to achieve better intervention effect. And intensive intervention is also very important.

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