The acquisition of English phonological awareness in Mandarin-speaking children

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Abstract

This thesis investigated the effectiveness of 3 intervention programs on the acquisition of English phonological awareness by 58 typically-developing Mandarin-speaking kindergarteners learning English as a foreign language. The programs consisted of perceptual-based, production-based, and phonemic awareness activities. The perceptual-based or production-based intervention was conducted in Phase I, followed by the phonemic awareness activities in Phase II. Children's phonological awareness skills in both Mandarin and English were assessed before and after each Phase. Results indicated that in Phase I, there was no significant difference of phonological awareness skills after the intervention for the groups who received either the perceptual- or the production-based intervention when compared to the control groups. In Phase II, there was a significant difference in overall English and Mandarin phonological awareness test scores for the groups who received phonemic awareness instruction when compared to the control group. Moreover, those children given the perceptual-based or the production-based intervention previously along with phonemic awareness instruction in Phase II did not show an advantage over those who received only phonemic awareness instruction in Phase II. Even though phonemic awareness intervention was carried out with English materials, children's performance in phonological awareness in both Mandarin and English improved. The findings suggest that implementing phonemic awareness activities in English-learning classrooms and in clinical settings where clients have limited English

experiences could enhance children's phonological awareness skills in both English and their native language.

Résumé

Cette thèse évalue l'efficacité de 3 programmes d'intervention visant l'acquisition de la conscience phonologique (CP) de l'anglais par 58 enfants parlant mandarin de maternelle ayant un développement normal et apprenant l'anglais comme langue étrangère. Une intervention au niveau de la perception ou de la production avait lieu lors de la phase I, qui était suivie par des activités de CP lors de la phase II. Les habiletés des enfants au niveau de la CP du mandarin et de l'anglais étaient évaluées avant et après chacune des phases. Les résultats indiquent que suite à la phase I, il n'y avait pas de différence significative au niveau de la CP entre les groupes ayant reçus les interventions au niveau de la perception ou de la production et les groupes contrôles. Suite à la phase II, il y avait une différence significative dans les résultats au niveau de la CP de l'anglais et du mandarin entre les groupes ayant reçus une intervention au niveau de la CP et le groupe contrôle. De plus, les enfants ayant reçu aussi une intervention au niveau de la perception ou de la production, en plus de celle portant sur la CP lors de la phase II, n'ont pas montré un avantage par rapport aux enfants ayant reçus seulement l'intervention portant sur la CP. Malgré le fait que les interventions utilisaient du matériel en anglais, les performances au niveau de la CP de l'anglais et du mandarin se sont améliorées. Ces résultats suggèrent que l'utilisation d'activités de CP dans les classes d'apprentissage de l'anglais et dans le milieu clinique lorsque les clients ont une expérience limité avec l'anglais peut améliorer les habiletés de CP des enfants en anglais de même que dans leur langue maternelle.

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Statement of Originality

This dissertation presents a novel investigation examining intervention effects of a perceptual-based, production-based and phonemic awareness intervention on typically-developing Mandarin-speaking children learning English as a foreign language. Specifically, the research design was characterized by the following novel elements: (1) teaching procedures designed to enhance the children's implicit knowledge of phonetic aspects of the targeted phonological structures and teaching procedures designed to enhance the children's explicit knowledge of phonemic segments in the targeted phonological structures were manipulated independently; and (2) the phonetic and phonological awareness interventions targeted a prosodic structure that is present in English but absent from the children's native language. The outcome of the study yielded an important and novel finding: Mandarin-speaking children learned to segment and blend phonemes within words containing a foreign-language prosodic structure, specifically complex onsets and codas, after less than 2 hours of intervention. This research was presented at the *2009 Acoustical Society of America Workshop on Speech: Cross-language speech perception and variations in linguistic experience* in Portland, Oregon and the *2009 National Conference on Bilingualism and Biliteracy Development* in Halifax, Nova Scotia.

INTRODUCTION

1.1 Phonological Awareness: An Overview

Phonological awareness refers to knowledge about the sound structure of words, and the capacity to manipulate sound units within words. Morais (1991) defined phonological awareness as a special kind of phonological knowledge that refers to conscious representations of phonological properties of words. Words can be broken down into three levels of sound units: syllabic, intrasyllabic (such as onset and rime), and phonemic units. One school of researchers considers phonological awareness as awareness of phonemic units only (e.g., Tunmer, Herriman, & Nesdale, 1988). However, a broader definition of phonological awareness can include awareness of all three levels (Dodd & Gillon, 2001; Goswami & Bryant, 1990). To explore children's skill at manipulating different level of linguistic units, the latter view of phonological awareness is adopted in the present study. The term 'phonemic awareness' will be used specifically to refer to the awareness of phonemic units.

Awareness of sound units can be measured by tasks that require subjects to detect, delete, or manipulate the targeted units at the specified level (Bentin, 1992). For example, a syllable counting task requires subjects to count the number of syllables in the presented word. A coda substitution task asks subjects to substitute one sound for another at the end of a syllable. Different tasks require different cognitive demands to perform the operation, depending on memory requirements and the complexity of the manipulation. Difficulty is also determined by the nature of the stimuli, with nonwords and unfamiliar words being more difficult than familiar words (Garlock, Walley, & Metsala, 2001). Therefore, even when implementing a task with relatively low cognitive demands, such as a matching task, matching words that share the same rhyme (e.g., c*at*-b*at*) is easier than matching words that share the phoneme at a specified position (e.g., lea*f*- kni*fe*) (Savage, Blair, & Rvachew, 2006).

Phonological awareness changes over development, progressing from awareness of larger linguistic units such as syllables to smaller units such as phonemes. This reflects development from a global, holistic phonological representation toward a more fine-grained, segmentalized representation of lexical items (Caravolas & Bruck, 1993; Fowler, 1991; Liberman, Shankweiler, Fischer, & Carter, 1974; Lonigan, Burgess, Anthony, & Barker, 1998; Treiman & Zukowski, 1996). In their study of 135 young children, Liberman et al. found that half their five-year-olds could segment by syllables but none of them could segment by phonemes. At the end of first grade, 90% of the children had mastered the syllable segmentation task, and 70% succeeded in the phoneme segmentation task. Subsequent research (e.g., Lonigan et al., 1998) has confirmed that young children manipulate sound units best at the whole word level, followed by the syllable level. Performance on the same type of task was least accurate at the phonemic level. Fowler has suggested the developmental progress of phonological awareness could be extended to reflect “more fundamental changes in phonological representations” (p. 53). In other words, children’s early lexical items are stored or represented in a more holistic manner and these phonological representations of words gradually become fine-grained and segmentalized at the phonemic level.

1.2 Phonological Awareness and its Contributing Variables

There are several variables that are thought to contribute to the development of phonological awareness in speakers of alphabetic languages. These include increased vocabulary size, improved speech perception and speech production skills, alphabetic knowledge, increased reading and spelling activities or instruction especially at the phoneme level. Each of these variables will be briefly addressed in turn.

Vocabulary size has been found to be significantly correlated with scores on phonological awareness tests in 3-, 4- and 5-year-olds (Chaney, 1992; Dickinson, McCabe, Anastasopoulos, & Poe, 2003; Metsala, 1999). Longitudinal studies of children with and without a family history of dyslexia also found that phonological awareness at 3.5 years of age in both groups could be predicted by vocabulary skills tested at 14-26 months of age (Puolakanaho, Poikkeus, Ahonen, Tolvanen, & Lyytinen, 2004). Metsala and Walley (1998) proposed that increased pressure of growing vocabulary size drives the restructuring of subcomponents of speech in order to facilitate lexical access.

In addition to vocabulary growth, the development of speech perception is another factor correlated with the maturity of the child's phonological awareness skills (e.g., Chiappe, Chiappe, & Siegel, 2001; Joanisse, Manis, Keating, & Seidenberg, 2000; McBride-Chang, 1995; Metsala, 1997; Rvachew & Grawburg, 2006). The hypothesis that the child's developing speech perception abilities may contribute to segmentalized phonological representations, and thus to better phonological awareness, follows from psychoacoustic theories of speech processing. Such theories (e.g., Diehl, Lotto, & Holt, 2004; Fant, 1967) suggest that when people process strings of speech, the acoustic input must first be transformed into a phonological code. The challenge for the child is to map continuously changing acoustic information to these discrete phonological units even though there is no one-to-one mapping between acoustic cues and phonological units. Rvachew (2006) established that speech perception measured by word identification tasks obtained prior to entry into kindergarten could predict phonological awareness measured at the end of kindergarten in children with speech sound disorders. If speech perception contributes to the development of phonological representations, perceptual-based training activities should lead to a better performance in post-intervention phonological awareness. However, findings so far do not present a consistent effect from perceptual-based training activities. A review of these will be presented shortly.

Speech production, or articulation, has also been shown to be correlated with phonological awareness skills (e.g., Magnusson, 1991; Senechal, Ouellette, & Young, 2004; Thomas & Senechal, 2004; Webster & Plante, 1995). Liberman and Mattingly (1985) proposed the motor theory of speech perception, based on the hypothesis that the basic units of speech perception are articulatory gestures, rather than acoustic cues. Following this perspective, Studdert-Kennedy (1987) described the word as an articulatory routine which includes a series of articulatory gestures and their corresponding acoustic correlates. According to this theory, word learning is therefore a process of routine consolidation. Locke (1988) also stated that if the child feels himself producing the right articulation of an auditory sound target, “the conversion of templates to syllabic and segmental sequences might occur just that much quicker” (p. 18). Stemberger (1992) took a broader perspective, viewing learning as a connectionist network of levels of linguistic units. According to him, children learn to compare the perceived form of their own productions to their perceptions of forms produced by adults. This comparison is done in order to build up the linking among units, so that the representations of the units and the correct pronunciations are more likely to occur next time. These hypotheses are based on the view that phonological representations contain a motor or gestural component, and articulation in word learning can thus be linked to the development of phonological representations. McCune and Vihman (2001) demonstrated a longitudinal link between early speech production and later lexical representations by tracking infants from 9 months to 16 months of age. Regression analysis showed that consistent use of a number of consonants at the earlier stage predicted the total number of referential words produced at 16 months old. Clinical studies of children with speech sound disorders also showed that these children performed less well on phonological awareness tests than their peers with normal speech production (Magnusson, 1991; Webster & Plante, 1995). If more accurate speech production contributes to better phonological awareness, a period of production-based training may lead to a significant improvement in phonological awareness. As with speech perception, intervention studies that focus on articulatory gestures have yielded conflicting findings. A review of these will be presented in the next section.

It is worth noting that both psychoacoustic theories of speech perception and the motor theory of speech perception/ production deal with the very nature of the speech signal that human ears perceive and store, with one targeting acoustic features and the other articulatory gestures. Perceptual-based training aims to improve children's perceptual knowledge of the acoustic and perceptual characteristics of sounds, and production-based training aims to improve articulatory knowledge of articulatory characteristics of sounds (Munson, Edwards, & Beckman, 2005). Phonological awareness, which is a higher level of phonological knowledge, above perceptual and articulatory knowledge, reflects the developing nature of phonological representations of words.

In addition to vocabulary growth, improved speech perception and articulatory skills, researchers have also proposed that other variables centering around the activity of learning to read might contribute to the development of phonological awareness. These include factors such as knowledge of the alphabet and increased reading and spelling experience and instruction (e.g., Burgess & Lonigan, 1998; Morais, Cary, Alegria, & Bertelson, 1979; Read, Zhang, Nie, & Ding, 1986). Learning the letters of the alphabet and their associated common phonemes may increase children's awareness of the sound structure of words. The early stages of learning to read and spell also draw attention to the structure of written and spoken words. Abundant research has demonstrated the reciprocal relationship between phonological awareness and literacy development (Bradley

& Bryant, 1983; Burgess & Lonigan, 1998; Morais et al., 1979; Read et al., 1986; Torgesen, Wagner, & Rashotte, 1994).

1.3 The Importance of Phonological Awareness

The predictive power of early phonological awareness development has been well documented in its relation to spelling, word recognition, and reading skills (e.g., Bradley & Bryant, 1983; Lundberg, Olofsson, & Wall, 1980; Nation & Hulme, 1997; Torgesen, Wagner, & Rashotte, 1994). Many studies have consistently demonstrated the predictive role of phonological awareness at the level of the phoneme (e.g., Bradley & Bryant, 1983). Specifically, in typically developing English-speaking kindergarten and young school-age children, phonemic awareness may be a better predictor than onset-rhyme awareness of later spelling (Caravolas, Hulme, & Snowling, 2002; MacDonald & Cornwall, 1995; Nation & Hulme, 1997) and reading (Fowler, 1991; Hulme et al., 2002; Muter, Hulme, Snowling, & Taylor, 1998; Share, Jorm, Maclean, & Mathews, 1984; Torgesen et al., 1994).

Cross-linguistically, significant correlations between first-language phonological awareness and second-language phonological awareness were also found (Cisero & Royer, 1995; Gottardo, 2002; Quiroga, Lemos-Britten, Mostafapour, Abbott, & Berninger, 2002). In relation to literacy, studies have demonstrated the predictive power of phonological awareness across languages. Results have shown that children's first-language phonological awareness skills also predict literacy skills in the second language in Spanish-English and English-French bilingual children (Comeau, Cormier, Grandmaison, & Lacroix, 1999;

Durgunoglu, Nagy, and Hancin-Bhatt, 1993; Quiroga et al., 2002; Tingley, et al., 2004).

1.4 Relevant Language Specific Issues

1.4.1 Phonological Awareness in Chinese-Speaking Children

In contrast to the abundant literature on English-speaking children's phonological awareness skills, there is much less research on the development of Chinese-speaking children's phonological awareness despite the large number of Chinese speakers around the world. A brief overview of Chinese phonology is presented first, followed by the literature documenting the phonological awareness skills in Chinese-speaking children.

1.4.1.1 Chinese Phonology

Chinese is a language family consisting of more than 10 spoken dialects including Mandarin and Cantonese. Syllables in Chinese have been viewed as a combination of the initial sound, the final (rhyme), and the tone, although the initial sound is optional. The final part of a syllable can include an optional medial vowel, a kernel vowel, and an optional coda. Only nasals /n/ and /ŋ/ can appear as a coda in Mandarin, although some regional dialects such as Cantonese allow other consonants in the coda position. Each syllable is represented orthographically by a Chinese character, which does not reveal any phoneme-letter correspondence as in alphabetic languages. There are 22 initial segments and 38 final segments in Mandarin, which constitute around 400 syllables in total (Chan, Hu, & Wan, 2005; Ho & Bryant, 1997). Cantonese has 19 initial segments and 51 final segments.

1.4.1.2 Literature

Most of the studies that have addressed phonological awareness in Chinese-speaking children have focused on Mandarin or Cantonese and, in particular, on onset and rhyme units (e.g., Ho & Bryant, 1997; Hu & Catts, 1998; Huang & Hanley, 1995; Chiang, 2002). The reason for this might be largely due to the fact that Mandarin has only 400 syllables, as opposed to more than 12000 syllables in English (Levelt, Roelof, & Meyers, 1999). Some researchers have argued that Mandarin Chinese speakers store syllable structures without detailed phonemic specifications in their mental lexicon (e.g., Yamada, 2004).

There is surprisingly little research on phonemic awareness of Chinese-speaking children (Chan, Hu, & Wang, 2005). An extensive and thorough literature review revealed that the only available research is by Chan et al. (2005), who studied 4th-graders' phonemic awareness in Mandarin in Taiwan. An oddity test required children to detect the word which had a different nucleus or coda from the others. This is considered a phonemic awareness test in that the children have to separate vowel combinations or separate the final consonant from the vowel in order to perform the test. Only 23% of these children achieved 75% mastery in this test, although 72% of them achieved 75% mastery in onset-rhyme awareness test. These 4th-graders' poor performance in phonemic awareness but not onset-rhyme awareness suggested that Mandarin-speaking children's underlying representations of syllable structures are mainly at the level of onset and rhyme.

Unlike English, in which there is evidence for a strong relationship between phonological awareness and reading, the role of phonological awareness in reading Chinese remains controversial (e.g., Wang, Koda, & Perfetti, 2003). Some researchers (e.g., Read, Zhang, Nie, & Ding, 1986) have argued that phonological awareness is not correlated with reading Chinese characters, based on results collected from adult Mandarin speakers (Read et al., 1986; Ko & Lee, 1996), typically-developing school-age children (Huang & Hanley, 1995) and children with reading difficulties (Chen, 1996). However, others have suggested that phonological awareness and Chinese reading are correlated in both typically-developing children (Chang, 1996; Huang, 1997) and children with reading difficulties (Tzeng, 1996).

1.4.2 Cross-linguistic Phonological Awareness and Early Literacy in Chinese-Speaking Children Learning English

A limited number of studies have investigated the impact of phonological awareness on the acquisition of L2 reading and spelling skills in Chinese-speaking EFL or ESL (English as a Foreign or Second Language) learners (Holm & Dodd, 1996; Hu, 2003; Knell et al., 2007; Li, 2008; McBride-Chang & Ho, 2005; Rickard Liow & Poon, 1998; Rickard Liow & Lau, 2006). These studies, however, did not present consistent findings concerning the relationship between phonological awareness in Chinese and reading or spelling in English. Findings that have shown that phonological awareness in Chinese correlates with English word learning or English word recognition skill will be presented first, followed by findings that did not show the predictive relationship. In addition, how different first-language background affected spelling in English will be reviewed.

Hu (2003) found a correlation between phonological awareness skills and concurrent ability to learn and name three unfamiliar English words in 5-1/2-year-old Mandarin-speaking children in Taiwan. The overall results supported the conclusion that phonological awareness in Mandarin was related to the children's ability to establish phonological representations for novel English words and to associate these representations with the appropriate semantic referent. McBride-Chang and Ho (2005) investigated Chinese phonological awareness, Chinese phonological memory and English word reading ability in Cantonese-speaking children in Hong Kong. Results demonstrated that Chinese phonological processing skills (phonological awareness and working memory) concurrently accounted for unique variance in English word recognition tested at the age of six. Similarly, Knell et al. (2007) reported that English letter-naming skills, along with Chinese phonological awareness and Chinese oral proficiency, significantly predicted English word recognition in Mandarin-speaking children enrolled in English immersion programs in primary schools in China.

Li (2008), however, reported that Chinese phonological awareness was not a significant predictor of concurrent English reading measures in Grade 2 and Grade 4 Mandarin-speaking children enrolled in English immersion programs in China.

Holm and Dodd (1996) suggested that skills acquired in reading Chinese may not have a positive effect in reading and spelling English nonwords. They reported that Cantonese-speaking university students in Australia showed difficulty with English nonword reading and spelling, but not real word reading and spelling, compared to peers coming from alphabetic first language backgrounds such as English and Vietnamese. The authors suggested that Cantonese learners of English may rely more on a visual strategy acquired from reading Chinese characters and may have greater difficulty processing unfamiliar English words compared to participants from alphabetic language backgrounds.

Similarly, studies conducted by Rickard Liow and colleagues also showed that different first language backgrounds appear to influence spelling performance in English as a second language (Rickard Liow & Poon, 1998; Rickard Liow & Lau, 2006). The researchers studied multilingual ethnic Chinese children in Singapore whose language backgrounds were Mandarin, English, or Bahasa Indonesian. These children all attended the same school and were learning English and Mandarin there. Children whose backgrounds were Bahasa Indonesian or English performed better on English spelling tests than those with a Mandarin background. The authors attributed this difference in performance to the children's language experiences.

In summary, the studies reviewed here show that phonological awareness in Chinese correlates with English word learning skill in kindergarteners (Hu, 2003), or explains variance in early English reading measures in 6-year-olds (McBride-Chang & Ho, 2005). However, the predictive relationship may be limited to young beginning language learners, or may depend on the complexity of reading tasks as the outcome measure in school-aged children (Li, 2008).

Moreover, researchers have shown that different first-language backgrounds appeared to influence school-aged children's spelling performance in English (Rickard Liow & Poon, 1998; Rickard Liow & Lau, 2006) or adults' English nonword reading and spelling skills (Holm & Dodd, 1996).

1.5 The Need for Intervention in Chinese-Speaking EFL/ESL Learners

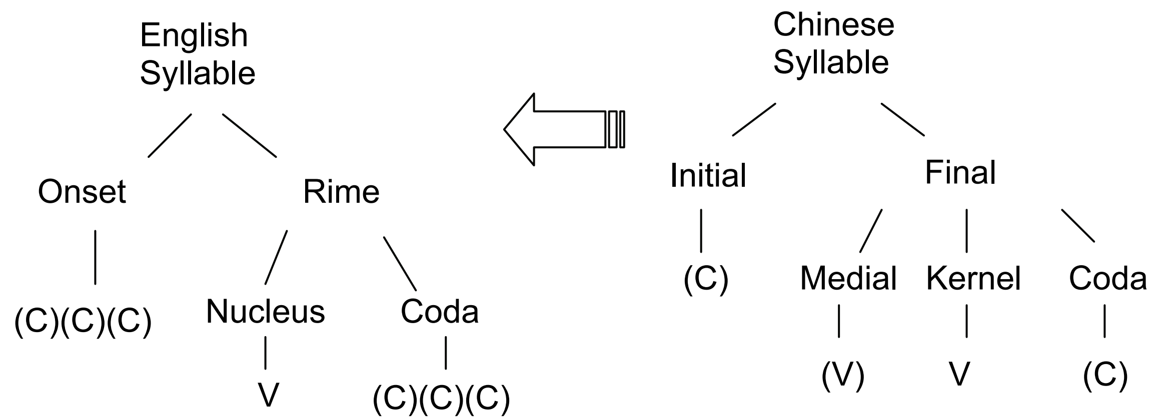
Commenting on a study by Wang, Koda, & Perfetti (2003) that compared Chinese and Korean students' performance in reading English, Yamada (2004) suggested that ESL students' reading in English is affected by the L1 phonological system, rather than the L1 logographic (e.g., Chinese) or alphabetic (e.g., Korean Hangul) writing system as suggested by Wang et al. Yamada claimed that the richer the L1 phonological system, or the closer it is to that of English, the more positive transfer there will be from the native phonological system to English. Chinese has around 400 syllables, which is much fewer than 12000 syllables in English (Levelt, Roelofs, & Meyer, 1999). Chinese has a simple syllable structure, mostly (C)V(C), while an English syllable can consist of (C)(C)(C)V(C)(C)(C) (e.g., *strengths*). Given that Chinese has neither rich syllables nor complex syllable structures, the transfer from the Chinese phonological system to the English system is inefficient (Yamada, 2004).

Chinese-speaking children may be at a disadvantage when learning to read in English especially when words increase in length and complexity. The monosyllabic syllable structure in Chinese, which does not allow consonant clusters, may not facilitate the emergence of phonemic awareness in Chinese and in English (see Figure 1.1b). Poor performance in Mandarin phonemic awareness of Mandarin-speaking 4th-graders reported by Chan, Hu and Wan (2005) supports this argument. Despite being exposed to reading and writing in Mandarin for four years, these school-age children performed poorly in the phonemic awareness test. Their phonemic awareness in Mandarin might therefore have been insufficient to help with learning to read in English.

For this reason, the question of how to promote Mandarin-speaking children's learning of phonological awareness in English has received considerable theoretical and pedagogical attention in recent years in Taiwan (e.g., Hu, 1999). The insufficient phoneme-level representation from L1 Chinese (e.g., Chan et al., 2005) and limited vocabulary of beginning learners of English make the transfer from L1 to L2 inadequate and the emergence of segmentalized representations in English difficult (Zapparoli, 2006). Furthermore, Mandarin-speaking children find it difficult to learn the English alphabet and their sound associations. Hu (2003) also showed that foreign word learning is "the learning of new sound patterns" (p. 431), which then map onto existing concepts or vocabulary in the first language. Given the challenge of learning a new phonological system and limitations on transfer, an effective intervention that helps young Chinese-speaking learners of English gain knowledge of its phonological structure and develop its phonological representations is of great importance.

Given the findings in the literature regarding the types of intervention activities used to promote English-speaking children's phonological awareness, three types of intervention activities focusing on speech perception, speech production, and phonemic awareness respectively are reviewed in the next sections. The present investigation, which incorporated these intervention approaches, will then be presented.

Figure 1.1 (a). English syllable structure. *(b).* Chinese syllable structure.



1.6 Three Types of Intervention

1.6.1 Phonological Awareness Intervention

Bradley and Bryant (1983) first presented empirical evidence of a causal link between phonological awareness and reading development in 5-year-old typically-developing children. A large number of studies have further found poor phonological awareness skills in many, but not all, children with reading difficulties (Duncan & Johnston, 1999; Morris et al., 1998; Swam & Goswami, 1997) and speech and/ or language disorders (Bird, Bishop, & Freeman, 1995; Cats, 1993; Fazio, 1997; Gillon, 2004; Holm, Farrier, & Dodd, 2008; Larrivee & Catts, 1999; Rvachew, Ohberg, Grawberg, & Heyding, 2003; Webster & Plante, 1992). Because phonological awareness, and particularly phonemic awareness, plays such an important role in language and literacy development, many intervention programs have been designed and implemented that aim to enhance phonological awareness in children. Such programs have been investigated in English-speaking children with dyslexia (Gillon & Dodd, 1995, 1997), phonological impairments (Gillon, 2002; Hesketh, Adams, Nightingale, & Hall, 2000), and specific language impairment (e.g. Zens, Gillon, & Moran, 2009). Intervention effects have also been studied in typically-developing English-speaking children (e.g., Byrne, & Fielding-Barnsley, 1991, 1993, 1995; Torgesen, Morgan, & Davis, 1992), Spanish-speaking children (Defior & Tudela, 1994), German (Schneider, Kuspert, Roth, & Vise, 1997), Danish (Lundberg, Frost, & Petersen, 1988), Swedish (Olofsson & Lundberg, 1983) and Hebrew (Bentin & Leshem, 1993). Research has also demonstrated improved reading scores following phonological awareness intervention on Grade 7 students who learned English as a second language (Swanson, Hodson, & Schommer-Aikins, 2005).

Troia (1999) examined 39 published studies on phonological awareness intervention and highlighted methodological weaknesses in many of them. Issues include non-random assignment of subjects in different conditions, failure to provide an alternative intervention to control groups, lack of treatment fidelity by the third party, the use of insufficiently sensitive measurement tools, and inadequate description of research participants. Given these methodological flaws, Ehri and colleagues (Ehri et al., 2001) examined 28 phonemic awareness studies from Troia's review and compared their effect size. They found that all studies showed statistically significant effect sizes. However, those that were designed rigorously showed much greater effect sizes than those with methodological flaws. The critique on methodological flaws reported by Troia did not seem to undermine the effectiveness of phonemic awareness intervention. Programs that targeted only one or two types of phonemic awareness tasks benefited the children most when compared to programs that included multiple types of phonemic awareness activities. It was also more effective to teach with printed letters than to teach without printed letters.

1.6.2 Perceptual-Based Intervention

As reviewed earlier, several descriptive studies involving linear structural and hierarchical regression modeling have suggested that speech perception is causally related to phonological awareness (McBride-Chang, 1995; Rvachew, 2006; Rvachew & Grawburg, 2006). Therefore it is reasonable to hypothesize that speech perception intervention might lead to improved phonological awareness abilities or improved response to phonological awareness training. In fact, the results of such studies have not led to clear conclusions about the relationship between these constructs. In Rvachew, Nowak, and Cloutier (2004), 34 preschoolers with moderate or severe expressive phonological delays were randomly assigned to one of two interventions that targeted different aspects of emergent literacy. All children received sixteen 15-minute treatment sessions in addition to their regular speech therapy sessions on a weekly basis. The experimental group engaged in activities that targeted phonemic perception, letter recognition, letter-sound association and onset-rhyme matching. The control group listened to stories presented on the computer and answered questions about the illustrations. The post-treatment assessment was conducted 6 months after the pre-treatment assessment. Although the experimental group demonstrated greater improvements in articulation accuracy than the control group, both groups made equivalent gains in phonological awareness.

However, a different perceptual-based intervention study found different results. Moore, Rosenberg, and Coleman’s (2005) research showed that phonemic discrimination training had an impact on typically-developing 8- to 10-year-olds’ phonological awareness scores. Children in one classroom were trained for 30 minutes at a time, three times a week, for 4 weeks with computer games targeting phonemic discrimination. One post-test assessment was given after 4 weeks and another after 5-6 weeks to evaluate the duration of the training effect. Children in a second classroom received these same assessments but no training. The group that received the intervention demonstrated enhanced phonological awareness during both post-treatment tests of phonological awareness skills. The control group did not make significant gains in phonological awareness.

In summary, the two studies differ in several approaches. It is unclear which factor results in enhanced phonological awareness compared to the control group. It could be that the younger participants in Rvachew, Nowak, and Cloutier's (2004) study benefitted less from the training, compared to the older children tested by Moore, Rosenberg, and Coleman (2005). Perhaps children with expressive phonological delays may not receive the most benefit from the training. It could also be that the training intensity of once a week in Rvachew et al. versus three times a week in Moore et al.'s research might affect the results. It is also possible that the literacy exposure that the control group received was as effective as the intervention that the experimental group received. More research in this respect is needed to answer these questions. So far, the limited results in English-speaking children seem to demonstrate that it is possible that a period of speech perception training could lead to better phonological awareness performance.

1.6.3 Production-Based Intervention

As with speech perception, intervention studies that have focused on articulatory gestures have yielded conflicting findings. Hesketh and colleagues (Hesketh, Adams, Nightingale, & Hall, 2000) compared the outcomes of phonological awareness and articulation therapy in a group of children with phonological disorders aged from 3;6 to 5;0. Children who received phonological awareness therapy showed equivalent gains in phonological awareness skill compared to those who received articulation therapy. Castiglioni-Spalten and Ehri (2003) also demonstrated in their phonemic awareness instruction programs that an articulation-focused training group and a perception-focused training group of kindergarteners displayed better phonological awareness skills after the phonemic awareness intervention compared to the control group, but the two training groups' phonological awareness post-tests did not differ from each other. Similarly, Wise, Ring, and Olsen (1999) compared three different approaches to the teaching of phonological awareness to 7- to 11-year-old children with reading difficulties. The interventions focused on three different conditions: awareness of sounds, awareness of articulatory gestures, or a combination of both. Post-treatment performance on tests of phonological awareness was surprisingly similar across the three groups, with very few differences among the conditions after 50 hours of training. However, children in the articulation condition gained the most in orthographic decoding, after they were trained in how to read correctly. Among these three studies, both Castiglioni-Spalten and Ehri and Wise et al. trained children's phonemic awareness with a focus on articulatory gestures. It is not clear if it is the articulation exercises in particular or the phonemic awareness training that contributed to the improvement. More research in this area is needed to answer these questions.

In conclusion, numerous studies have demonstrated the effectiveness of the explicit teaching of phonemic awareness. Ehri and colleagues (2001) summarized a few characteristics of successful programs, despite some methodological flaws (Troia, 1999). In terms of perceptual-based and production-based intervention, studies have yielded conflicting results with respect to their improvements on phonological awareness. In the next section, the purpose and the design of the present investigation that incorporated these intervention programs will be presented.

1.7 The Present Investigation

1.7.1 Purposes

As stated previously, young Chinese-speaking learners of English are at a disadvantage when it comes to acquiring the English phonological system and reading in English. One reason is that Chinese has neither rich syllables nor complex syllable structures. So the transfer from the Chinese phonological system to the English system is inefficient (Yamada, 2004). Another reason is that given the nature of the syllable structure in Chinese (that is, the initial sound, the final and the tone), children's phonological representations are mainly at the onset-rhyme level (Chan, Hu & Wan, 2005). Moreover, beginning learners of English have limited vocabulary which makes the emergence of phonological representations in English difficult (Zapparoli, 2006). Given the challenge of acquiring a new phonological system and limitations on transfer, an effective intervention that helps young Chinese-speaking learners of English gain knowledge of English phonological structure is of great importance.

Effective programs must be informed by what is already known from the scientific literature, although this is mostly focused on the acquisition of phonological awareness by English-speaking children. The primary goal of the present investigation was to examine if the selected programs that are generally thought to be effective for English-speaking children would be effective for Mandarin speakers who are at the beginning level of learning English as a foreign language. Another purpose was to contribute to the limited literature on the development of phonological awareness skills of ESL or EFL children (Lesaux & Siegel, 2003) and describe the potential changes of their skills after the intervention.

1.7.2 Intervention

The present investigation incorporated a phonemic awareness intervention that teaches children to blend and segment the phonemes in increasingly complex English words. After analyzing the research on factors that contribute to the development of phonological awareness, it was decided that explicit teaching of phonemic awareness would be combined with an additional intervention that focused on either the perceptual characteristics of speech sounds or the articulatory characteristics of sounds. This was done in order to determine if a single session of perceptual-based or production-based intervention would enhance children's phonological awareness, and also to determine if either of these additional interventions would enhance the children's responses to phonemic awareness instruction. Although vocabulary size is known to be an important factor (Chaney, 1992; Dickinson, McCabe, Anastasopoulos, & Poe, 2003; Metsala, 1999) it was not directly manipulated in this study due to the limited time available in which to implement the intervention. Factors such as reading and spelling instruction were not incorporated into the program for the present investigation, largely due to the young age and limited vocabulary and reading experience of the EFL learners.

1.7.2.1 Phonemic Awareness Intervention

Interventions that emphasize explicit teaching of phonemic awareness have been shown to be effective for children at risk in several studies (see Gillon, 2004, for a review), but not yet in young EFL or ESL learners. The first objective of the present investigation was to examine the effects of phonemic awareness instruction on typically-developing EFL learners who were native speakers of Mandarin. Although explicit teaching of phonemic awareness can be conducted in several ways, the focus in the present research was on instructional procedures that have been found to be effective in the literature. In Ehri and colleagues' (2001) review of 52 phonemic awareness intervention studies, it was found that interventions that used only one or two types of phonemic awareness activities benefitted children the most, whereas interventions that targeted multiple types of activities were less effective. In addition, Torgesen, Morgan and Davis (1992) reported that only children who received both blending and segmentation training activities showed improved word learning skills afterwards, but not children who received only blending activities in their study. Therefore, in the present investigation, two phonemic awareness activities were taught: blending phonemes into words, and segmenting words into phonemes.

1.7.2.2 Perceptual-Based and Production-Based Intervention

Another goal of this study was to determine if children's acquisition of phonological awareness would be facilitated by improved perceptual or articulatory knowledge of the English sound system at the phonetic level. As studies of both perceptual-based and production-based interventions are limited in nature and in number, the findings to date do not provide a convincing picture of whether either type of intervention enhances children's acquisition of phonemic awareness. The second objective of the present investigation was therefore to design a well- controlled study to examine their effectiveness in EFL learners. Care was taken to avoid methodological flaws from previous research. First, some studies did not include a 'no treatment' or 'placebo treatment' control group. In such studies the lack of a true control group made it difficult to interpret whether the experimental and comparison conditions were equally ineffective or effective (Hesketh, Adams, Nightingale, & Hall, 2000; Rvachew, Nowak, & Cloutier, 2004). Second, some studies (Castiglioni-Spalten & Ehri, 2003; Wise, Ring, & Olsen, 1999) trained perceptual awareness of sounds or articulatory awareness of gestures through phonemic awareness activities. These two studies showed that the two experimental conditions led to equivalent gains in phonological awareness. In other words, there was neither a particular articulatory training effect nor a particular perceptual training effect that was independent of phonemic awareness training itself. Therefore, taking these considerations into account, a clear control group which was not exposed to any language or literacy related activities was utilized in the present study. In addition, in order to separate the contribution of phonological awareness activities and speech perception or production training, the training groups in this proposed study received perceptual- or production-based activities independent of phonological awareness activities.

1.7.3 Outcome Measures

The effectiveness of intervention was measured using carefully designed phonological awareness tests in both English and Mandarin. No other reading or learning outcome was measured. One difficulty was deciding what type of phonological awareness test best represented participants' skills before and after the intervention. It was therefore decided that similar types of phonological awareness tasks would be avoided in the phonological awareness instruction and its outcome measure. Phonological awareness can be indexed by a variety of tasks which vary on two dimensions; one is the unit size of the targeted subcomponent, such as syllables, onsets, rhymes, and phonemes, and the other is the cognitive level and phonological knowledge required to perform operations, such as detecting a unit implicitly, or deleting, and substituting a targeted unit explicitly (Morais, 1991).

The selection of appropriate outcome measures was modeled on research by Savage, Blair, and Rvachew (2006), who designed a matching task and a common unit task to tap implicit and explicit phonological awareness respectively. In their study with English-speaking preschoolers, performance level by target unit varied significantly as a function of task. Specifically, the number of correct responses was greater when the target stimuli shared larger units such as the head or rhyme, in comparison to stimuli sharing smaller units when the children were tested with the matching task. However, when the children were tested with the common unit task, performance levels were higher when target stimuli shared smaller units such as the onset or coda, in comparison to stimuli sharing larger units. The results of this study led to the conclusion that the course of phonological awareness may follow distinct paths for tasks tapping input representations versus those tapping output representations or for those tapping implicit versus explicit phonological knowledge. In the context of the current study, it is possible that the perceptual-based intervention may have different effects on these two different outcome measures in comparison to the articulation-based intervention since these two programs tap different levels of phonological representation.

In addition, the phonological awareness tasks used in the present study were presented via pictures, to lower the working memory load for young children. All the stimuli were carefully chosen to avoid the impact of overall phonological similarity between the target and foils. As well as addressing these issues, the present investigation further improved on previous studies that used live-voice stimulus presentation by displaying all the trials with pre-recorded sound files through PowerPoint slides. This procedure allowed participants to listen to a word more than once and reduced the potential impact of observing how the examiner pronounced the words during the test.

Finally, the targeted subcomponent of the matching task and the common unit task in this study was limited to onsets and codas in English. The rhyme unit was not considered in the present investigation because Savage, Blair and Rvachew (2006) reported that articulating the rhyme was difficult for pre-reading English-speaking children. Considering that most kindergarten-age children learning English in Taiwan cannot yet read English, this unit was excluded to avoid a potential floor effect. In Mandarin, onsets and rhymes were the targets of the matching task and the common unit task, partly due to the simple syllable structure in Mandarin, and partly due to the long-debated issue of whether phonemic awareness is present in Chinese speakers.

1.7.4 Study Design

The present investigation was designed to be a randomized control study, which avoided one of the major methodological flaws pointed out by Troia (1999) and was expected to determine effectively the intervention effect (Altman & Bland, 1999). Two interventions were designed to enhance phonetic level knowledge, one perception-based and one production-based; a third intervention was designed to teach phonemic awareness. As the present investigation did not aim to compare the effectiveness of these interventions, these three programs were not implemented in the same phase. The perceptual-based or production-based phase was administered first to the child, followed by the phase of phonemic awareness instruction. This design made it possible to examine whether phonemic awareness intervention is more effective when combined with perceptual-based or production-based activities, or if phonemic awareness intervention alone can be effective. Detailed design of the present investigation will be illustrated further in the next chapter.

1.7.5 Goals and Hypotheses

The primary goal of the present investigation was to examine if phonemic awareness instructional procedures that are generally thought to be effective for English-speaking children would be effective for Mandarin speakers who are at the beginning level of English learning. To be specific, this investigation aimed to determine if a brief period of instruction in phoneme segmentation and blending, targeting English words with consonant clusters, would improve Mandarin-speaking children's phonological awareness skills when compared to a control condition. A further goal was to determine if these phonemic awareness instructional procedures would be even more effective when combined with either a perception-based or a production-based intervention designed to enhance the children's phonetic knowledge of English consonant clusters.

The following hypotheses were posited: (a) English phonemic awareness intervention will be effective in enhancing phonological awareness skills in both English and Mandarin; (b) English phonemic awareness intervention combined with a perceptual- or production-based intervention will be more effective than the phonemic awareness intervention alone; and (c) all groups will have more difficulty with explicit than implicit phonological awareness tests, particularly in English, but there will be a significant increase in scores post-treatment for the groups which receive phonemic awareness instruction.

METHOD

2.1 Subjects

Sixty-eight Mandarin-speaking children were recruited from four different kindergartens in Tainan, a southern metropolitan city in Taiwan. Out of these participants, 6 did not participate in any of the testing due to scheduling difficulties. Two failed to complete the seven testing sessions. Another 2 participants were removed from the final data set, one because he had very low Mandarin vocabulary and the other because he had detectable articulation difficulties in some fricatives and affricates in Mandarin. The final sample was composed of 58 typically-developing children without speech or language difficulties, and who completely finished seven sessions.

The participants ranged in age from 61 to 78 months, with an average age of 71.8 months at the time of first testing. They did not have any known difficulties in hearing, motor control, language, or cognition from school teachers' reports. In order to represent natural variation in exposure to English as it occurs in the society, the amount of English instruction was not controlled. The amount of English instruction varied depending on the school participating. One of the kindergartens was an English immersion school (School I) with English native speakers as teachers. Two of the kindergartens (Schools H and S) exposed their children to English language activities given by ESL speakers twice per week, with each class being 40 minutes in duration. The remaining school (School B) did not give any formal English instruction but provided parents and children with access to English storybooks and audio materials. The aim of the present investigation was to examine the effectiveness of intervention in Mandarin-speaking children learning English as a foreign language. As long as children demonstrated typical development in Mandarin, limited exposure to English was not considered an excluding factor.

Children were from middle to high social economic backgrounds and largely used Mandarin at home. However, there were some children from families of lower social economic status according to teachers' report and a few children used both Taiwanese and Mandarin at home. Forty-four children had a parent who received a college or a university degree or more extensive education. Eight children had a parent who reported completing senior high school, which is 12 years of formal education. One child had a parent who completed junior high school, which is 9 years of formal education. Information regarding parental education for the remaining five children was not available. Most participants were tested at their school but some were tested at home due to scheduling difficulties. School testing was set up at various locations inside the school, depending upon room availability at the time of testing. Options included a spare room, the teachers' office, and the library. The majority of children came to the testing location with the experimenter, without being accompanied by parents or teachers. In the event that some were accompanied, the other person was seated at a distance behind the participant. At the end of each testing session, all the participating children picked a toy of their choice as a reward.

2.2 Procedures

2.2.1 Design

This study involved a pre-training language assessment followed by two training phases. Outcome assessments were given before Phase I, between Phase I and II, and at the completion of training Phase II. Three different conditions for four groups were implemented in Phase I: two experimental conditions assigned to two groups, specifically Perceptual-Based intervention and Production-Based intervention for each group, and one control condition for two control groups, who received activities of Number Knowledge. In Phase II, two different conditions for the same four groups were implemented, an experimental condition assigned to three groups targeting explicit learning of phonemic awareness (PA) and a control condition targeting Letter Puzzles and Letter Matching for a control group.

The study was designed as a randomized control trial with children randomly assigned to four different groups receiving different combinations of Phase I and Phase II conditions as shown in Table 2.1. Group 1 received Perceptual-Based intervention followed by phonemic awareness intervention; Group 2 received Production-Based intervention followed by phonemic awareness intervention; Group 3 participated in Number Knowledge control activities in the first phase but received the phonemic awareness intervention in the second phase; Group 4 participated in control activities in both phases of the study. Children were given a subject number as soon as the consent form was received, and then they were assigned to groups randomly. Initially 68 children from four kindergartens were assigned to groups, yielding groups sizes of 18, 17, 17, and 16 for groups 1 through 4 respectively. After drop-outs and exclusions, the final group sizes were Group 1 = 13, Group 2 = 16, Group 3 = 15, and Group 4 = 14. The randomization procedure was not done with concealment; in other words, the experimenter knew which participant was in which treatment group from the beginning. The number of participants by group and by school is presented in Table 2.2.

In this thesis, the results are described separately for Phase I and Phase II of the study. In both phases, Group 1 will be termed “Perception + PA”, Group 2 will be termed “Production + PA”, Group 3 will be termed “Control + PA”, and Group 4 will be named “Control + Control”.

Table 2.1

Activities by Session and by Group

	Session & Task	Group 1 (*n* = 13)	Group 2 (*n* = 16)	Group 3 (*n* = 15)	Group 4 (*n* = 14)
1	Language Assessment	✓	✓	✓	✓
2	Outcome Measure: Phonological Awareness Test 1 (PA1)	✓	✓	✓	✓
3	Experimental: Perceptual-Based Intervention	✓			
3	Experimental: Production-Based Intervention		✓		
3	Control: Number Knowledge			✓	✓
4	Outcome Measure: Phonological Awareness Test 2 (PA2)	✓	✓	✓	✓
5	Experimental: Phonemic Awareness Intervention: English Sound Blending	✓	✓	✓	
6	Experimental: Phonemic Awareness Intervention: English Phoneme Segmentation	✓	✓	✓	
5	Control: Letter Puzzles				✓
6	Control: Letter Matching				✓
7	Outcome Measure: Phonological Awareness Test 3 (PA3)	✓	✓	✓	✓

Table 2.2

Number of Participants by School and by Group

School	Group 1	Group 2	Group 3	Group 4
I	5	4	3	5
H	1	2	2	1
S	3	3	2	2
B	4	7	8	6
Total	13	16	15	14

Note. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. School I was an English immersion school. School H and S provided some English activities weekly. School B did not provide any English instruction.

2.2.2 Sessions

Each participant was given a subject number and its corresponding grouping. All participants then received a series of tasks in seven sessions individually as shown in Table 2.1. The first session was a language assessment session and included vocabulary tests in English and in Mandarin. Furthermore, a Zhu-Yin Symbol Recognition and Blending test was given. The content of the test will be explained in the next section. In the second session, the first set of phonological awareness tests, referred to as PA1 hereafter, was given in both languages. Subsequently in the third session, either English perceptual-based intervention or English production-based intervention or a number activity would be administered depending upon the group to which each participant was randomly assigned. In the following session, all participants were tested with a similar set of phonological awareness tests, referred to as PA2 hereafter in Mandarin and in English. Next, the fifth session consisted of either an English sound blending activity in experimental groups or an English alphabet puzzle activity in the control group. A session involving an English phonemic segmentation activity in experimental groups or an English alphabet matching activity in the control group then followed as the sixth session. The testing was concluded in the seventh session with another set of phonological awareness tests, referred to as PA3 hereafter. Each session lasted forty minutes to an hour. The testing interval was between six and ten days.

2.3 Tasks

2.3.1 Language Assessment

2.3.1.1 Vocabulary Tests

2.3.1.1.1 Mandarin. The Peabody Picture Vocabulary Test-Revised (PPVT-R, Mandarin Version, Lu & Liu, 1994) is a test of receptive vocabulary. The participant was required to respond to an orally presented item by pointing to the corresponding picture among four. The test was terminated when the child made six errors in eight consecutive items. The raw score was then calculated by subtracting the number of total errors from the ceiling item. The Mandarin version of this test was adapted from the English original of PPVT-R (Dunn & Dunn, 1981) and was tested and normed in Taiwan by Lu & Liu (1994). The split-half reliability coefficient has been shown to be between .90 and .97. The test-retest reliability is .90.

2.3.1.1.2 English. An English vocabulary test, designed by Li (2001), was designed for testing English learners' basic vocabulary comprehension. This was not a standardized test but had been used in several studies to test Mandarin-speaking children's English vocabulary in Taiwan (Cheung & Peng, 2000; Hu, 2002). Children were required to point to the corresponding picture among three or four that best represented the target item given orally. There were 40 items in total. The test was terminated when the participant made six errors in eight consecutive items. The score was calculated by subtracting the number of total errors from the ceiling item.

2.3.1.2 Zhu-Yin Phonetic Symbol Recognition and Blending Test

Zhu-Yin is a system of phonetic symbols used in Taiwan only, as opposed to Pin Yin system used in Mainland China. Mandarin characters, or orthographic units, are logographic, which means Chinese uses visual symbols instead of phonemes to represent words. In order to assist children with pronunciation of these characters, a system of phonetic symbols is introduced at the onset of early literacy. The Zhu-Yin system is formally introduced in the first 10 weeks of grade 1 in all primary schools. However, parents and kindergarten teachers usually start teaching this system prior to the children's entry to grade 1. Introduction of this system includes presenting 21 consonants and 16 vowels, and learning to blend consonants and vowels together with tones into monosyllabic words.

The purpose of this test is to examine children's ability to read and blend phonetic symbols in their last semester of the kindergarten year. They were first asked if they could recognize the Zhu-Yin symbols while being presented the test at the same time. Each participant was shown a list of 10 symbols, including vowels and consonants and one phrase of five words written in Zhu-Yin with different tones. Children were instructed to name these symbols. A point was given for each correct naming. They were then instructed to read the given phrase by blending sounds into words along with tones. A point was given for each successful blending. The test was terminated if the participant had difficulty recognizing and naming the symbols. A score of 15 was therefore given for successful completion of the test.

2.3.2 Phonological Awareness Tests

There were three sets of phonological awareness tests in the present study:

PA1, PA2, and PA3. PA1 was used as a pre-test. PA2 and PA3 were used at the end of Phase I and Phase II respectively. The approximate time to complete each test was 40 minutes to an hour. All three sets were created according to the same guidelines. Each set of phonological awareness tests consisted of four subtests: (a) matching tests in English, (b) matching tests in Mandarin, (c) common unit tests in English, and (d) common unit tests in Mandarin. Each subtest was labeled 1, 2, 3 following the subtest name in order to indicate the pre-test, the post-test in between, and the post-test at the end.

2.3.2.1 Matching Tests in English

The matching tests in English required the participant to match on the basis of shared onset or coda. This test was further divided into: (a) an onset matching test of 15 test trials, and (b) a coda matching test of 10 test trials. Each trial consisted of three words/ pictures displayed on a laptop screen with Microsoft Office PowerPoint. Children were presented with a slide of three pictures corresponding to the target word (e.g., *soup*) shown at the top of the slide, and two response choices (e.g., *sack, deer*), that appeared side by side below the target (Figure 2.1). The experimenter then clicked on sound files of these three words, pre-recorded by a female native speaker of Canadian English throughout the study, in order to play them. No orthography was presented. Children were instructed to help find the best friend or the best match for the target word (i.e., *soup* in this example) by matching the words/ pictures that shared the same beginning sound in onset matching trials or that share the same ending sound in coda matching trials (see Table 2.3 and Figure 2.1 for instructions and examples).

The target sound at the top was always presented first. The presentation order of correct and foil response alternatives was counterbalanced. Three practice trials were given before both the onset matching and the coda matching test.

Figure 2.1. Example of the onset matching test 1 (top: *soup* - *sack* - *deer*) and the onset common unit test 1 (bottom: *soup* - *sack*) in English.

Table 2.3

Instructions and Examples of Matching and Common Unit Tests in English

	Matching	Common Unit
Instructions[a]	There are three pictures with their names here. This picture at the top is looking for a matching picture that sounds the same at the beginning/ end. Let's listen to them first. (Play the sound) Could you help it find the match now?	We just matched these two pictures together. This one is (play the sound); this one is (play the sound). What is the same sound that both share at the beginning/ end?
Examples	*soup*, *sack*, *deer*[b]	*soup*, *sack*
	brown, *break*, *blade*[b]	*brown*, *break*

Note. [a]Instructions were given in Mandarin in all tests. [b]Target, correct response, foil.

The selection of foils in all matching tests was carefully manipulated according to the complexity of syllable structures and phonetic features of onsets/codas between the target and the foil. Among 15 test trials of the onset matching test, five trials of Consonant-Vowel-Consonant (CVC) words and 10 trials of CCVC words as the target and the correct response word were included. The difficulty of the trials was manipulated by selecting foils that represented decreasing numbers of differences in phonetic features and syllable structure between the target/ correct response and the foil, thus increasing the similarity of the two response alternatives. For example, the trial of *trail, treat, zip* has a CVC foil *zip*, which differs from the CCVC target syllable structure, and /z/ is different from /t/ in terms of both voicing and manner of articulation. This appears to be much easier than the trial *brown, break, blade.* In this example, both the target and the foil *blade* have a CCVC structure. In addition, they all share the same initial sound /b/, and the second consonant consists of two English liquid sounds, /r/ and /l/ respectively in the target/ correct response and the foil. The foil and correct response are thus very similar in phonetic features and environment. In the onset matching test in English, clusters such as pl-, kl-, fl-, kr-, gr-, br-, dr-, and st- were used in the 10 CCVC trials in the pre-test. Each correct response received 1 point. Successful completion of the onset matching test received a total of 15.

Similar design principles were applied to the construction of the coda matching tests. There were 10 test trials, including five trials of CVC words and five trials of CVCC words as the target and the correct response word. Foil words were manipulated in a similar manner to the onset matching test, making some trials such as *lip, rope, dog* easier than some like *sand, bound, tent*. Final clusters such as -nd, -nt, -ld, -st, and -ft appeared in the five CVCC trials in the pre-test. Successful matching of all trials received a total of 10 in the coda matching test.

2.3.2.2 Matching Tests in Mandarin

The matching tests in Mandarin required the participants to match on the basis of shared onset or rime. Syllables in Chinese, including Mandarin, Cantonese, and other regional dialects, are generally thought to consist of a combination of an initial sound (optional), a final part (rime), and a tone. The final part of a syllable can include an optional medial vowel, a kernel vowel, and an optional coda. Only nasals /n/ and /ŋ/ can appear as a coda in Mandarin, although some regional dialects such as Cantonese allow other consonants. All syllables used in the Mandarin tests included an initial consonant and a kernel vowel, with an optional medial and coda sound, with a level tone (tone 1), appearing as C(V)V(C)1.

An onset matching test of five trials and a rime matching test of five trials formed the matching tests in Mandarin. Given the time constraint in each testing session, only a small number of Mandarin trials were designed. Each trial consisted of three syllables and pictures. The presentation and design of the stimuli was as described for the English trials. The selection of foils was based solely on phonetic features in the onset or coda position, since consonant clusters do not exist in Mandarin. Trials contained some Mandarin-specific consonants and rimes. Successful completion received a score of 5 in each test.

2.3.2.3 Common Unit Tests in English

This test required the children to pronounce the shared phoneme explicitly in the onset position or in the coda position of the two words/ pictures presented via PowerPoint slides. See Table 2.3 for test instructions and examples. Each trial consisted of the same target word and its correct response (e.g., *soup* - *sack*), presented previously in the onset matching test and the coda matching test. In other words, each trial in the common unit test was the same trial in the matching test without the foil, accumulating the same total number of 15 trials in the onset position and 10 trials in the coda position. The same pictures and recordings were presented. Responses were transcribed on site. One point was given for each correct response, which could include an isolated phoneme with or without a following schwa, or an entire consonant cluster with or without a following schwa. Examples of test items and instructions are given in Table 2.3 and Figure 2.1.

2.3.2.4 Common Unit Tests in Mandarin

The test consisted of the same trials as the matching tests in Mandarin, but without the foil. There were 5 trials in the onset common unit test and 5 trials in the rime common unit test. Responses were also transcribed and scored on site.

2.3.3 Phase I Training and Control Activities

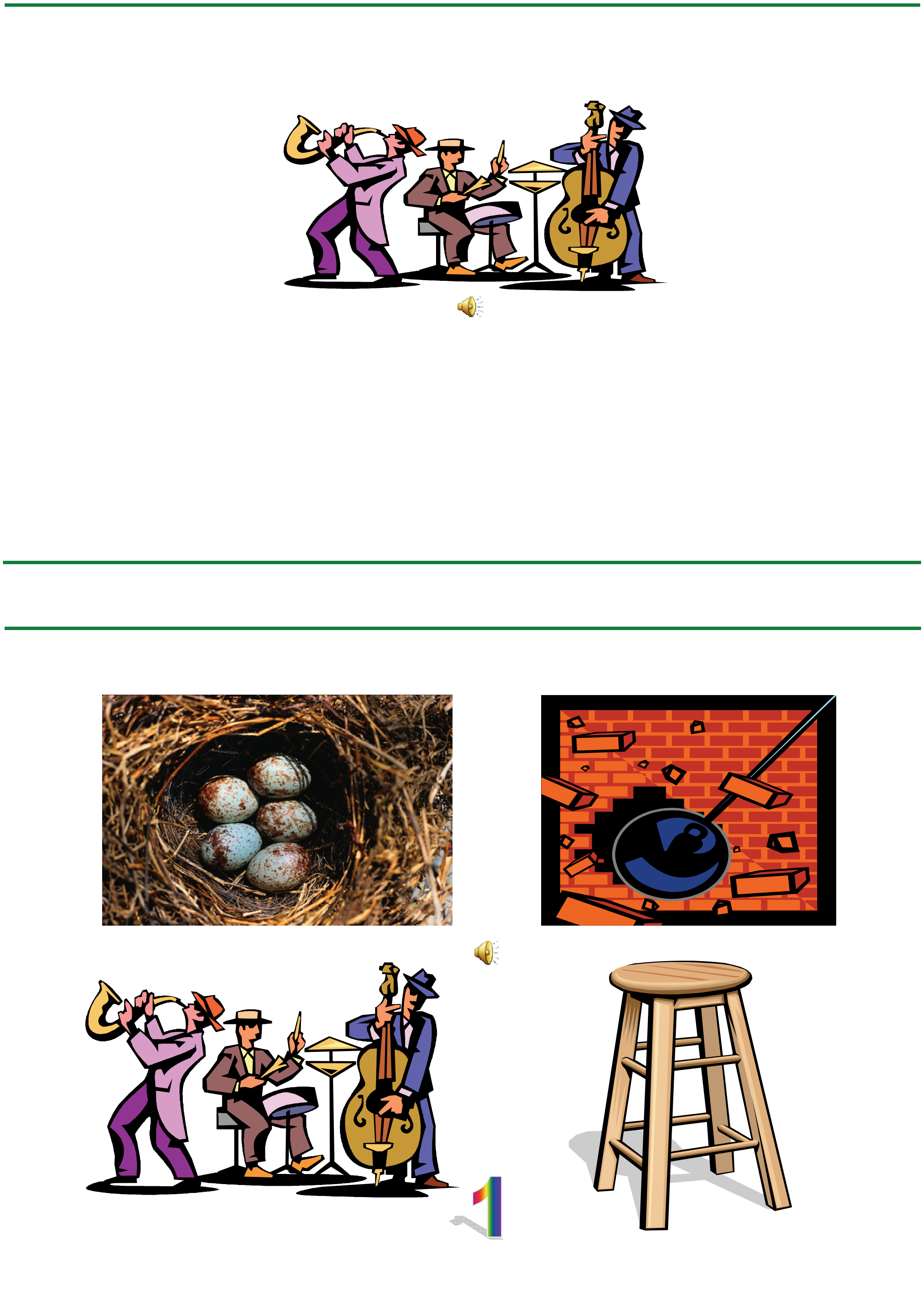
The third session was devoted to a series of computer-assisted activities, involving either the perceptual-based intervention, production-based intervention, or number activities, depending upon the group to which the child was randomly assigned. This session lasted for 40 minutes to an hour. The child’s responses during all the training activities were not scored.

2.3.3.1 Perceptual-Based Intervention

The purpose of perceptual-based intervention was to emphasize the saliency of four English consonant clusters perceptually through the introduction of four words: *band, nest, brick,* and *stool*. The word selection process was based on the following criteria. First, the monosyllabic word contained an onset cluster (i.e., CCVC) or a coda cluster (i.e., CVCC). Second, the words were expected to be unfamiliar to most children. Finally, the words must be concrete nouns which can be represented through pictures. Three tasks were involved in this session: a word learning task, a word discrimination task, and a word identification task. Subjects were seated in front of a laptop computer, wearing headphones.

2.3.3.1.1 Word learning task. A word learning task was used for teaching comprehension of four stimulus words: *band, nest, brick and stool*. Two steps were involved: an introduction step and a familiarization step. In the introduction step, each word was introduced with a matching picture and a sound file presented on the PowerPoint slide, recorded by a female Canadian English speaker (Figure 2.2, top). No orthography was presented. Word meaning was conveyed by the picture or explained by the experimenter in Mandarin. After the sound file was played twice with its matching picture, it was then played 10 consecutive times in 10 different slides with all four pictures (Figure 2.2, bottom) in order to familiarize the children with the target word, which was the familiarization step. The participant was instructed to listen to the target word and point to the matching picture among four. Since the same audio target appeared 10 times in 10 continuous slides to familiarize subjects with the vocabulary, the position of the target word's matching picture varied in slides so that participants had to concentrate on keeping track of the matching picture. This procedure was repeated for the other three words, with the order being *band, nest, brick,* and *stool*. Oral feedback was given after each response. If the child pointed to the wrong picture, he or she was brought back to the initial slide to learn the sounds of the target and its corresponding picture, and then brought back to the task.

Figure 2.2. Examples of the word learning task. Initial introduction (top: *band*) and the familiarization (bottom: *band*).



2.3.3.1.2 Word discrimination task. The purpose of the word discrimination task was to train the participant to attend to phonetic differences in two words presented aurally. The children's task was to discriminate between whether the two spoken stimuli were the 'same' or 'different'. The same four target words were used. Ten trials were involved for each target. Half of them were correct- correct pairs, and another half were correct- foil pairs. These pairs were constructed with one of five correct articulations and one of five foils. For example, for the target word *stool*, five correct recordings of /stul/ and five foils /tul/, /sul/, /ʃtul/, /spul/, /ʧul/ were paired with the target in a random order (Table 2.4). This task was administered via a teacher character who teaches the target word to a student character on PowerPoint slides. The student character mimics the target word by saying either the correct /stul/ (correct- correct pair) or one of the foils, e.g., /sul/ (correct- foil pair). The child was instructed to be the judge, deciding if the student on the computer screen is saying the same word as the teacher character or not. The teacher-student setting was shown in Figure 2.3. All the recordings, correct and foils included, were from the same female Canadian English speaker as previous tasks. Ten trials or slides for each target were presented in the order of *band*, *nest, brick,* and *stool*. Feedback was given following the child's response. If children failed to discriminate what the teacher and student said, they were instructed to listen again, with some perceptual hints such as "Did you hear the hissing sound /s/ at the beginning?"

2.3.3.1.3 Word identification task. This task trained participants to identify if the spoken stimulus corresponded to one of the same target words, *band, nest,* *brick,* and *stool* learned in the previous task. Children were presented with an audio stimulus input of either a target or a foil through the headphone. They were then instructed to click to the matching picture or the "X" key of the computer screen (Figure 2.4). An X indicated a wrong match, while the matching picture should correspond to the correct target. The picture on the left panel served as a reinforcer which changed after each clicking response. This task was presented through Speech Assessment and Interactive Learning System (SAILS, Version 1.2), with 10 consecutive stimuli, correct and foils included, for each target. These stimuli were presented randomly. The children were expected to have learned the four target words already so that they would be able to match the spoken stimulus to their mental representation of this word. The experimenter first confirmed that the participant still remembered these words. If they did not, they were brought back to the initial slides of word learning task to listen to the target again. Oral feedback was provided right after the child's responses. If the participant matched incorrectly, they were instructed to attend to the perceptual information and listen again. If the matching still failed, confirmation was obtained that the child still remembered the target. Word learning slides were brought back as a reminder if necessary.

Table 2.4

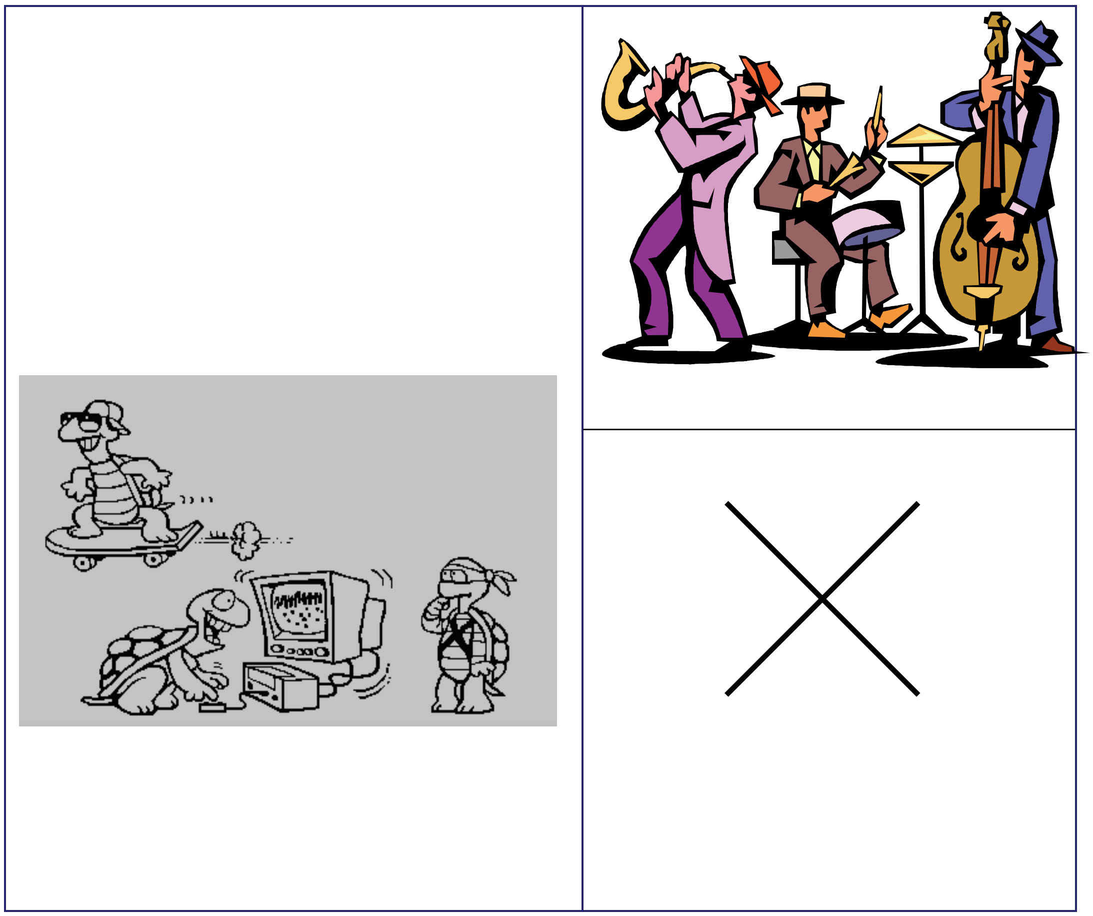
Targets and Foils in the Word Discrimination Task

Target[a]	Foils[b]
band	/bæd/ /bæn/ /bænt/ /bæst/ /bæld/
nest	/nɛs/ /nɛt/ /nɛsd/ /nɛnt/ /nɛs/ /nɛts/
brick	/rɪk/ /bɪk/ /blɪk/ /prɪk/ /plɪk/
stool	/tul/ /sul/ /ʃtul/ /spul/ /ʧul/

Note. [a]Produced by the teacher and the student. [b]Produced by the student only.

Figure 2.3. Example of the word discrimination task: *band – band*.

Figure 2.4. Example of the Layout of SAILS.



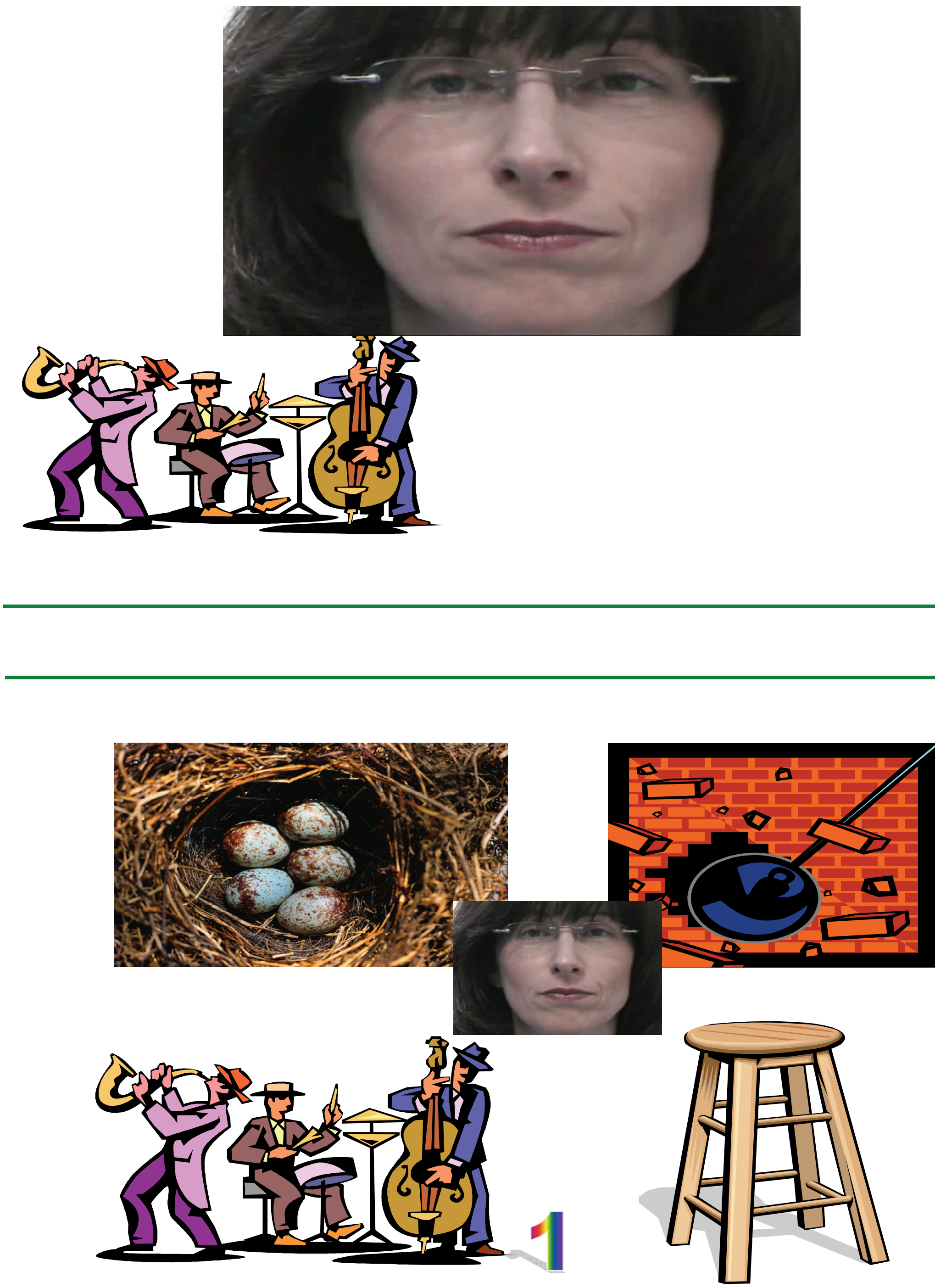
2.3.3.2 Production-Based Intervention

The purpose of the production-based intervention was to familiarize the participants in this group with four English consonant clusters through the introduction and articulation of four words: *band, nest, brick*, and *stool*. Activities included a word articulation task and a word learning task. The participant was seated in front of a laptop computer, wearing headphones.

2.3.3.2.1 Word articulation task. The participant learned to articulate target words in this task. The child was initially introduced to four English words with matching pictures on the computer screen. After all the pictures were explained in Mandarin, the child was presented with a video clip of the first target word, along with its matching picture (Figure 2.5, top). A female Canadian English speaker, the same as for the perception training audio materials, was filmed with the focus on her face. She slowly articulated the target word twice, with approximately three seconds' pause in between. The participant was instructed to observe and imitate articulation of the word. Each video clip would prompt two attempts of imitation. After the introduction, each clip was played five times for familiarization purposes, leading to 10 articulation attempts for each target word.

The oral feedback provided by the experimenter was restricted to hints pertaining to oral gestures and their imitation. For example, following the child's misarticulation of *band* as *ban*, the experimenter would respond, "You didn't tap your tongue at the end." with a repetition of the missed target segment or the entire target word.

Figure 2.5. Example of the word articulation task (top: *band*) and the word learning task (bottom: *band*).



2.3.3.2.2 Word learning task. This task was similar to the word learning task from the perceptual-based intervention. Each target word was presented via a video clip in the middle, with four pictures on the screen (Figure 2.5, bottom). The participant was instructed to watch the video and imitate the articulation, and then point to the matching picture of this target. Each target was presented 10 times in 10 consecutive slides. To keep the children's interest, the position of the matching picture again varied in each slide. If the child failed to match the video and the picture, they would be reminded again using the initial slides from the word articulation task in which a matching picture and its video clip were presented together. The child was prompted to imitate and repeat after the clip 10 times in total for each target. Oral feedback was provided following misarticulation.

2.3.3.3 Phase I Control Activities- Number Knowledge

In accordance with other computerized activities in perceptual-based or production-based intervention in this session, participants randomly assigned to receive control activities in this phase participated in four computer games. All these games, designed for children, were about numbers and were downloaded from various locations on the Internet. A sheep game required the child to move sheep from one ranch to another until the destination ranch reached its required number of sheep shown on the screen. A garden count game involved looking for and then counting a certain object hidden in the garden. A peacock feather counter game followed, in which the child had to match the fallen feather to the peacock's body using the same number indicated on the feather and the body. The last game involved a numbered frog on one side of the riverbank who tried to leap across the river upon floating leaves, each with a random number on it. Children were required to sequence the numbers, beginning with the one on the frog and clicking on the next number shown on the floating leaf. A successful sequence of a series of numbers helped the frog reach the other bank without falling into the river.

2.3.4 Phase II Training and Control Activities

Phase II training activities were administered after Phonological Awareness Test 2 (PA2). These included a session of English sound blending (the fifth session) and another session of English phonemic segmentation activities (the sixth). Each session lasted approximately one hour.

2.3.4.1 English Sound Blending

In this session, each child was required to learn to blend three-, four-, and five-phoneme English words (Table 2.5). This blending activity was conducted by unlocking three different treasure chests and assembling puzzle pieces inside to form words. Children were shown three locked treasure chests, labelled 1, 2, and 3 on the desk in front of them. They were instructed to unlock chest number 1, with any of three keys handed by the experimenter. The children were unaware that all three keys and locks were the same. They had to figure out how to open the padlock with any of the keys. Inside chest number 1 were four bundles of puzzle pieces. Each bundle contained three pieces, representing a three-phoneme word, including *bat, dog, ant,* or *ask*. A letter was written on each piece so that when the three pieces in each bundle interlocked successfully, they formed a three-phoneme English word. While children were putting pieces from a bundle together, a color-printed picture of the target word was presented by the experimenter to help the child associate foreign words with meaning. The meaning of the picture and the word was explained in Mandarin, and then the child was guided to blend the three sounds on the pieces together. For example, the experimenter pointed to each letter on the piece and in Mandarin said, “This is /b/; this is /æ/, and this one is /t/.” “What would it become if you blend /b/ /æ/ together?” If the child failed to blend /b/ and /æ/, the answer /bæ/ would be given. This procedure continued for each word until all bundles in chest number 1 were taken out, assembled, and then blended into words. Treasure chest number 2 contained six 4-phoneme words, all with clusters either in the onset or the coda position. These target words were *desk, nest, band, lift, mint, swing*. Similarly, a letter was written on each puzzle piece, except that the two letters –ng in swing appeared on one piece representing a single phoneme. The last chest contained six 5-phoneme words of *stools, plant, bricks, blink, blast, stamp*. Again, letter combinations representing a single phoneme appeared together on the same puzzle piece (i.e., -oo- and –ck). Children were required to finish all the puzzle pieces in the three treasure chests in order to complete the session and receive the toy.

All the puzzles could be successfully completed without knowledge of the English alphabet, since there was only one way to join the pieces. Children who had experience with the English alphabet might have been confused with letter-sound correspondences in some circumstances when learning to blend, such as the letter –i- pronounced as /ɪ/ in the word *blink*, and letter –e- as /ɛ/ in *desk*. When this occurred, children were told that individual letters such as –i- and –e- were sometimes read differently in English. This session also included the same target words *band, nest, brick,* and *stool*, previously taught in the perceptual-based and production-based intervention. However, not all the children who received this English sound blending session received perceptual-based or production-based intervention.

Table 2.5

Words in Both English Sound Blending and Phonemic Segmentation Tasks

Treasure Chest	Words
1. Three-Phoneme	*bat, dog, ant, ask*
2. Four-Phoneme	*desk, nest*[a]*, band*[a]*, lift, mint, swing*
3. Five-Phoneme	*stools*[b]*, plant, bricks*[b]*, blink, blast, stamp*

Note. [a]Appeared in Phase I training. [b]Appeared in Phase I training as singular forms.

2.3.4.2 English Phonemic Segmentation

Each child learned to segment the same English words used in the blending exercise in the previous session. They were first presented with several colored wooden cubes and were then presented with a color-printed picture with its pronunciation given by the experimenter. The activity started with three-phoneme words. No orthography was presented. Their task was to produce 'robot speech' by repeating each presented word very slowly, as if spoken by a robot. Meanwhile, the child was instructed to move a wooden cube for each sound segment uttered to a designated place. Having finished the word, all the cubes should therefore have been moved. For the three-phoneme words, children were given three cubes of different colors, four cubes for four-phoneme words, and five cubes for five-phoneme words.

This session appeared to be the most difficult of all the training activities. While the robot speech was expected to lead to successful segmentation, children tended to segment the word in their own way. Instead of saying b-a-t, some would say an elongated "ba-" followed by –t, or "de-" followed by -s-k in *desk*, thus leaving a wooden cube behind. Children were told that ba- or de- is blended from two sounds, not a single unit. Conversely, in cases such as the word *bricks*, some children were aware that two cubes were involved in br-, but they appeared to have difficulty in further segmenting br- into a b- and an -r.

2.3.4.3 Phase II Control Activities

Two control activities related to puzzles and wooden cubes were designed for this phase, in parallel with the English sound blending session and the English phonemic segmentation session respectively. In the fifth session, children were presented with a box of puzzle pieces with an English letter on each piece. Successful sequencing of the puzzle pieces could be accomplished independent of limited alphabet knowledge to generate a caterpillar. A complete caterpillar with letters on it, printed on the puzzle box, was also available if the child preferred to follow the model. Letters were not explicitly taught to the children; however, it was natural for those who recognized the letter to name it while sequencing it. Children who had no or little knowledge of the English alphabet tended to follow the model to complete the sequence. Naming of letters by the experimenter occurred on occasion.

In the sixth session, a letter matching activity was introduced. The aim of the activity was to match the letter shown on the playing card to that on the wooden cube. The child was presented with a variety of colored wooden cubes on the desk and a pile of playing cards in the experimenter's hand, all with either an upper or lower case letter from A-Z on it. The child's task was to pick a card randomly from the experimenter and look for the same printed letter on wooden cubes. Letters were not explicitly taught, though naming in the process of the game was natural and inevitable. The game was terminated when all the cards were selected and matched to the cubes. The completion of this activity was independent of limited knowledge of alphabet, since matching could rely on the shapes and curves of the letter.

RESULTS

The results of the language assessment and the three Phonological Awareness Tests (PA1, PA2, and PA3) are presented in this chapter. A language assessment and PA1 were administered in the first session and the results of these are presented first. Moreover, this chapter includes a section describing Phase I intervention effects, a section detailing Phase II intervention effects and a final section involving item analysis. In the section involving Phase I intervention effects, prior to discussing changes from Time 1 to Time 2, between-group differences in PA2 test performance will be examined. Similarly, in the following section, between-group differences in PA3 test performance will be examined first, followed by the analysis of intervention effects from Time 1 to Time 3. In the final section, English common unit subtest performance will further be discussed by item.

3.1 Language Assessment

A one-way ANOVA was used to examine between-group differences in performance on three language ability tests. No statistically significant differences were observed for English receptive vocabulary score, Mandarin PPVT raw score, and Phonetic Symbol Recognition and Blending test score as shown in Table 3.1.

3.2 Phonological Awareness Test 1

A one-way ANOVA was used to examine between-group differences in PA1 scores, considering the test in each language separately. The maximum score on the English onset matching test and the English onset common unit test was 15 for each of these subtests. The maximum score for the English coda matching and the English coda common unit test was 10 for each these subtests. These four subtests constitute the English PA1 test, with a maximum total score of 50 points. The maximum score was 5 for each of the Mandarin subtests: the Mandarin onset matching test, the Mandarin onset common unit test, the Mandarin rime matching test and the Mandarin rime common unit test, constituting the Mandarin PA1 test, with a maximum total score of 20 points. When examining the mean obtained scores on PA1 in English, results showed no significant between-group differences, $F\,(3, 54) = .34$, $p = .79$, or in Mandarin, $F\,(3, 54) = .22$, $p = .88$, as illustrated Figure 3.1. Similarly, no between-group differences were observed for performance on the four different subtests of the English or Mandarin PA1 tests, as detailed in Tables 3.2 and 3.3 respectively.

Within each group, mean scores were higher in English matching tests than in English common unit tests in the onset position [$t(12) = 11.4$, $p < .0005$; $t(15) = 8.08$, $p < .0005$; $t(14) = 10.5$, $p < .0005$; $t(13) = 10.08$, $p < .0005$ for Group 1, 2, 3, and 4 respectively] and in the coda [$t(12) = 7.33$, $p < .0005$; $t(15) = 6.67$, $p < .0005$; $t(14) = 10.46$, $p < .0005$; $t(13) = 6.54$, $p < .0005$ for Group 1, 2, 3, and 4 respectively]. In Mandarin, Group 1 performance was not statistically different in onset matching versus the onset common unit test [$t(12) = 1.26$, $p = .23$] nor in rime matching versus the rime common unit test [$t(12) = 1.83$, $p = .09$]. Group 2 had a marginally higher score in the Mandarin onset matching than in the Mandarin onset common unit [$t(15) = 2.07$, $p = .056$], but scored significantly higher in the Mandarin rime matching than in the Mandarin rime common unit [$t(15) = 2.63$, $p = .02$]. Groups 3 and 4 gained a significantly higher score in

Mandarin onset matching [$t(14) = 2.48$, $p = .03$; $t(13) = 3.18$, $p = .007$] and rime matching [$t(14) = 2.35$, $p = .03$; $t(13) = 2.92$, $p = .01$] than in the Mandarin common unit tests.

Overall, these analyses indicate that the randomization procedure resulted in four groups equally matched with respect to language and phonological awareness skills in English and in Mandarin. Phase I intervention effects as a function of group will be considered in the next section.

Table 3.1

Mean (Standard Deviation) Scores for English and Mandarin Vocabulary, and Phonetic Symbol Recognition and Blending Test by Group

	Group 1	Group 2	Group 3	Group 4	*F*	*p*
English Vocabulary	24.0	15.3	21.3	16.9	1.45	.238
	(11.6)	(14.0)	(9.1)	(14.6)		
Mandarin PPVT	68.0	64.4	73.5	65.6	.82	.489
	(20.1)	(16.9)	(15.3)	(16.8)		
Phonetic Symbol[a]	11.2	10.1	11.3	9.9	.238	.869
	(5.5)	(5.5)	(5.2)	(6.0)		

Note. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. [a]Phonetic Symbol = Phonetic Symbol Recognition and Blending Test. [a]Maximum Score = 15. In order, *n* = 13, 16, 15, 14.

Figure 3.1. Mean total score on English and Mandarin Phonological Awareness Test 1, by group. Maximum English score = 50; maximum Mandarin score = 20. Standard error bars shown.

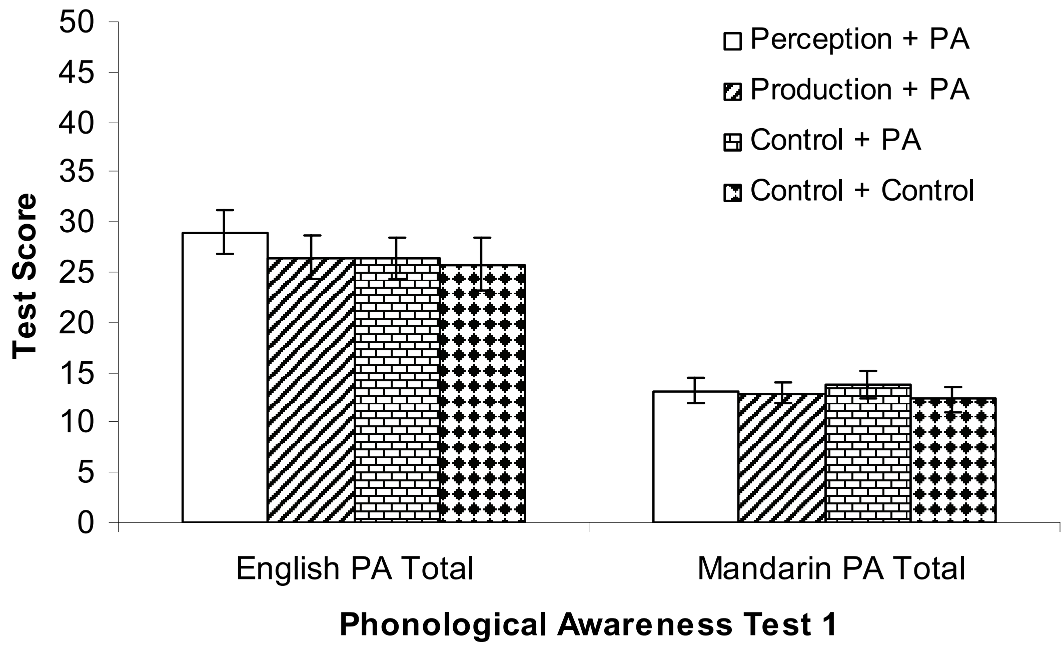


Table 3.2

Mean (Standard Deviation) Number of Correct Responses on English Phonological Awareness Test 1 by Group and Subtest

		Group 1	Group 2	Group 3	Group 4	*F*	*p*
Matching	Onset[a]	11.92	10.94	11.33	11.43	.376	.771
		(2.69)	(2.41)	(2.26)	(2.65)		
	Coda[b]	8.46	7.75	8.33	7.64	.877	.459
		(1.51)	(1.53)	(1.80)	(1.74)		
Common	Onset[a]	3.31	3.25	1.73	3.07	.467	.706
Unit		(3.43)	(4.60)	(3.99)	(4.55)		
	Coda[b]	5.23	4.5	5	3.64	1.531	.217
		(1.79)	(2)	(1.65)	(2.84)		

Note. [a]Maximum score = 15. [b]Maximum score = 10. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. In order, n = 13, 16, 15, 14.

Table 3.3

Mean (Standard Deviation) Number of Correct Responses on Mandarin Phonological Awareness Test 1 by Group and Subtest

		Group 1	Group 2	Group 3	Group 4	*F*	*p*
Matching	Onset[a]	4.08	3.88	4.07	4	.127	.943
		(1.12)	(1.09)	(.96)	(.88)		
	Rime[a]	3.46	4	4.2	4.07	1.317	.278
		(1.2)	(.89)	(1.15)	(.92)		
Common Unit	Onset[a]	3.31	2.44	2.6	2	.765	.518
		(2.32)	(2.25)	(2.23)	(2.32)		
	Rime[a]	2.31	2.63	2.87	2.21	.260	.854
		(2.18)	(2.03)	(2.29)	(2.42)		

Note. [a]Maximum score = 5. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. In order, n = 13, 16, 15, 14.

3.3 Phase I Intervention Effects

3.3.1 Phonological Awareness Test 2

During Phase I, children in the experimental conditions received a single intervention session designed to improve their phonetic knowledge of specific English onset and coda clusters. Group 1 received a perceptually focused intervention (Perception + PA) and Group 2 received a production focused intervention (Production + PA). The two control groups received a single session of number activities. During the subsequent week the children's phonological awareness skills were reassessed with PA2. The test performance within PA2 itself was examined.

A one-way ANOVA revealed no significant differences in PA2 test scores in English, $F(3, 54) = .17$, $p = .92$, or Mandarin, $F(3, 54) = .274$, $p = .84$, as illustrated in Figure 3.2. No between-group differences in subtest scores were observed at Time 2 either, as detailed in Table 3.4 for the English PA2 and in Table 3.5 for Mandarin PA2.

A more adequate assessment of change in phonological awareness test performance due to this brief intervention was obtained by using a repeated measures ANOVA and taking appropriate covariates into account however. Specifically, between-group differences in the amount of change in scores from Time 1 to Time 2 were assessed, after accounting for the covariates described in the next section. A repeated measures analysis ideally is not applied to unbalanced designs (i.e., unequal group sizes). In reality, however, unbalanced designs arise due to various factors. In dealing with this, authors such as Maxwell and Delaney

(1990) and Howell (2002) recommend the use of Type III Sum of Squares, and these are the default settings in the statistical software SPSS (Landau & Everitt, 2004) used in the present analyses.

Figure 3.2. Mean total score on English and Mandarin Phonological Awareness Test 2, by group. Maximum English score = 50; maximum Mandarin score = 20. Standard error bars shown.

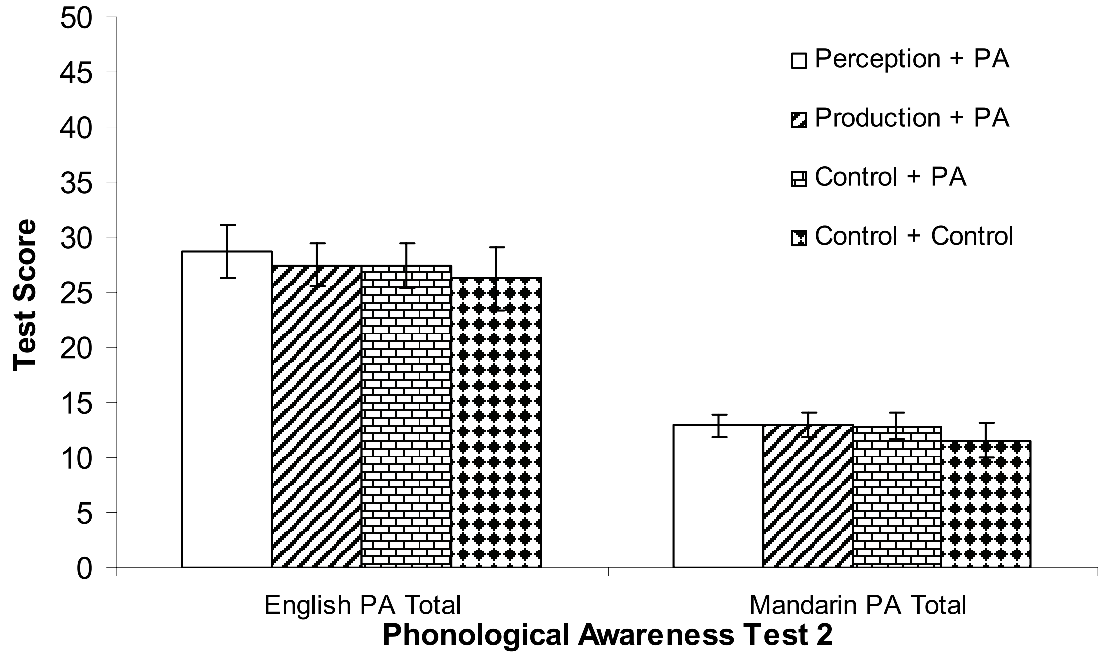


Table 3.4

Mean (Standard Deviation) Number of Correct Responses on English Phonological Awareness Test 2 by Group and by Subtest

		Group 1	Group 2	Group 3	Group 4	*F*	*p*
Matching	Onset[a]	11.54	11	11	10.71	.22	.88
		(2.18)	(2.37)	(2.78)	(3.20)		
	Coda[b]	8.31	8.38	9.07	7.93	1.03	.39
		(1.93)	(1.54)	(1.67)	(2.02)		
Common	Onset[a]	4	3.88	2.47	3.07	.36	.78
Unit		(4.67)	(4.44)	(4.19)	(5.08)		
	Coda[b]	4.85	4.25	4.87	4.57	.32	.81
		(1.63)	(1.69)	(1.73)	(2.77)		

Note. [a]Maximum score = 15. [b]Maximum score = 10. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. In order, *n* = 13, 16, 15, 14.

Table 3.5

Mean (Standard Deviation) Number of Correct Responses on Mandarin Phonological Awareness Test 2 by Group and by Subtest

		Group 1	Group 2	Group 3	Group 4	*F*	*p*
Matching	Onset[a]	4	3.81	3.67	3.64	.35	.79
		(.91)	(.98)	(.90)	(1.28)		
	Rime[a]	3.62	4	4.2	3.71	1.29	.29
		(.96)	(.73)	(.77)	(1.07)		
Common	Onset[a]	3	2.5	2.6	2.36	.20	.90
Unit		(1.91)	(2.28)	(2.29)	(2.47)		
	Rime[a]	2.31	2.62	2.4	1.86	.37	.78
		(1.93)	(2.06)	(2.13)	(2.03)		

Note. [a]Maximum score = 5. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. In order, *n* = 13, 16, 15, 14.

3.3.2 Choice of Covariates

Before conducting analyses to examine between-group differences across different time points in phonological awareness test (PA1, 2, 3) performance as a function of intervention condition, it was necessary to determine if the phonological awareness test scores should be corrected for certain subject factors. Four factors were considered as potential covariates in examining intervention effects: Mandarin receptive vocabulary score, English receptive vocabulary score, age, and Phonetic Symbol Recognition and Blending Test score. These candidates were assessed according to the following criteria for selecting (or rejecting) factors as covariates in the repeated measures analysis: (1) a suitable covariate must be correlated with the dependent variables PA1, 2 and 3; (2) a suitable covariate must be linearly related to the dependent variables; and (3) the regression slopes between a suitable covariate and the dependent variables must be constant across treatment conditions (i.e., groups).

A correlation analysis was first conducted to examine relationships between dependent variables (three phonological awareness test scores) and each covariate candidate (Table 3.6). The age factor was not correlated with any of the dependent variables and was ruled out of further analyses. There was a high degree of correlation between English vocabulary, Phonetic Symbol Recognition and Blending and all three dependent variables at alpha level $p < .01$. There was a less strong correlation between the Mandarin vocabulary score and the last phonological awareness assessment, $r(56) = .312$, $p = .017$.

Table 3.6

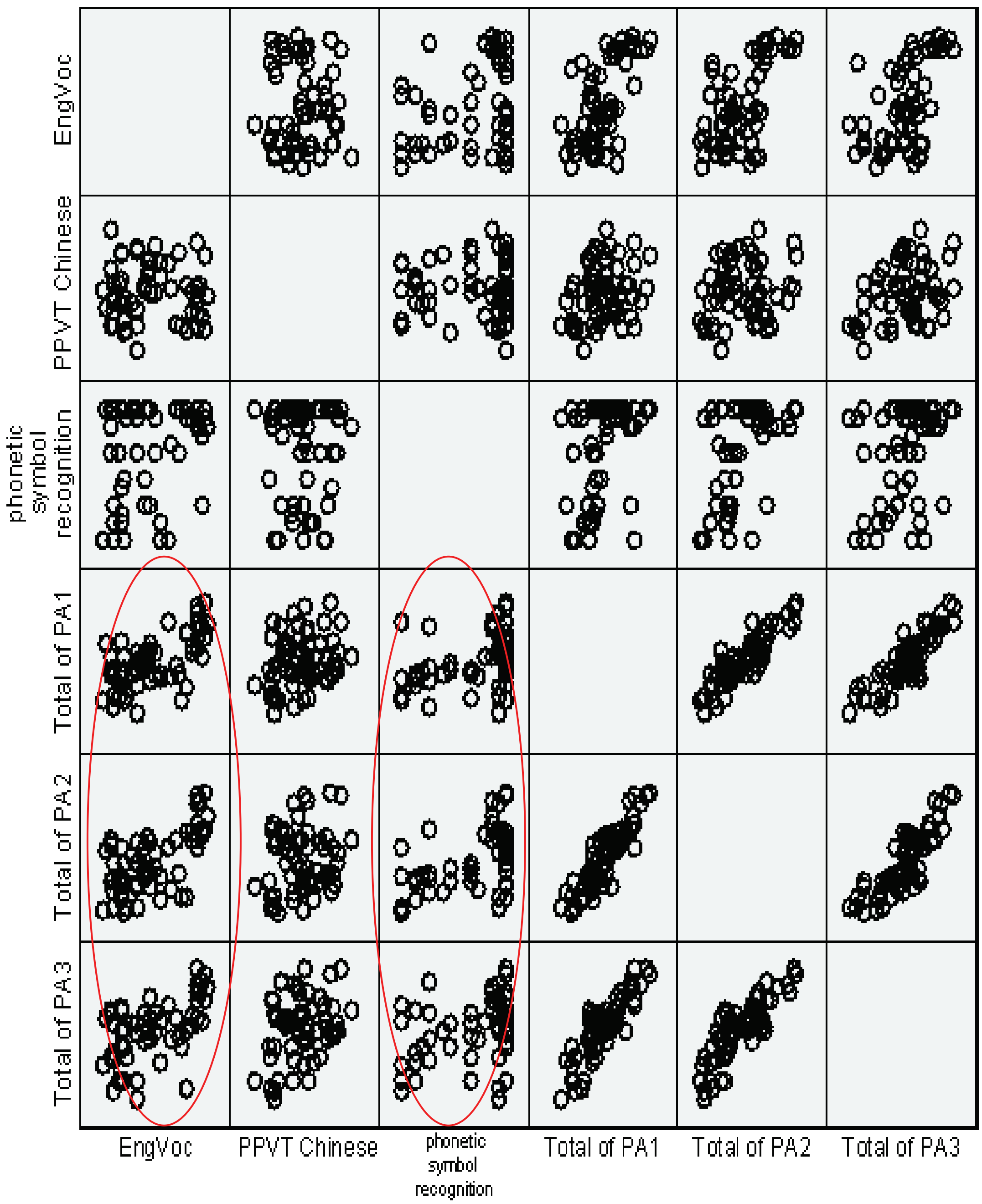
Correlations between Covariate Candidates and Dependent Variables

	1	2	3	4	5	6	7
1. Age	--	-.345**	.356**	-.210	-.133	-.178	.069
2. English Vocabulary		--	-.061	.333*	.633**	.638**	.551**
3. Mandarin Vocabulary			--	-.069	.248	.193	.312*
4. Phonetic Symbol[a]				--	.394**	.497**	.341**
5. PA1 Total					--	.897**	.857**
6. PA2 Total						--	.852**
7. PA3 Total							--

Note. **. Correlation is significant at the 0.01 level (2-tailed).

*. Correlation is significant at the 0.05 level (2-tailed). [a]Phonetic Symbol = Phonetic Symbol Recognition and Blending Test.

Figure 3.3. *Scatterplot for test of linearity between covariate candidates and dependent variable.*



Two critical tests of assumption for ANCOVA, a test of linearity and a test of homogeneity of regression slope, were then computed to examine the three remaining factors – Mandarin vocabulary score, English vocabulary score, and Phonetic Symbol Recognition and Blending score. The test of linearity results are shown in Figure 3.3 which shows the scatterplot matrix of dependent variables and covariate candidates. In this graph, English vocabulary comprehension and PA1, PA2, and PA3 were relatively linear; Phonetic Symbol Recognition and Blending also displayed some linearity. Curve estimation analysis showed that the linearity fit was significant for English vocabulary at each time point with $F(1, 56) = 37.42$, $p < .0005$, $R^2 = .401$ for PA1, $F(1, 56) = 38.38$, $p < .0005$, $R^2 = .407$, for PA2, and $F(1, 56) = 24.47$, $p <.0005$, $R^2 = .304$ for PA3. The linearity fit between the Phonetic Symbol Recognition and Blending score and PA1, PA2, and PA3 was also found to be significant, with $F(1, 56) = 10.28$, $p = .002$, $R^2 = .155$ for PA1, $F(1, 56) = 18.40$, $p< .0005$, $R^2 = .247$ for PA2, $F(1, 56) = 7.36$, $p = .009$, $R^2 = .116$ respectively. The regression slope of Mandarin vocabulary with dependent variables, however, did not fit a linearity curve significantly at the alpha level of .01, with $F(1, 56) = 3.65$, $p = .061$, $R^2 = .061$ for PA1, $F(1, 56) = 2.17$, $p = .146$, $R^2 = .037$ for PA2, $F(1, 56) = 6.05$, $p = .017$, $R^2 = .097$ for PA3. Thus, Mandarin vocabulary was ruled out as a covariate after being examined by this analysis.

The final assumption test, homogeneity of regression slope, is concerned with the similarity of regression slopes between covariate candidates and the dependent variables across groups or treatment conditions. No interaction effect between the covariate candidates and the treatment condition should be found.

Given the dependent variables of PA1, PA2, and PA3, no significant interaction effect between the treatment condition or the grouping factor and the covariate candidates was found (Table 3.7). The assumption that regression slopes between covariates and dependent variables should not differ across groups was upheld by the factors of English vocabulary score and Phonetic Symbol Recognition and Blending Test score.

In summary, among four covariate candidates, age and Mandarin vocabulary were ruled out in a correlation analysis and a test of linearity respectively. English vocabulary and Phonetic Symbol Recognition and Blending skills both remained as legitimate covariates after being examined by three tests.

For all analyses across three time points described in the following sections, both covariates were entered in the statistical analyses of overall phonological awareness scores in both languages. To best address language specific issues, only English vocabulary was entered as the covariate for all analyses of English phonological awareness tests. Only the Phonetic Symbol Recognition and Blending factor was entered as the covariate in all analyses of Mandarin phonological awareness tests.

Table 3.7

Interaction Effects between the Grouping Factor and Covariate Candidates

	PA1		PA2		PA3	
	F	*P*	*F*	*p*	*F*	*p*
Grouping*Phonetic	1.20	.32	1.63	.20	1.26	.30
Grouping*EngVoc	.09	.97	.30	.82	.17	.92

Note. Phonetic = Phonetic Symbol Recognition and Blending test score. EngVoc = English Vocabulary test score.

3.3.3 Change from Time 1 to Time 2

A two factor mixed effects ANCOVA was conducted to examine between-group differences in the amount of change in phonological awareness test scores from Time 1 (PA1) to Time 2 (PA2). With this analysis an interaction of Time x Group would suggest a significant training effect. The results of this analysis are reported for total PA test score, English PA test score and Mandarin PA test score separately.

3.3.3.1 Total PA Test Score

First, a 2 (Time) x 4 (Group) ANCOVA, with English vocabulary and Mandarin Phonetic Recognition and Blending being the covariates, was conducted to examine change in total PA test scores from Time 1 to Time 2 as a function of group. No significant effects were observed for Time, $F(1,52) = 1.88$, $p = .176$, or for Group, $F(3,52) = .55$, $p = .065$. Furthermore, no significant effect of Time x Group was observed, $F(3,52) = .239$, $p = .868$.

3.3.3.2 English PA Test Score

Next, a 2 (Time) x 4 (Group) ANCOVA, with English vocabulary as the covariate, was conducted to examine change in English phonological awareness test scores from Time 1 to Time 2 as a function of group. The outcome was similar to that observed for total test score, with no significant effect of Time $F(1,53) = .031$, $p = .86$, or Group $F\ (3,53) = .654$, $p = .584$, and no significant Time x Group interaction $F(3,53) = .305$, $p = .821$.

3.3.3.3 Mandarin PA Test Score

Finally, a 2 (Time) x 4 (Group) ANCOVA, with Phonetic Symbol Recognition and Blending being the covariate, was conducted to examine change in Mandarin phonological awareness test scores from Time 1 to Time 2 as a function of group. Again, no significant effect of Time $F(1,53) = 3.389$, $p = .071$, or Group $F(3,53) = .153$, $p = .927$, was observed and there was no significant interaction of Time x Group, $F(3,53) = .46$, $p = .711$.

In summary, a session of perceptual-based or production-based intervention in this phase did not show a significant effect on the amount of change in phonological awareness test scores from Time 1 to Time 2.

3.4 Phase II Intervention Effects

3.4.1 Phonological Awareness Test 3

In Phase II, Groups 1, 2, and 3 received two sessions of phonemic awareness instruction; Group 4 played with alphabet puzzles as a control activity. In the final week of the study the children's phonological awareness skills were reassessed (PA3). The test performance within PA3 itself was examined in this section.

A one-way ANOVA revealed no significant between-group differences among mean PA3 scores in English, F (3, 54) = 1.75, p = .17, but planned comparisons showed significant differences between the Perception + PA group compared to the Control + Control group, as shown in Figure 3.4 (left). In the Mandarin tests, a significant group effect was found [F (3, 54) = 2.84, p = .046]. Planned comparisons revealed that each treatment group performed significantly better than the Control + Control group, as illustrated in Figure 3.4 (right).

Table 3.8 shows all subtest scores for PA3 in English along with the associated results of the one-way ANOVAs. In contrast to the results for the PA1 and PA2, a significant group effect was found for English onset matching and coda matching. Planned comparisons further showed that each of the treatment groups outperformed the Control + Control group for English onset matching and for English coda matching. There was no significant group effect for the English common unit tests however.

Table 3.9 shows all subtest scores for PA3 in Mandarin along with the associated results of the one-way ANOVAs. For the Mandarin tests, no significant between-group differences were observed for onset or rime subtests whether assessed through matching or common unit tasks.

Figure 3.4. Mean total score on English and Mandarin Phonological Awareness Test 3, by group. Maximum English score = 50; maximum Mandarin score = 20. Standard error bars shown. Significance at $p < .05$ marked with asterisk.

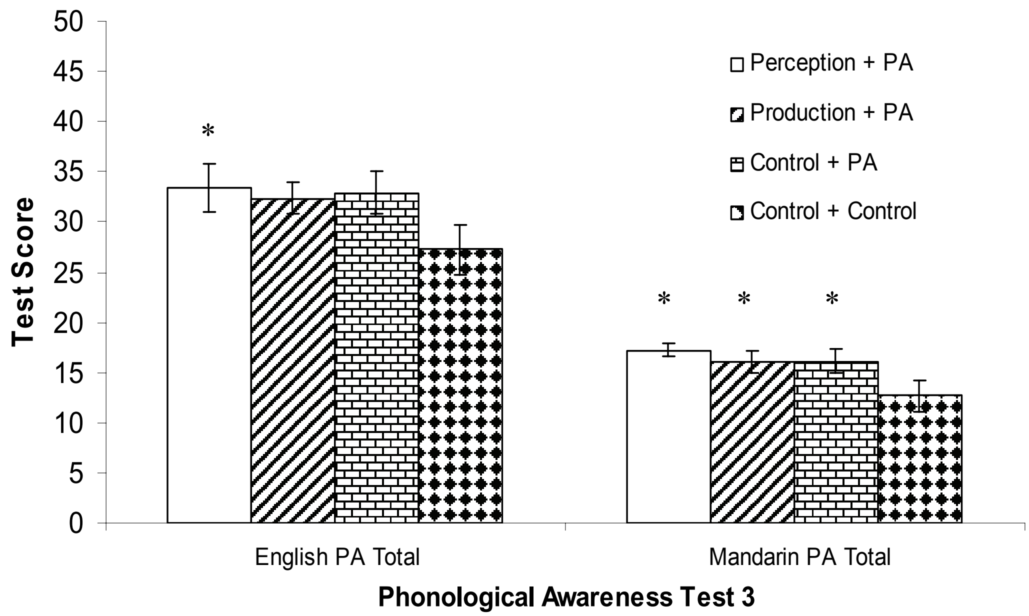


Table 3.8

Mean (Standard Deviation) Number of Correct Responses on English Phonological Awareness Test 3 by Group and Subtest

		Group 1	Group 2	Group 3	Group 4	*F*	*p*
Matching	Onset[a]	11.85_c	11.75_c	12.47_c	10_d	2.84	.046*
		(3.11)	(1.77)	(1.92)	(2.63)		
	Coda[b]	9.15_c	9.06_c	9.2_c	7.36_d	4.60	.006*
		(1.46)	(1.24)	(1.26)	(2.17)		
Common	Onset[a]	5.15	5	4.4	3	.64	.59
Unit		(4.49)	(4.76)	(4.34)	(4.77)		
	Coda[b]	7.23	6.56	6.87	6.86	.44	.73
		(1.3)	(1.03)	(2.13)	(1.56)		

Note. [a]Maximum score = 15. [b]Maximum score = 10. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. In order, *n* = 13, 16, 15, 14. **p* < .05. $_{cd}$Means with different subscripts differ significantly at *p* < .05 by the Least Significant Difference test.

Table 3.9

Mean (Standard Deviation) Number of Correct Responses on Mandarin Phonological Awareness Test 3 by Group and Subtest

		Group 1	Group 2	Group 3	Group 4	*F*	*p*
Matching	Onset[a]	4.08	3.88	4.2	3.43	1.21	.31
		(1.19)	(1.20)	(.77)	(1.40)		
	Rime[a]	4.46	4.63	4.53	4.07	1.47	.23
		(.88)	(.62)	(.83)	(.73)		
Common	Onset[a]	4.77	4	3.67	3	2.54	.065
Unit		(.44)	(1.46)	(2.06)	(2.18)		
	Rime[a]	3.92	3.5	3.73	2.14	2.58	.062
		(1.32)	(1.93)	(1.71)	(2.35)		

Note. [a]Maximum score = 5. Group 1 = Perception + PA, Group 2 = Production + PA, Group 3 = Control + PA, Group 4 = Control + Control. In order, $n = 13, 16, 15, 14$.

3.4.2 Change from Time 1 to Time 3

A two factor mixed effects ANCOVA was conducted to examine between-group differences in the amount of change in phonological awareness test scores from Time 1 (PA1) to Time 3 (PA3). With this analysis an interaction of Time by Group would suggest a significant training effect. The results of this analysis are reported for total PA test score, English PA test score and Mandarin PA test score separately. Planned comparisons were conducted by using a one-way ANCOVA to compare between-group estimated marginal means at Time 3 after controlling for Time 1 (PA1) and language assessment results.

3.4.2.1 Total PA Test Score

A 2 (Time) x 4 (Group) ANCOVA, with English Vocabulary and Phonetic Symbol Recognition and Blending entered as covariates, was conducted to assess change in total PA test score from Time 1 to Time 3. As shown in Figure 3.5, a significant effect of Time was revealed, $F(1,52) = 29.44$, $p < .0005$. There was no significant effect of Group, $F(3, 52) = .96$, $p = .417$, but there was a significant Group x Time interaction $F(3,52) = 5.99$, $p = .001$, reflecting greater change over time for the three treated groups in comparison to the Control + Control group. Estimated marginal means for total PA test score by group are reported in Table 3.10. Planned comparisons confirmed that the three experimental groups had significantly higher PA3 test performance than the Control + Control group after controlling for PA1 and language test performance at Time 1.

3.4.2.2 English PA Test Score

Next, a 2 (Time) x 4 (Group) ANCOVA, with English vocabulary as the covariate, was conducted to examine change in English phonological awareness test scores from Time 1 to Time 3 as a function of group. A significant effect of Time was revealed, $F(1, 53) = 38.52$, $p < .0005$. A significant effect of Group was not observed, $F(3, 53) = 1.071$, $p = .369$. A significant Group x Time interaction $F(3, 53) = 4.76$, $p = .005$ was found however, reflecting greater change over time for the three experimental groups in comparison to the Control + Control group. Estimated marginal means for total PA test score by group are reported in Table 3.10. Planned comparisons confirmed that the three experimental groups had significantly higher English PA3 test performance than the Control + Control group after controlling for English vocabulary and English PA1.

3.4.2.3 Mandarin PA Test Score

Finally, a 2 (Time) x 4 (Group) ANCOVA, with the Phonetic Symbol Recognition and Blending score being the covariate, was conducted to examine change in Mandarin phonological awareness test scores from Time 1 to Time 3 as a function of group. Again, a significant effect of Time was revealed, $F(1, 53) = 15.96$, $p = .0002$. No significant effect of Group was found, $F(3, 53) = 1.071$, $p = .369$. A significant Group x Time interaction $F(3, 53) = 3.728$, $p = .017$ was found, reflecting greater change over time for the three experimental groups in comparison to the Control + Control group. Planned comparisons confirmed that the three experimental groups had significantly higher Mandarin PA3 test performance than the Control + Control group after controlling for Phonetic Symbol Recognition and Blending and Mandarin PA1.

These analyses demonstrated that the phonemic awareness instruction was highly effective. The significant Time x Group interaction indicated that the children who received phonemic awareness instruction made greater improvements in phonological awareness score over time in comparison to the Control + Control group. Even though the intervention targeted a phonological structure that is specific to English phonology, significant improvements were observed in both English and Mandarin phonological awareness test performance. In the next section, differences in PA3 test performance will be examined for specific subtests, taking both languages and syllable positions (i.e., onset, coda/ rime) into account.

3.4.2.4 English Subtests

A one-way ANCOVA with Time 1 subtest performance and English vocabulary as the covariates was used to compare between-group performance at Time 3 for each subtest in the following order: English Onset Matching, English Coda Matching, English Onset Common Unit and English Coda Common Unit. A significant group effect was found for both the English onset matching, F (3, 52) = 4.57, p = .006 and the English coda matching tests, F (3, 52) = 4.24, p = .009, as shown in Figure 3.7. Planned comparisons showed that the Perception + PA, the Production + PA, and the Control + PA groups each outperformed the Control + Control significantly in both English onset matching (p = .045, .005, .001 respectively) and English coda matching (p = .013, .002, .006 respectively). In the English onset common unit subtest, a significant group effect was also found, F (3, 52) = 3.10, p = .03. Planned comparisons showed that the Production + PA, and the Control + PA outperformed the Control + Control significantly (p = .02, .009 respectively), but the Perception + PA did not significantly outperform the Control + Control statistically (p = .075), as shown in Figure 3.7. For the English coda common unit test, there was no significant group effect following training, F (3, 52) = .96, p = .42.

3.4.2.5 Mandarin Subtests

A one-way ANCOVA with Time 1 subtest performance and Phonetic Symbol Recognition and Blending as the covariates was used to compare between-group performance at Time 3 for each subtest in the following order: Mandarin Onset Matching, Mandarin Rime Matching, Mandarin Onset Common Unit and Mandarin Rime Common Unit. No significant group effect was found in Mandarin onset matching, F (3, 52) = 1.05, p = .38, in Mandarin rime matching, F (3, 52) = 1.47, p = .23, or in Mandarin onset common unit, F (3, 52) = 2.12, p = .11. For the Mandarin rime common unit test, a significant group effect was found, F (3, 52) = 3.91, p = .01. Planned comparisons showed that the Perception + PA, Production + PA and Control + PA outperformed the Control + Control significantly (p = .002, .021, .02 respectively). The performance of Mandarin subtests was shown in Figure 3.8.

In summary, following Phase II phonemic awareness intervention, an overall improvement in total PA3 test score, English PA3 test score, and Mandarin PA3 test score was found, after taking PA1 and language assessment covariates into consideration. Specifically, the children showed a significant improvement in English onset matching, English coda matching, and English onset common unit subtest performance. Conversely, children showed a significant improvement only in rime common unit subtest performance among all the Mandarin subtests.

Figure 3.5. Mean total score on PA1 (tested at Time 1) and PA3 (tested at Time 3), by group.

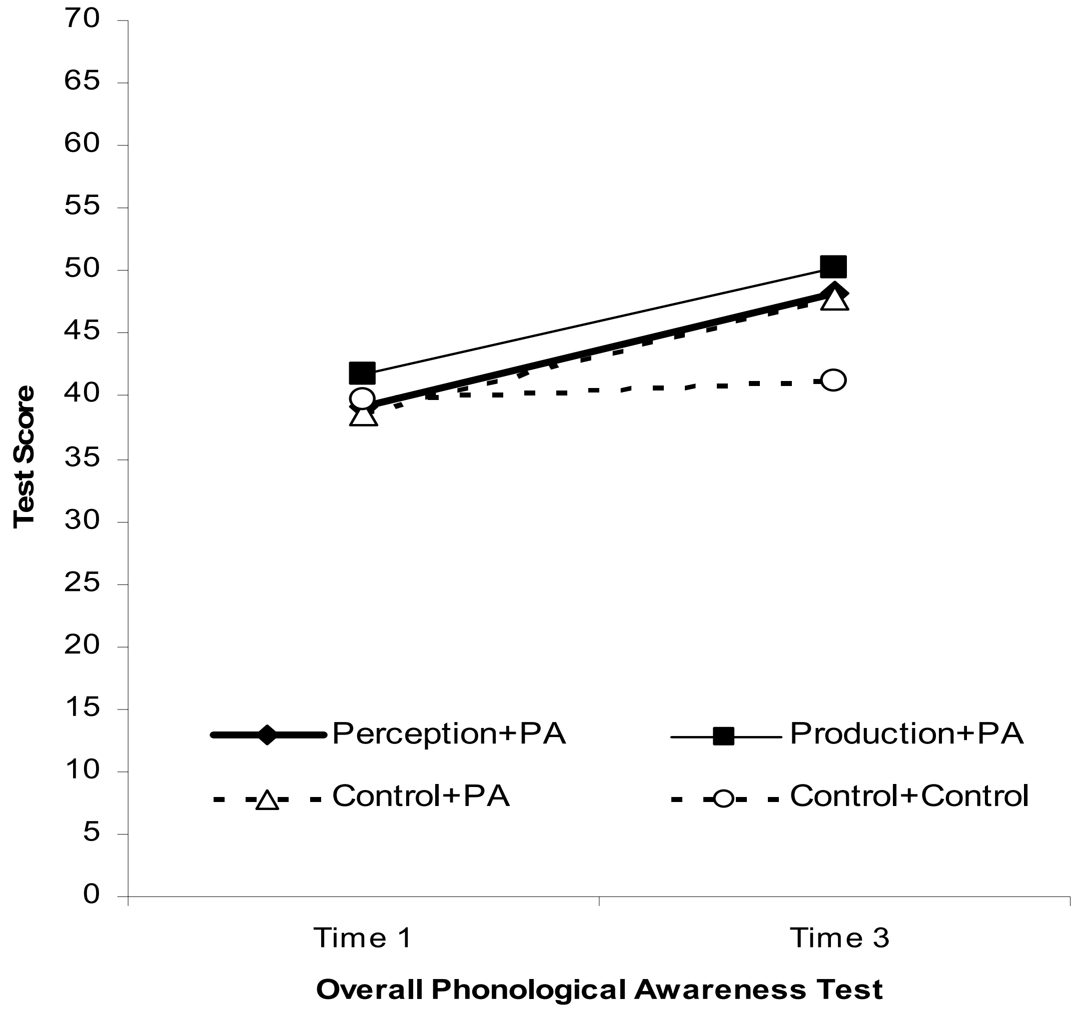


Figure 3.6. Mean total score on English (top) and Mandarin (bottom) Phonological Awareness Tests at Time 1 and Time 3, by group.

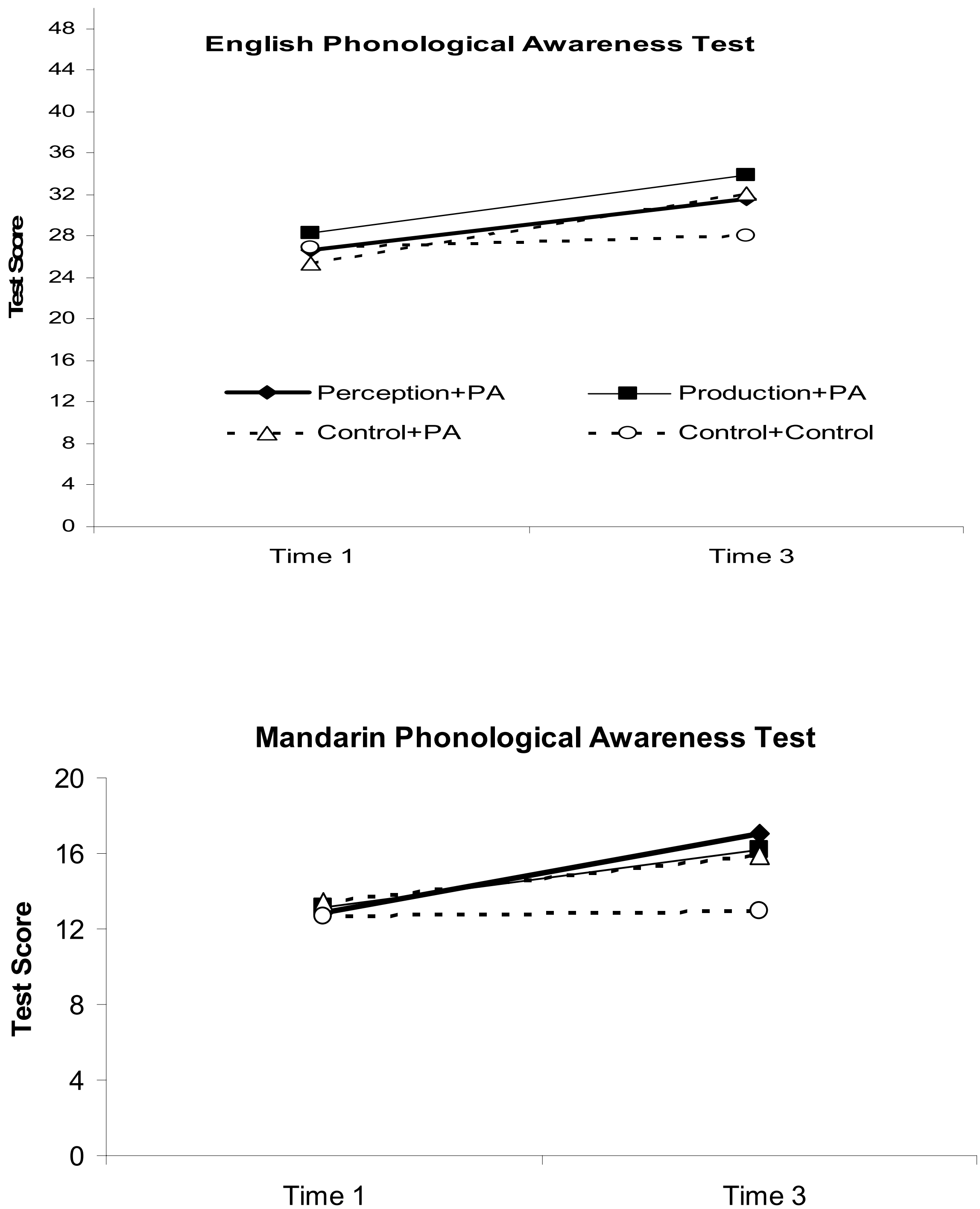


Table 3.10.

Estimated Marginal Means (Standard Errors) for Time 3 Outcomes after Controlling for Time 1 Covariates

	Group			
Time 3 Outcome Variable	Perception + PA	Production + PA	Control + PA	Control + Control
Total PA3	48.80 (1.57)$_{a}$	48.75 (1.41)$_{b}$	48.87 (1.44)$_{c}$	41.33 (1.49)$_{abc}$
English PA3	31.70 (1.13)$_{a}$	32.66 (1.03)$_{b}$	33.31 (1.05)$_{c}$	28.06 (1.08)$_{abc}$
Mandarin PA3	17.12 (.79)$_{a}$	16.09 (.71)$_{b}$	15.63 (.73)$_{c}$	13.18 (.76)$_{abc}$
English Onset Matching 3	11.52 (.54)$_{a}$	12.02 (.49)$_{b}$	12.49 (.50)$_{c}$	9.98 (.52)$_{abc}$
English Coda Matching 3	8.96 (.40)$_{a}$	9.19 (.36)$_{b}$	9.07 (.37)$_{c}$	7.53 (.38)$_{abc}$
English Onset Common Unit 3	4.47 (.60)	4.88 (.56)$_{b}$	5.19 (.57)$_{c}$	2.93 (.57)$_{bc}$
English Coda Common Unit 3	6.96 (.35)	6.57 (.32)	6.68 (.32)	7.30 (.34)
Mandarin Onset Matching 3	4.04 (.32)	3.92 (.29)	4.16 (.29)	3.45 (.30)
Mandarin Rime Matching 3	4.57 (.21)	4.62 (.18)$_{b}$	4.47 (.19)	4.05 (.20)$_{b}$
Mandarin Onset Common Unit 3	4.44 (.36)$_{a}$	4.08 (.32)	3.62 (.33)	3.27 (.34)$_{a}$
Mandarin Rime Common Unit 3	3.99 (.36)$_{a}$	3.48 (.33)$_{b}$	3.51 (.34)$_{c}$	2.35 (.35)$_{abc}$

Note. See text for details of covariates for each outcome variable. Subscripts denote pairs of scores that are significantly different, $p < .05$.

Figure 3.7. Estimated marginal means for English PA3 by subtest, after controlling for Time 1 and the covariate. Standard error bars shown. Significance at $p < .05$ marked with asterisk.

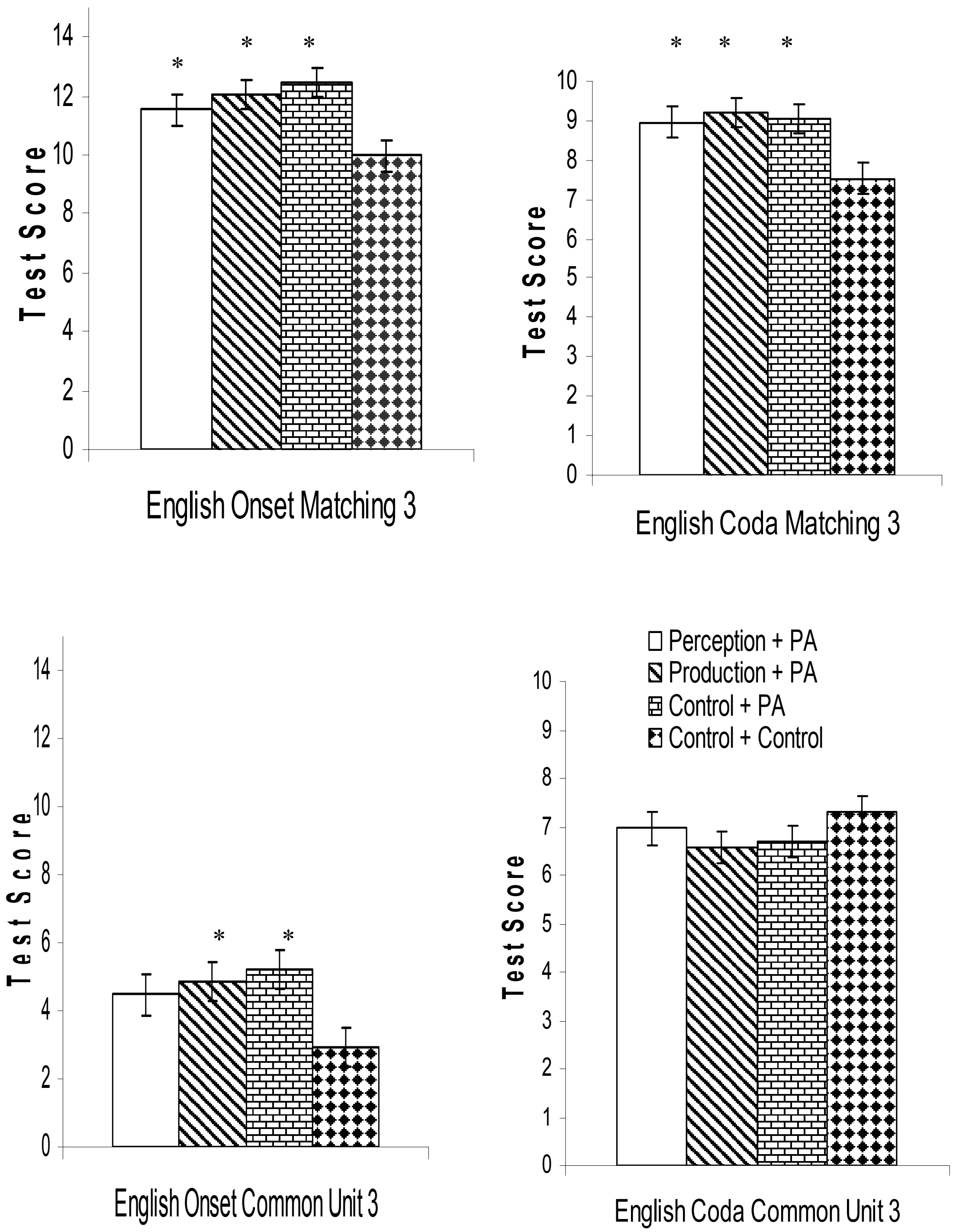
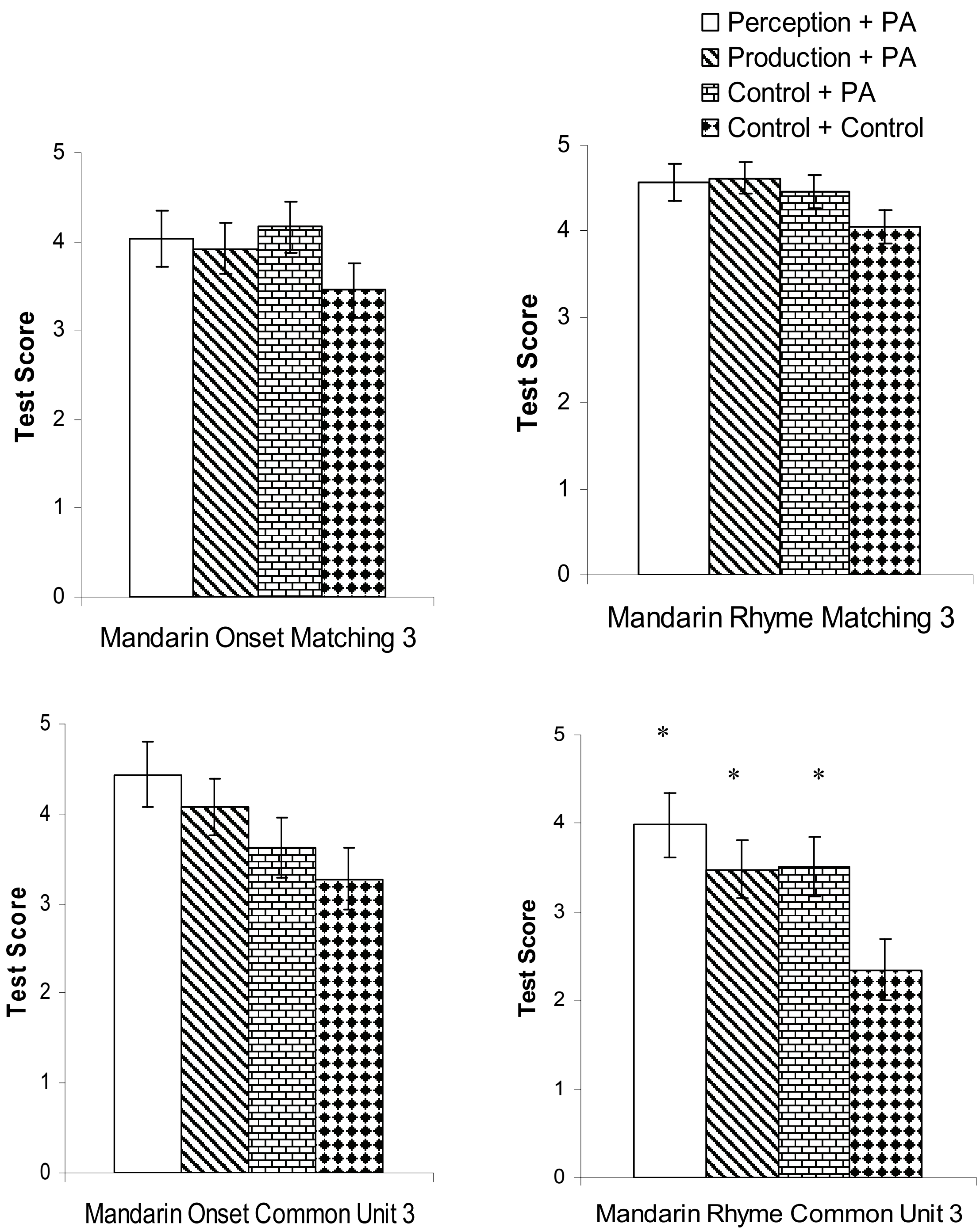


Figure 3.8. Estimated marginal means for Mandarin PA3 by subtest, after controlling for Time 1 and the covariate. Standard error bars shown. Significance at $p < .05$ marked with asterisk.



3.5 Item Analyses

3.5.1 Rescoring Common Unit Tests

In the original scoring of the common unit subtests, children were given a point for each totally correct response. In the trial of *drive- drum,* for example, one point was given for correct elicitation of the common dr- cluster. However, only 12 out of the 58 children correctly produced /dɹ/ as the answer. Others provided partially correct answers such as /ʤʌ/ or /ɹʌ/ or /dʌ/. These partially correct and incorrect answers were all given zero points. To best represent how children treated clusters in the English common unit tests, their answers were further examined and rescored, taking the number of consonants correct into consideration. Because there are no consonant clusters in Mandarin, Mandarin common unit test performance was not re-analyzed. The procedure and results of rescoring the English common unit tests will be presented in the following sections.

3.5.2 Procedure

Every child's response for every trial in all English common unit tests at each of the three time points was entered into a spreadsheet. Trials with singleton onsets or codas were not of concern here, as the elicited common unit was either a correct consonant or incorrect consonant. Only trials with cluster onsets or codas were rescored. A totally correct response with both consonants correct was given a score of 2, and partially correct responses with one of the targeted consonants correct were given a score of 1. The elicited consonants or consonant clusters could stand alone or be followed by a short schwa or schwa-like neutral vowel. For example, in the previously mentioned targets *drive- drum*, answers such as /ʤʌ/, /ɹʌ/, or /dʌ/ were given 1 point. However, an answer such as /dɹai/ was given no point at all as the onset was not successfully separated from the vowel.

3.5.3 Results

3.5.3.1 Preliminary Results

The raw scores for each trial, averaged across all 58 children, are reported in Table 3.11 for the onset and coda subtests. Out of a total score of 2 for each trial, the children scored, on average, .55 on the trial of *fl*- for example in English onset common unit 1. They scored up to 0.97 for *fl*- trial in English onset common unit 3. Similarly in the coda position (Table 3.11, bottom), children scored an average of 1.41 out of 2 for *–st* trial in Time 1 and 1.84 in Time 3.

3.5.3.2 Change from Time 1 to Time 2

A one-way ANCOVA with Time 1 subtest performance and English vocabulary as the covariates was used to compare between-group performance at Time 2 for the English onset common unit test and the English coda common unit test score. No significant group effect was found in the onset common unit, F (3, 52) = 2.04, p = .12, or in the coda common unit, F (3, 52) = .595, p = .621.

3.5.3.3 Change from Time 1 to Time 3

A one-way ANCOVA with Time 1 subtest performance and English vocabulary as the covariates was used to compare between-group performance in English onset common unit test and English coda common unit test score at Time 3. A significant group effect was found in the English onset common unit test, F (3, 52) = 4.42, p = .008. Planned comparisons showed that the Production + PA and Control + PA groups outperformed the Control + Control group significantly (p = .001, .01 respectively), which is consistent with the previous report based on original scoring. The Perception + PA group also demonstrated a marginal significant effect (p = .046) when compared to the Control + Control group. This effect did not appear in the previous report based on original scoring.

For English coda common unit test, no significant effect was found, F (3, 52) = 1.06, p = .376.

In summary, the result based on the rescores of the English onset common unit test and the English coda common unit test was in line with the result obtained from the original scoring. The only difference was found in the planned comparison between the Perception + PA group and the Control + Control group in English onset common unit test from Time 1 to Time 3. In other words, when the scores were given based on the new scheme, the Perception + PA group showed an advantage when compared to the Control + Control group.

Table 3.11

Mean Score on English Onset (top) and Coda (bottom) Common Unit Subtests at Time 1, Time 2, and Time 3 by Trial

Onset Common Unit 1		Onset Common Unit 2		Onset Common Unit 3	
st-	0.83	st-	0.86	st-	1.10
st-	0.72	st-	0.91	br-	0.83
br-	0.48	br-	0.74	br-	0.95
br-	0.57	fl-	0.86	fl-	0.91
fl-	0.55	fl-	0.69	fl-	0.97
pl-	0.41	gr-	0.59	tr-	0.76
dr-	0.52	dr-	0.72	gl-	0.81
kr-	0.55	kr-	0.59	pr-	0.5
kl-	0.71	ɵr-	0.33	bl-	0.86
gr-	0.43	ʃr-	0.45	ɵr-	0.29

Coda Common Unit 1		Coda Common Unit 2		Coda Common Unit 3	
-st	1.41	-st	1.78	-st	1.84
-nd	0.74	-nd	1	-nd	1.03
-nk	0.84	-nt	0.90	-nk	1.03
-lt	0.88	-ld	0.98	-sk	1.83
-ðr	0.64	-ft	1.55	-rt	1.12

3.6 Conclusion

Results of the language assessment and three Phonological Awareness Tests (PA1, PA2, and PA3) were examined in this chapter. Children in the four groups performed statistically the same in all language assessment measures, despite the fact that they came from different kindergartens and different familial backgrounds. In Phase I, the children who received a session of either perceptual-based or production-based intervention did not perform differently from those who received control activities. In Phase II, the children who received two sessions of phonemic awareness instruction performed significantly better than those in the control group, after taking Time 1 performance and language assessment measures into consideration. This improvement was reflected in both English phonological awareness test scores and Mandarin phonological awareness test scores. Specifically, the effect was found in three out of four English subtests, including the English onset and coda matching, and in the English onset common unit. In Mandarin, the effect was found only in rime common unit test. In terms of English common unit test, a similar pattern was found when a new detailed scoring scheme was applied which considered the number of consonants correct.

DISCUSSION

The present study examined the differential effectiveness of certain combinations of intervention procedures designed to enhance the phonological awareness skills of Mandarin-speaking children learning English as a foreign language. The interventions were based on the assumption that these children were at a disadvantage of developing English phonological representations at the phonetic and phonemic levels of representation, given the limit of transfer from L1 to L2 and their small amount of English vocabulary acquisition. The selection of intervention procedures was based on research into the literature. Three intervention conditions were employed: a perceptual-based phonetic intervention, a production-based phonetic intervention, and a phonemic awareness intervention. The primary purpose of the present investigation was to examine for the effect of these interventions on the phonological awareness skills of Mandarin-speaking children at the beginning level of learning English as a foreign language. Specifically, phonemic awareness intervention alone, phonemic awareness intervention when preceded by a single session of a perceptual-based phonetic intervention, and phonemic awareness intervention when preceded by a single session of a production-based phonetic intervention were compared to a no-intervention control condition. Children's performance was assessed using implicit phonological awareness tests (matching tasks) and explicit phonological awareness tests (common unit tasks) in both English and Mandarin. A summary of the findings is described first, followed by a discussion of these findings. Finally, limitations, future directions, and implications will be presented.

4.1 Summary of the Findings

The primary goal of the present investigation was to examine the effectiveness of the phonemic awareness intervention, conducted in Phase II of the present study. Effectiveness was assessed by examining the children's overall performance on phonological awareness tests in English and in Mandarin. Children in all groups who received phonemic awareness instruction outperformed the control children (i.e., the Control + Control group) when performance was compared to Time 1, before the intervention had taken place. The improvement was found in the total phonological awareness test scores, in the English phonological awareness test scores, and in the Mandarin test scores. Therefore, the first hypothesis that English phonemic awareness intervention would be effective was supported. Analyzed by subtest, there was an improvement on the English onset matching, English coda matching, and English onset common unit tests, as well as the Mandarin rime common unit test. A significant improvement was not observed in the English coda common unit test or any other Mandarin subtests.

A further goal of the present investigation was to examine the effectiveness of combining each of the production-based and perceptual-based intervention with the phonemic awareness instruction. A significant group effect at Time 3 on overall phonological awareness in English and in Mandarin was found after controlling for Time 1 phonological awareness test performance. Pairwise comparisons showed that the Perception + PA, the Production + PA, and the Control + PA groups all outperformed the Control + Control group, and no other significant pairwise comparisons were found. In other words, the combination of the phonemic awareness instruction with speech perception or with speech production did not seem to have a superior intervention effect compared to the phonemic awareness instruction alone. Therefore, neither intervention that targeted phonetic knowledge of English clusters facilitated the children's responses to the phonological awareness instruction provided in Phase II. The second hypothesis was thus refuted.

Moreover, the present investigation also examined the effect of perceptual-based and production-based interventions, which were conducted in Phase I of the study, on the children's phonological awareness skills. The effects of these interventions, which targeted phonetic knowledge of the English sound system, were assessed by examining improvements in phonological awareness during Phase I of the study. Children who received either the perceptual-based or production-based intervention did not perform differently on phonological awareness tests compared to those who received control activities in Phase I. In other words, a session of perceptual-based or production-based activities did not enhance children's performance on the English phonological awareness test at Time 2.

The third hypothesis stated that all groups would have more difficulty with explicit than implicit phonological awareness tests, particularly in English. Findings of the present investigation revealed inconsistent patterns in both languages. A detailed report on the performance of explicit and implicit tasks in different syllables in both languages will be presented in the next section.

4.2 Phonological Awareness in EFL Mandarin-Speaking Children

A discussion of the children's performance in Mandarin is presented first, followed by a discussion of their performance in English. Although a significant group effect was observed on the overall Mandarin tests at Time 3, after Time 1 score and

Phonetic Recognition and Blending score were controlled, not all four Mandarin subtests reflected such an effect statistically. It was only the rime common unit subtest that exhibited a significant group effect. Interpretations of this result will be discussed first for the matching subtests, which require only implicit awareness of shared units, and then for the common unit subtests, which require explicit awareness as the child is expected to detach and pronounce the shared common units when presented with two words. At the implicit level of phonemic awareness, no significant group effect was found in the onset matching or in rime matching subtests. There are two possible explanations for this finding. One is that explicit phonemic awareness treatment did not have an effect on implicit detection of shared rimes or onsets. Another possible explanation may be due to the small number of trials in the Mandarin tests. Out of a total of 5, children's scores ranged from 3.46 to 4.08 (*SD* ranged from .88 to 1.2) at Time 1, and from 3.43 to 4.63 (*SD* ranged from .73 to 1.4) at Time 3 on the matching tests. Thus, the children were close to, or at, ceiling on these tests in their native language before the intervention. An intervention effect, if present, could therefore not be observed because the assessment test was not sufficiently sensitive.

In terms of the explicit level of awareness, as assessed by the common unit subtests in Mandarin, a significant group effect was found in the rime position, but not in the onset position. That the intervention effect was found for rime manipulation earlier than for the onset is consistent with the developmental progression hypothesis of phonological awareness (Cisero & Royer, 1995). According to this view, rime awareness is the foundation of phonological awareness, and onset awareness builds upon this foundation. Previous studies (Bryant, Maclean, Bradley & Crossland, 1990; Goikoetxea, 2005; Stanovich, Cunningham, & Cramer, 1984; Treiman & Zukowski, 1990, 1991) have all provided evidence that children find rime awareness easier than onset awareness. It should be noted that rime awareness was assessed at the implicit level in these studies. However, Savage, Blair, and Rvachew (2006) found the opposite results when an explicit task (i.e., common unit task) was employed as the measure of rime awareness. Both readers and nonreaders in their study scored the lowest on the rime common unit test, compared to manipulating other linguistic units such as the onset. The discrepancy between these two sets of findings might lie in the complexity of the tasks used to assess rime awareness. Previous studies that have demonstrated that rime awareness tasks are easier than onset awareness tasks examined rime at the implicit level, not at the level of explicitly detaching rime from the rest of the word.

With respect to performance on the English tasks, the children in the experimental groups performed significantly better than those in the control group on overall English phonological awareness. At the implicit level (i.e., the matching subtests), significant group effects were observed in both onset and coda positions. The effect was further observed on the explicit tests in the onset position, but not the coda. This pattern of development could be explained by Gombert's (1992) model of metalinguistic awareness and by the phonological status hypothesis (Goswami, 1993, 1999). In Gombert's developmental model, epilinguistic control, which is implicit or unconscious awareness of linguistic forms, is acquired first, and only when epilinguistic control is "mastered at a functional level" does explicit conscious metalinguistic control come in (Gombert, p. 190). According to this, it is not surprising to find that intervention effects were observed in both epilinguistic tasks of implicit awareness (i.e., English onset matching and coda matching). For an explicit intervention to be effective and applicable at the conscious level, the underlying unconscious level must be functionally mature first. In addition, the effect was further found when children were required explicitly to manipulate onsets, but not codas. This finding, demonstrated by the present Mandarin-speaking EFL children, is in line with previous findings (Savage, Blair, & Rvachew, 2006; Stanovich, Cunningham, & Cramer, 1984; Treiman & Zukowski, 1990) and with the phonological status hypothesis in that awareness of English onsets is expected to be easier and appear earlier in development than awareness of English codas.

Interestingly, participants in the experimental groups and the control group all showed an improvement in the performance of English coda common unit test at Time 3 of testing, when compared to Time 1. During the common unit task at Time 3, participants also performed significantly better on coda than onset items [t (57) = -4.66, p < .0005]. This advantage for the coda in comparison to the onset, does not correspond with previous results in English-speaking children (e.g., Savage, Blair, & Rvachew, 2006; Stanovich, Cunningham, & Cramer, 1984; Treiman & Zukowski, 1990, 1991) and Spanish-speaking children (Cisero & Royer, 1995; Goikoetxea, 2005). It also conflicts with the phonological status hypothesis which predicts that the level of onset-rime awareness develops earlier than individual phonemes such as in the coda. It is speculated that these Mandarin-speaking children found the English coda perceptually salient because Mandarin syllable structures allows only nasal codas. The saliency of the English coda was possibly reinforced in the present study by the use of repeated practice trials and repeated exposure to test trials that required the children to detach the coda from the word from Time 1 to Time 3.

In summary, the findings in the present study suggest that Mandarin-speaking EFL children mainly followed similar developmental order of acquisition of phonological awareness as English-speaking children as reported in the published literature.

However, there are some striking differences between the current participants and English-speaking children. These children did not receive much, if any, instruction regarding grapheme-phoneme correspondence in English. They had very limited vocabulary knowledge in English, and they had not learned to read in English. Even though 17 of the 58 children were attending English immersion classes and may thus have received instruction in grapheme-phoneme correspondence in English, some of these 17 children had been immersed in English for only 4 months, from September to the time of testing in early January. Of the remaining 41 children, those who had learned English had done so through exposure to the alphabet and basic vocabulary only. With limited linguistic experience in English, it is remarkable that, after two sessions of English phonemic awareness instruction, their phonological awareness skills in both languages improved at both implicit and explicit levels. Considering the limited linguistic support from English these children had, as reflected in their limited knowledge of English, it is interesting that the blending and segmenting exercises themselves were sufficient to enhance their awareness of the English sound structure, especially considering how different it is from that of Mandarin Chinese.

4.3 Perceptual-Based and Production-Based Intervention

Previous studies have attempted to show that interventions that target children's phonetic knowledge of the sound system will enhance acquisition of phonological awareness. However, interpretation of these studies is complicated because phonetic-level interventions have been confounded by concomitant activities that might also impact phonological awareness. These included practicing articulation through activities that also teach phonological awareness (Castiglioni-Spalten & Ehri, 2003; Wise, Ring, & Olsen, 1999) as well as control conditions that might enhance phonological awareness in the control group (Rvachew, Nowak, & Cloutier, 2004). A contribution of the present research was the "clean" nature of the tasks each group was engaged in during Phase I. It may be because of the tight controls exercised in the creation of the production- and perceptual-based intervention session, which focused only on four English consonant clusters via four English words, that the perceptual-based and production-based interventions did not yield the expected effects. Children in the experimental groups and the control groups did not perform differently after the session of perceptual-based or production-based intervention at Phase I.

4.3.1 Why Was the Speech Perception Intervention Ineffective?

Although the present investigation, Rvachew and colleagues (Rvachew, Nowak, & Cloutier, 2004), and Moore, Rosenberg and Coleman (2005) share the concept of perceptual-based intervention, these three studies differ in many methodological details, including age and characteristics of participants, the content of their interventions, and the intensity and total amount of time of the respective interventions. A comparison of research findings by themselves is not sufficient to judge if a perceptual-based intervention could or could not lead to improved phonological awareness. It is only sufficient to conclude that a session of 40 minutes to an hour of perceptual-based intervention in the present study did not result in enhanced phonological awareness in

Mandarin-speaking children. The nature and duration of perceptual-based intervention must also be considered.

Based on the results of previous research on extensive perceptual-based training, it is possible to improve the perception of nonnative speech sounds (Bradlow, Pisoni, Yamada, & Tohkura, 1997; Goldstone, 1998; Rochet, 1995), reading performance of reading-impaired children (Kujala et al., 2001) and phonological awareness of typically developing children (Moore, Rosenberg, & Coleman, 2005) after a period of perceptual-based training. In his review of perceptual learning, Goldstone (1998) summarized four perceptual learning mechanisms: attention weighting, imprinting, differentiation, and unitization. Moore et al. (2005) also stated that successful perceptual learning takes place when the trainee is alert and working hard, which might make the attention weighting and differentiation mechanisms come into play in an effective way. In perceptual-based training studies, the training stimuli usually involved the manipulation of specific acoustic cues implicated in specific phonemic contrasts, requiring the trainee to discriminate or identify the target(s). This strategy helps to focus the trainee's attention on the information that is most important for the required linguistic judgment. However, in the present design, the perceptual-based intervention was manipulated at the level of syllable structure, rather than at the level of phonemic categories. The training stimuli were new real English words with consonant clusters, rather than short simple CV syllables from either synthetic or natural speech. The foil words were manipulated with a mix of syllable structures (e.g., *band-bad*) and phonemes (e.g., *band-bant*) in the discrimination task. Participants in the present study had to learn and memorize the words first, in order to perform discrimination and identification tasks. There might have been too much information load in this process and it may have been difficult for participants to pay attention simply to a certain part of the new words. One piece of evidence that supports this possibility comes from some of the children's responses in the word discrimination task. Some children responded to the discrimination tasks by pointing out the different acoustic features of two words that were phonemically and lexically the same, such as the duration of a certain phoneme. As these children did not know the target words until instructed, it is thus understandable that they might perceive it as a different word if the acoustic information that they attended to was changed. This example illustrates that some children did not pay attention to the targeted clusters of the novel words but to other acoustic information instead. These factors might partly contribute to the unsuccessful training in the present study.

Another relevant issue concerning the nature of perceptual-based intervention is variability in the training stimuli and the amount of training time. Goldstone (1998) noted that training time required to reach threshold levels of accuracy varies as a function of within category variability (Posner & Keele, 1968). It has also been suggested that high variability identification tests could modify listeners' perceptual categories and generalize to new words (Lively, Pisoni, Yamada, Tohkura, & Yamada, 1994). In the present investigation, stimuli from one speaker were used in only a single intervention session, and the trials were composed of different words in the intervention and in the post-test, which used phonological awareness test as the outcome measure. The relatively short amount of training time, no speaker variability in the stimuli, and different words and tasks in the intervention and post-test could all contribute to the unsuccessful intervention in this study.

4.3.2 Was the Speech Production Intervention Effective?

Although no significant between-group difference in the English onset common unit subtest was found from Time 1 to Time 2, $F(3, 52) = 2.04$, $p = .119$, the pairwise comparisons showed that a significant effect was present for the Production + PA group when compared to the Control + Control group ($p = .018$). However, this effect was significant only based on the rescored data, not on the original scoring. In addition, in this Phase, the Production + PA group only outperformed one of the two control groups, the Control + Control group. No effect was observed with respect to the Control + PA group, which also received the Control activities in the first Phase. Even if the rescoring represented a finer performance pattern, it is questionable to suggest that the production-based intervention might help participants' phonological awareness based on the present results. The effect found with one control group but not the other might be due to sampling error from heterogeneity and small numbers of participants in these groups.

Another possibility could be that production training did have a certain effect on the performance of the post-test. Evidence supporting this argument indirectly comes from Callan and colleagues (Callan, Jones, Callan, Akahane-Yamada, 2004). These researchers suggested that second language learners use articulatory-auditory and articulatory-orosensory mappings to identify nonnative phonemes while native speakers activated more auditory-phonetic based regions in the brain when performing the same phoneme identification task. This illustrates that second language learners might rely more on articulatory characteristics of novel words and phonemes even when encountering perceptual tasks in a foreign language. Although their study did not investigate articulation in a second language, their findings based on their perceptual tasks suggests articulatory characteristics of foreign words might play an important role in perceiving a foreign language. More research following this argument will be needed to validate and support the efficacy of production-based intervention in a foreign language.

4.4 Phonological Awareness Intervention

It is interesting to observe a training effect following only two sessions of phonemic awareness intervention. Ehri et al. (2001) in their review suggested that effects were largest when the intervention lasted between 5 and 18 hours rather than longer, each session lasting approximately 30 minutes. The present study did not invest such a long intervention time in Mandarin-speaking English beginning learners, yet an effect was observed in all three experimental groups. What elements or processes made this intervention work, given the lack of L2 linguistic knowledge and vocabulary support, is an intriguing question. When English-speaking children are able to manipulate linguistic units, it is implied that children's underlying representations for lexical items are composed of, or segmented at, certain levels. However, it is doubtful that the present participants possessed as finely detailed and segmented representations for English words as one would expect for English-speaking children. The effect that carried over from the training materials to the testing materials might not be the same as that in English-speaking children. The attempt to answer these questions is only limited to speculations however.

One interpretation is that the intervention helped construct some mental representations for the foreign English words they just encountered in the Interlanguage system (Selinker, 1972). The early Interlanguage Hypothesis stated that while learning a second language, adult second language learners construct a mental grammar at a certain stage, which is partially distinct from their L1 and L2. The Interlanguage Hypothesis was later extended from adults to children learning a second language (Selinker, Swain, & Dumas, 1975). Two sessions of phonemic awareness instruction in English may have helped construct such a temporary Interlanguage system. Second language learners can employ a number of different strategies for organizing novel representations in their interlanguage system. The syllable structures with onset clusters or coda clusters in English that differ from Mandarin Chinese might have forced the children to represent foreign syllables in chunks or schemas or a combination of both (Segui & Ferrand, 2002, for a review) in their Interlanguage. For example, the words *desk* and *mask* might be represented as two similar but different syllable chunks because they contain different sounds, i.e. 'de + sk' and 'ma +sk". Alternatively, the two words might be represented as the same schema of a CVCC syllable. Another strategy is to represent the words as a combination of Mandarin syllables with English codas. There is insufficient empirical evidence to specify what the syllabic representations might be in this temporary Interlanguage system. In any case, salient differences in syllable structures in English in comparison to Mandarin might draw children's attention to the prosodic tier of syllables, rather than down to the segmental tier of the phonological representation for the words. Therefore, the greater effectiveness of the phonemic awareness instruction, which focused on the syllable structure of the words, compared to the perception- and production-based interventions that focused on the acoustic- and articulatory-phonetic characteristics of the segments in the words, is perhaps not surprising.

Another interpretation of such training effects following the phonemic awareness intervention might come from the possibility of improved attention in performing the tasks. Phonological awareness tasks, as one type of metalinguistic awareness task, require attention to focus actively on a certain part of mental representations (Bialystok, 2001). Consonant clusters were emphasized a great deal in the training materials and it is possible that the children learned to attend to these specific features of the stimulus words during training and, similarly, during the post-test. This line of argument is not mutually exclusive with the previous interpretation based on the Interlanguage system. According to Bialystok, attention must be directed to some representation during metalinguistic awareness. Given that she assumed that representations for metalinguistic awareness in bilingual children are developed during the acquisition of the first language, they would also be available to use in a second language. This may be true, however, for languages that share similar syllable structures. It is argued here that a part of metalinguistic knowledge is shared and available to use for both languages, but a different part could be language specific, especially in situations when two languages are distinct in syllable structures. In the process of learning new foreign words with unfamiliar consonant clusters, children must find a way to represent these novel words and novel structures, which they clearly know do not belong to Mandarin. The Interlanguage system, which plays a role at certain stage of second language learning, might provide the platform for this newly-built representation in the course of phonemic awareness intervention.

4.5 Limitations

In addition to the weaknesses illustrated previously in 4.3.1 and 4.3.2 on the length and materials of the perceptual-based and the production-based intervention, some other weaknesses should be addressed. One was the heterogeneity of the participants. Children were recruited from four different kindergartens, with unequal numbers from each school. These four different kindergartens attracted parents of different social and economic backgrounds and provided different curricula, from the English immersion classroom in one school to no English instruction at all in another school. Even though the present study randomized the participants into different conditions, the wide range of differences in language experiences and backgrounds should be noted.

The second weakness of the present study comes from unequal sample sizes in different conditions. The number of subjects in each group was 13, 16, 15, and 14, respectively, for the Perception + PA, the Production + PA, the Control + PA, and the Control + Control group. The Perception + PA group in particular was the group with fewest subjects, which might partially explain the insignificant effect observed in the English onset common unit test from Time 1 to Time 3, while other two experimental groups exhibited significant effects based on the original scoring. The relatively small number of participants in this group made it difficult to determine if there was no intervention effect or if the sample size was too small to achieve a significant effect. Another issue was sampling error coming from the heterogeneity and small number of participants in each group. Both factors increased the risk of sampling error in the present investigation. As discussed earlier in this Chapter, the pattern whereby the Production + PA group only outperformed one of the two control groups from Time 1 to Time 2 might be due to sampling error.

In addition, the investigator was fully aware of children's skills in both languages and the experimental conditions to which the children were randomly assigned. Even though the participants were randomly assigned at the beginning and all the outcome measures were administered through PowerPoint files, the investigator's initial experience with the children in the first language assessment session might have affected how children were approached, trained, and tested throughout the rest of the study.

Lastly, due to the time constraints in each session, the number of trials in each Mandarin subtest was limited to 5. This small number of trials might have made it difficult to observe how and if phonological awareness skills in Mandarin changed in addition to what present findings revealed.

4.6 Future Directions

Future directions will be addressed from two aspects, one from limitations of the present investigation, another from issues to be further explored based on the present findings. The primary limitations of the present investigation were the heterogeneity of the research participants and the potential for investigator bias. When research participants are children with speech or language difficulties, the heterogeneity of the group as a whole, and individual child's difficulties, are usually addressed by researchers. However, when typically developing children are involved, researchers tend not to address how heterogeneous the group is. Admittedly, human participants do not come in standard sizes, and the attempt to standardize participants is not realistic. Future studies, however, could aim to minimize further the different characteristics among participants, such as recruiting participants of similar socioeconomic status and/or from schools providing a similar curriculum. These factors could have an impact on participants' language performance and on how well they are able to follow the training instructions. Recruitment should also aim for a large number of participants in order to confirm further the training effects following the perceptual-based and production-based intervention. As for the issue regarding a single investigator, it is inevitable in a thesis study for only one investigator to deal with designing materials, recruiting, testing and analyzing data. A similar design could be replicated in a larger scale study with multiple investigators who are unaware of the variables being manipulated, as well as assessors who are blind to the children's treatment condition, to confirm the present findings.

Several lines of future research can be developed based on the present findings. The current study demonstrated the effectiveness of brief phonemic awareness intervention for beginning English learners, which is consistent with the literature of English-speaking children. In addition, other variables generally considered important in drawing attention to or enhancing children's phonological awareness could also be researched. One of these is to test the hypothesis that increases in vocabulary size can trigger the restructuring of representations (Metsala & Walley, 1998) in Mandarin-speaking children learning English. Moreover, the variables of speech perception and speech production are also worth further investigation, by extending the training time and manipulating the training materials. In speech perception, high variability stimuli from different speakers could be implemented. Instead of manipulating foreign syllabic or prosodic tier, both perceptual training and production training could focus on the segmental tier by drawing attention to non-native phonemic segments. Another area for future studies is to examine the retention of training effects. Follow-up assessments of participants in the present study to see if the effects would remain for more than a week were not conducted. If the treatment effect is only temporary, the treatment program needs to be re-considered.

4.7 Implications

Pedagogical implications should only be considered seriously when the effectiveness of brief phonemic awareness instruction in ESL or EFL children is further confirmed, and its retention lasts for a period of time. Despite these cautions, the present findings imply that inclusion of phonemic awareness instruction in classrooms of Mandarin-speaking beginning level second language learners could be helpful in enhancing learners' phonological awareness of a foreign language at both the implicit and explicit level. An investment of brief phonemic awareness activities into the curriculum could help narrow the gap between the native language and English, in which children find the phonological and orthographical system very difficult. Moreover, the findings also have implications in the clinical field when speech-language pathologists in English-speaking communities deal with children with limited English experiences born to immigrant parents or French-speaking parents in Canada. Results suggest that offering intervention programs in English could be of great help in promoting phonological awareness in both English and the native language. Moreover, the findings observed from Mandarin-speaking EFL learners may extend to other second language learners. Strengthening phonological awareness skills in one language would impact positively upon the skills in another language.

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APPENDIX A

English Vocabulary Test

Frame	Practice	Target word	Yes / No
:	a. Show me the	**Dog**	
	b. Which one is	**Blue**	
	Test		
O	1. Show me the	**Pig**	
□	2. Show me the	**Lion**	
▵	3. Show me the	**Banana**	
Ω	4. Show me the	**Bird**	
☺	5. Show me the	**Shoes**	
☆	6. Show me the	**Ball**	
◇	7. Show me the	**Birthday cake**	
O	8. Show me the	**School**	
□	9. Which one is	**Rainy**	
▵	10. Show me the	**Umbrella**	
Ω	11. Show me the	**Chair**	
☺	12. Show me the	**Bear**	
☆	13. Who is	**Short**	
◇	14. Who is	**Watching TV**	
O	15. Show me the	**Cup**	
□	16. Show me the	**Pencil**	
▵	17. Show me the	**Small black dog**	
Ω	18. Who is	**Sleeping**	
☺	19. Who is	**Playing**	
☆	20. Show me the	**Doctor**	
◇	21. Show me the	**Toys**	
O	22. Which one has a	**Long nose**	
□	23. Who is	**Dancing**	

▵	24. Show me the	**Camp**	
Ω	25. Point to the picture that shows	**Summer**	
☺	26. Which one is	**Big**	
☆	27. Which one is	**Dog in his doghouse**	
◇	28. Show me the	**Triangle**	
O	29. Who is	**Reading**	
□	30. Who is	**Running**	
▵	31. Which one is	**Little**	
Ω	32. Which one is	**Heavy**	
☺	33. Show me the	**Radio**	
☆	34. Who is	**Drinking**	
◇	35. Show me the	**Stamp**	
O	36. Which one is	**Wet**	
□	37. Show me the one that are the	**Same?**	
▵	38. Which one is	**Empty**	
Ω	39. Show me the	**Telescope**	
☺	40. Show me the	**Half cookie**	

APPENDIX B

Phonological Awareness Tests (English) 1, 2, and 3

PA- English Onset 1

	Matching			Response		Common Unit	Point
practice	pig	pin	veal				
practice	dog	dice	flower				
practice	brain	bride	hook				
1	rock	roll	moon				
2	soup	sack	deer				
3	bell	bead	van				
4	foot	fog	veal				
5	cheek	chair	gym				
6	plum	plate	man				
7	drive	drum	talk				
8	crown	creek	bleed				
9	clown	clock	plane				
10	green	ground	globe				
11	state	steel	cook				
12	stool	stop	zone				
13	breeze	bright	trade				
14	flood	flag	slim				
15	brown	break	blade				
Total							

PA- English Onset 2

	Matching			Response		Common Unit	Point
practice	pig	pine	rose				
practice	gate	goose	jet				
practice	brain	bride	can				
1	bag	bird	meat				
2	jet	judge	goose				
3	hook	hat	can				
4	lip	lock	rose				
5	van	vase	four				
6	grave	groom	vase				
7	drill	dream	tooth				
8	throat	thrush	plum				
9	crab	cream	clock				
10	Shrek	shrug	fruit				
11	stair	stall	dice				
12	stick	stain	shawl				
13	floor	fleet	track				
14	broom	bride	dress				
15	flame	flat	freeze				
Total							

PA- English Onset 3

	Matching			Response		Common Unit	Point
practice	dog	dice	flower				
practice	pig	pine	rose				
practice	brain	bride	kiss				
1	duck	dog	soap				
2	girl	gate	van				
3	fan	food	pal				
4	tire	teach	dog				
5	thumb	thin	salt				
6	trail	treat	zip				
7	glass	glove	cake				
8	prize	press	glare				
9	black	blood	brace				
10	thread	throne	frame				
11	stage	star	ball				
12	brain	bridge	pig				
13	flower	flame	train				
14	brick	bride	grain				
15	flash	float	fridge				
Total							

PA- English Coda 1

	Matching			Response		Common Unit	Point
practice	flower	stair	dog				
practice	moose	dice	train				
practice	dust	toast	vase				
1	rock	lake	booth				
2	bead	lid	gas				
3	pin	sun	deer				
4	foot	shoot	beak				
5	sauce	horse	bush				
6	feather	wither	lime				
7	last	post	red				
8	bend	sound	rock				
9	belt	salt	fold				
10	sink	bank	paint				
Total							

PA- English Coda 2

	Matching			Response		Common Unit	Point
practice	moose	glass	train				
practice	dog	bag	horse				
practice	dust	toast	shoot				
1	thumb	time	pipe				
2	girl	towel	save				
3	fan	moon	bus				
4	ride	jade	tube				
5	jet	bat	talk				
6	hand	send	buzz				
7	dust	taste	soap				
8	bold	field	socks				
9	raft	lift	test				
10	paint	mint	round				
Total							

PA- English Coda 3

	Matching			Response		Common Unit	Point
practice	flower	stair	dog				
practice	moose	glass	train				
practice	dust	toast	shoot				
1	lip	rope	dog				
2	bag	dig	size				
3	read	bed	pine				
4	kiss	moose	rush				
5	boat	suit	cook				
6	tart	court	push				
7	tank	bunk	leg				
8	desk	mask	fist				
9	rest	toast	band				
10	sand	bound	tent				
Total							

APPENDIX C

Phonological Awareness Tests (Mandarin) 1, 2, and 3

PA-Mandarin Onset 1

	Matching			Response		Common Unit	Point
practice	包	背	蝦				
practice	山	家	收				
1	操	擦	膚				
2	篩	傷	撥				
3	豬	張	塌				
4	開	看	割				
5	滴	單	偷				
Total							

Transcription:

1	/ts^{ɦ}au/	/ts^{ɦ} a/	/pu/
2	/ʂai/	/ʂaŋ/	/p^{ɦ}o/
3	/tʂu/	/tʂaŋ/	/t^{ɦ}a/
4	/k^{ɦ}ai/	/k^{ɦ}an/	/kʌ/
5	/ti/	/tan/	/t^{ɦ}o/

PA- Mandarin Rhyme 1

	Matching			Response		Common Unit	Point
practice	背	飛	山				
practice	包	刀	擦				
1	山	攤	滴				
2	噴	分	哭				
3	蟑	缸	掏				
4	風	烹	悶				
5	聽	叮	親				
Total							

Transcription

1 /ʂan/ /t^{h}an/ /ti/

2 /p^{h}ʌn/ /fʌn/ /k^{h}u/

3 /tʂaɳ/ /kaɳ/ /t^{h}au/

4 /fʌɳ/ /p^{h}ʌɳ/ /mʌn/

5 /t^{h}ɪɳ/ /tɪɳ/ /tɕ^{h}ɪn/

PA- Mandarin Onset 2

	Matching			Response		Common Unit	Point
practice	包	背	蝦				
practice	山	家	收				
1	悶	貓	收				
2	喝	哈	撥				
3	三	塞	溝				
4	槍	秋	家				
5	栽	髒	擦				
Total							

Transcription

1	/mʌn/	/mao/	/ʂou/
2	/xʌ/	/xa/	/pʱo/
3	/san/	/sai/	/kou/
4	/tɕʱ iaɳ/	/tɕʱ io/	/tɕ ia/
5	/tsai/	/tsaɳ/	/tsʱa/

PA- Mandarin Rhyme 2

	Matching			Response		Common Unit	Point
practice	背	飛	山				
practice	包	刀	擦				
1	乾	攤	包				
2	奔	森	擦				
3	槍	薑	蝦				
4	燈	烹	針				
5	湯	傷	攀				
Total							

Transcription

1 /kan/ /t^{h}an/ /pau/

2 /pʌn/ /sʌn/ /ts^{h}a/

3 /$tɕ^{h}$iaɳ/ /tɕiaɳ/ /ɕia/

4 /tʌɳ/ /p^{h}ʌɳ/ /tʂʌn/

5 /t^{h}aɳ/ /ʂaɳ/ /p^{h}an/

PA- Mandarin Onset 3

	Matching			Response		Common Unit	Point
practice							
practice							
practice							
1	揹	搬	屈				
2	攤	湯	珠				
3	翻	飛	粗				
4	家	間	敲				
5	刀	燈	禿				
Total							

Transcription

1 /pei/ /pan/ /tɕʱy/

2 /tʱan/ /tʱaɳ/ /tʂu/

3 /fan/ /fei/ /tsu/

4 /tɕia/ /tɕian/ /tɕʱiau/

5 /tao/ /tʌɳ/ / tʱu/

PA- Mandarin Rhyme 3

	Matching			Response		Common Unit	Point
practice							
practice							
practice							
1	攀	沾	飛				
2	伸	根	鬚				
3	噹	方	摸				
4	坑	崩	跟				
5	天	鮮	薑				
Total							

Transcription

1 /p^{h}an/ /tʂan/ /fei/

2 /ʂʌn/ /kʌn/ /ɕy/

3 /taɳ/ /faɳ/ /mɔ/

4 /k^{h}ʌɳ/ /pʌɳ/ /kʌn/

5 /t^{h}ian/ /ɕian/ /tɕiaɳ/