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PHONOLOGICAL AWARENESS AND LISTENING COMPREHENSION AMONG CHINESE ENGLISH-IMMERSION STUDENTS

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ABSTRACT

This study investigates the relationship between English listening comprehension and English and Chinese phonological awareness (PA), and the cross-linguistic transfer of PA in 48 Grade 2 and 47 Grade 4 Chinese English-immersion students. The results of the study indicate a correlation between English PA and English listening comprehension. English listening comprehension had a significant effect on English PA in both grades; this effect is evident after considering Chinese PA, but only in Grade 4. A similar pattern is found for the effect of English PA on English listening comprehension. Only weak evidence exists pertaining to a connection between cross-linguistic transfer from Chinese PA (L1) to English listening comprehension (L2).

INTRODUCTION

English is widely regarded today as the chief language of international communication and has increasingly become a compulsory school subject among nations around the world. This is particularly true for countries like China where success in learning English has become the key to academic success (Cheng, 2008). English immersion programs were established in China during the late 1990s in the lower grades. However, little is known about the factors that contribute to the successful achievement of learning L2 (English) on the part of Chinese children in primary grades. Listening comprehension is one of the four basic language learning skills (listening, speaking, reading, and writing) and is regarded by some language learners as the most difficult language skill to learn in L2 (Hasan, 2000). Therefore, a better understanding of what contributes to English listening comprehension will enhance English-immersion students' development of aca-

demic learning and overall success in this language learning. The present study investigates the relationship between listening comprehension and phonological awareness in Chinese English-immersion students. Phonological awareness is a meta-linguistic skill— showing a sensitivity to the sound components of spoken words and the ability to manipulate those components. Phonological awareness is a powerful predictor of reading success, and we will argue that it may be a predictor of listening comprehension. We have also examined cross-linguistic transfer of phonological awareness to listening comprehension in Chinese English-immersion students.

IMMERSION EDUCATION AND CHINESE ENGLISH-IMMERSION PROGRAMS

French immersion programs [i.e., using French, a second language (L2) to teach school subjects to students whose native language is English] have prospered in Canada for over three decades and have demonstrated that immersion education is an effective way of facilitating students' language proficiency and literacy without detrimental effects to their first language (L1) (Cummins, 1999; Genesee, 1987, 1995; Lapkin, Hart, & Turnbull, 2003; Turnbull, Lapkin, & Hart, 2001). This has been confirmed by the recent studies by Turnbull et al. (2001) and Lapkin et al. (2003) based on the Education Quality and Accountability Office tests in literacy and mathematics in Ontario, Canada. Turnbull et al. (2001) found that French immersion students (i.e., students whose L1 is English and L2 is French) performed equally well to their monolingual peers on tests of English language arts and mathematics after formal instruction in English was provided in Grade 3. Later, Lapkin et al. (2003) indicated that at Grade 6, immersion students' English literacy and mathematics test scores were better than their peers' in English-only programs. Furthermore, Genesee (2004) demonstrated that French immersion students continue to perform as well as their peers in non-immersion programs in all English reading skills after Grade 6.

These successful French immersion programs in Canada have been adopted as a model of second language learning in China. In 1998, early English immersion programs were carried out in elementary schools starting in Grade 1 in several major Chinese cities, such as Beijing, Shanghai, Guangzhou, and Xi'an, attempting to expose students to more English at an earlier age due to the increasingly important role that English plays in China (Cheng, Li, Kirby, Qiang, & Wade-Woolley, 2010). The goal of the English immersion programs was to improve the existing English language programs in China by using English (L2) to teach some non-language subjects.

Although different schools have their unique features, the overall immersion program at each school in China in this study follows a similar pattern, in which 40% of the curriculum is taught in English and the other 60% in Chinese. English immersion programs in China do not have as much English (L2) input as immersion

programs in other countries do. Thus, Chinese English-immersion programs did not adopt the entire model of French immersion programs but rather only the concept underlying immersion programs in which some non-language subjects are taught in L2. For example, subjects taught in English include English language arts, science, and social studies. The teaching of physical education, art, and music in English or Chinese varies in different immersion programs according to the available teacher resources. Chinese and mathematics are taught in Chinese.

English immersion programs have been running in China for over ten years; however, little empirical research has been conducted to examine the students' cognitive processes of learning in the programs. Recently, Li, Kirby, and Georgiou (2011) examined development of rapid automatized naming (RAN) components (i.e. articulation time and pause time) in English and Chinese, and their relationship to English reading comprehension, in Chinese English immersion students at Grades 2, 4 and 6. They found that all component times decreased with grade level, but the decrease in English pause time between Grades 2 and 4 was the greatest. Only English pause time explained variance in English reading comprehension in Grade 6. Little evidence of cross-language transfer from Chinese RAN components to English reading comprehension existed, and the authors suggested that the effect of RAN is specific to the automaticity of the actual visual-verbal codes, which is language-specific. Another study by Knell et al. (2007) investigated the effectiveness of the early English immersion program and the students' cognitive processes of English literacy in Xi'an, China. After giving English immersion students measures of Chinese and English word identification, phonological awareness, and vocabulary, as well as English oral proficiency and letter name knowledge, Knell et al. found that phonological awareness and letter name knowledge significantly predicted English word identification for immersion students.

To our knowledge, no research so far has examined the cognitive processes of listening comprehension of English immersion students in China. Therefore, the exploration of the students' cognitive processes of English listening comprehension in immersion programs can improve our understanding of English learning in English-immersion students in China, and it can also provide better information for educators and researchers aiming to improve English learning in other countries whose L1 is not English.

LISTENING COMPREHENSION IN L1 AND L2

Comprehension is a specialized type of reasoning process that brings about a mental representation of a message when attempting to understand both oral and written text (Perfetti, Landi, & Oakhill, 2005). In L1 learning, listening comprehension is strongly related to reading comprehension because both depend on the ability to interpret words, sentences, and larger units of text. Empirical studies have demonstrated that listening comprehension is highly correlated with L1 reading comprehension and is a powerful predictor of reading comprehension

even when other factors, such as phonological awareness and vocabulary, are controlled (Hagtvet, 2003; Nation & Snowling, 2004).

Although listening comprehension and reading comprehension share similarities, there are differences between them. One distinction is that text content stays present in reading, whereas it disappears quickly in listening (Kirby & Savage, 2008); if one has not grasped an idea after reading a passage, one can go back and look at it again, but it is much more difficult when one has only heard the text. Therefore, in L1 learning, listeners may rely more on top-down processing, in which prior knowledge and higher-level skills are used to build a framework for comprehension, because listeners recall more main ideas as the listening material disappears quickly (Vandergrift, 2004). In contrast, readers may depend more on bottom-up processing, in which meanings are built from letters or words up to understanding because readers can attend to more details as the text remains present (Lund, 1991).

In L2 learning, the relationship between listening comprehension and reading comprehension may not be the same as in L1 learning; reading competence tends to develop much more rapidly than listening comprehension in L2 because individual words can be perceived more clearly in print and can be consulted again and again and because L2 students often learn to read before they have access to authentic listening input (Lund, 1991). Unlike L1 listeners who are able to process listening materials automatically and efficiently with little conscious attention to details of individual words, L2 listeners have to consciously focus on the details of the material to which they are listening (Segalowitz, 2003; Vandergrift, 2004, 2007). Because L2 learners have lower language proficiency in their L2 than in their L1, the top-down processing that they would normally apply in L1 listening comprehension may change to bottom-up processing in their early stages of L2 learning (Davis & Bistodeau, 1993; Lund, 1991). This means L2 listeners may perform listening comprehension by paying more conscious attention at the word level before progressing up to higher levels.

Listening comprehension remains the least researched area of the four language skills, not only due to its implicit nature but also as a result of the difficulty in observing comprehension processes. Research into L2 listening comprehension from the perspective of students' cognitive processes will provide us with a better understanding of the relationship between L2 listening comprehension and cognitive development and thus has implications for immersion education.

RELATIONSHIP BETWEEN PHONOLOGICL AWARENESS AND LISTENING COMPREHENSION IN L1 AND L2

An extensive body of research has established a relationship between phonological awareness and early reading acquisition for English as L1 (for reviews, see Adams, 1990; Bus & van IJzendoorn, 1999; Goswami & Bryant, 1990; National Reading Panel, 2000; Scarborough, 1998; Torgesen et al., 1997; Wagner

et al., 1993, 1997). Phonological awareness (PA) is the ability both to recognize that spoken words can be broken down into sound units and also to talk about, reflect upon, and manipulate those units (Adams, 1990; Kirby, Parrila, & Pfeiffer, 2003; Wagner et al., 1997). Researchers concede that PA is a powerful predictor of early reading development and is causally related to reading ability. In one of the most cited publications in the study of the process of learning to read, Adams (1990) proposed that PA is also associated with reading comprehension. In a meta-analysis evaluating the effects of PA instruction on learning to read, Ehri et al. (2001) summarized 52 studies to conclude that PA instruction benefits not only word reading but also reading comprehension because reading comprehension depends on effective word reading. With regards to the relationship between PA and reading development, Wagner et al. (1997) indicated that the relationship between these two variables is bidirectional: Individual differences in PA influence the development of individual differences in reading development, and reading development also influences the development of PA.

Although the relationship between PA and written language processing (i.e., reading) is well-established, the relation between PA and spoken language (i.e., listening comprehension) is not as clear. Does spoken language experience contribute to the ability to analyze spoken sounds? Does PA have an impact on spoken language comprehension?

Researchers have recently begun to investigate the relationship between PA and listening comprehension, attempting to link PA not only to written but also to spoken language (e.g., Caravolas & Bruck, 1993; Cheung, 2007; Cheung, Chen, Lai, Wong, & Hills, 2001). These authors have compared the phonological skills of children who speak languages differing along certain phonological dimensions that should influence how speech sounds are explicitly organized. For example, after completing a study that compared the PA of children from three different linguistic backgrounds on their PA, Cheung et al. (2001) concluded that spoken language has an effect on the development of PA. After comparing the performance of Czech- with English-speaking children on certain PA tasks, Caravolas and Bruck (1993) came to the same conclusion— that spoken language plays a role in PA development.

Likewise, PA makes a contribution to the development of spoken language. Cheung (2007) suggested that PA is associated with listening and reading comprehension because PA "provides an informational space for the phonological information derived from listening and reading to register in a common format" (p. 151). As PA is the ability to analyze spoken language into its component sounds and manipulate these smaller units, this ability is expected to exert an impact on spoken language processing. Listeners need to parse streams of speech sounds into words quickly so that they can retrieve the meanings of the words and then construct the meaning of sentences (e.g., Salwen & Stacks, 1996). A listener's sensitivity to sound units facilitates retrieving the right words, although these words may have similar sounds to other words, thus enabling the listener to retrieve the

appropriate meanings. Because PA relates to speech sounds and helps in distinguishing among sounds and words, it should contribute to oral word recognition, vocabulary recognition, sentence processing, and listening comprehension. The relation between PA and listening comprehension in English as an L2 has not yet been empirically established; therefore, research is needed to explore the mutual relationship between PA and listening comprehension in the L2 context.

CROSS-LINGUISTIC TRANSFER AND THE PRESENT STUDY

Cross-linguistic transfer indicates that a particular linguistic ability developed in one language can be used in another language. Studies of cross-linguistic transfer have focused mainly on the relationship between PA and reading ability. These studies have shown that PA in L1 is highly correlated with PA in L2, and that phonological skills can be transferred cross-linguistically and can predict word reading development in the other language even though the two languages are in different orthographies, e.g. English and Chinese (for reviews, see Chow, McBride-Chang, & Burgess, 2005; Geva & Wang, 2001; Gottardo et al., 2001; Knell et al., 2007).

Two methods of analysis have been used to assess cross-linguistic transfer with respect to reading. One is a liberal method of predicting reading in one language from PA in another language without controlling for PA in the language of reading (e.g. Chow et al., 2005; Knell et al., 2007). In other words, factors such as gender, age, or L1 vocabulary may be taken into account in predicting L2 reading, but L2 phonological processing skills are not controlled.

Another way to explore cross-linguistic transfer is more conservative, controlling for PA in L2 (see Gottardo et al., 2001). The conservative method provides a more accurate test of cross-language transfer, eliminating many possible confounding factors, but it may control for too much. Specifically, if PA in L1 is an important contributor to PA in L2, controlling either may eliminate the effect of the other. In this study, we explored the cross-linguistic transfer of PA to listening comprehension using both methods.

The present study focused on the cognitive processes of English listening comprehension in Chinese English-immersion students, attempting to uncover the relationship between PA and listening comprehension in English and the extent of cross-linguistic transfer of PA. The literature review has demonstrated that listening comprehension has an impact on PA; thus we hypothesize that listening comprehension will predict PA for Chinese English-immersion students. Previous studies have shown that prior knowledge, phonological memory skill, vocabulary knowledge, and metacognitive strategies can predict growth in listening comprehension (French, 2003; Long, 1990; Mecartty, 2000; Vandergrift, 2006). The current study looked at the predictors of listening comprehension from the perspective of whether phonological awareness can predict listening comprehension. In order to control other potential factors which may influence listening compre-

hension, the Chinese (L1) and mathematics achievement scores were controlled because they are the result of a broad range of background factors, including IQ, vocabulary, learning strategies, working memory, general prior achievement, and so on. PA is related to sound structure, and students need to listen to sounds of words first in order to mentally recognize the words' meanings before they can comprehend; therefore, we hypothesize that PA will predict listening comprehension in the current study. We are also interested in examining the effects of controlling various factors on the relations between PA and listening comprehension. We expect the effects to run in both directions. In other words, we hypothesize that spoken language recognition influences PA and that the ability to comprehend spoken language is affected by PA. We are also interested in whether PA in Chinese is transferred to English. The present study is the first attempt to investigate the bidirectional relationship between PA and listening comprehension and to look for cross-linguistic phonological transfer from Chinese to English. We address two research questions in this study: (1) How are PA and listening comprehension in English (L2) related? (2) Is there cross-linguistic transfer from PA in Chinese (L1) to listening comprehension in English (L2)?

METHOD

Participants

Ninety-five Chinese students (48 in Grade 2 and 47 in Grade 4) from English immersion programs participated in this study. Students were recruited with parental permission from three schools in three Chinese cities— Dongguan, Guangzhou, and Xi'an. Approximately equal numbers of males and females and approximately equal numbers from each class were randomly selected.

PA Measures

English Sound Detection (James, 1996, adapted from Bryant & Bradley, 1985). Two individually-administered tests of initial sound detection and final sound detection in English developed by James (1996), adapted from Bryant and Bradley (1985), were administered to assess the English PA (onset-rhyme awareness) of English immersion students. The tests include two practice items and ten test items in each of initial and final sound detection. The test pattern is similar to those on the Comprehensive Test of Phonological Processing (CTOPP) (Wagner, Torgesen, and Rashotte, 1999). Previous research has demonstrated that the number of items is adequate to measure students' PA. A native English speaker recorded all the items on a CD in English, and the time interval between items was fixed at five seconds. During testing, the tester and the student each used headphones so as not to be influenced by environmental noises. The tester asked each student to listen to the CD with headphones. In each practice item, four words were presented orally, and the student was asked to indicate which one of the words began with a different sound from the other three words. The student

responded by pointing to one of four options on an answer sheet, which had the numerals, 1, 2, 3, and 4 in separate squares, each representing one of the four words in one item. For example, after listening to *rot*, *rod*, *rock*, and *box*, the student was expected to choose option 4 on the answer sheet, referring to the fourth word *box*. Once the student finished the two practice items and was familiar with the test, the student was given the 10 test items. Similarly, in English final sound detection, the student was asked to choose which one of four words ended with a different sound from the other three words. The total of the initial and final sound detection scores was termed English PA. The reliability coefficients of English PA in Grades 2 and 4 were .84 and .64, respectively. The score was the number of correct answers, and all students' scores were marks of correct answers out of 20.

Chinese Sound Detection. The Chinese initial and final sound detection tests developed by Liao, Georgiou, & Parrila (2008) were adapted and administered to each student to assess Chinese PA (onset-rhyme awareness). Monosyllabic Chinese words were used in the task. Tones of syllables were controlled so that all four syllables in each item were in the same tone. There were ten initial sound detection items and 10 final sound detection items, each preceded by two practice items. The Cronbach's alpha coefficients in Liao et al.'s study were .83 for Grade 2 and .62 for Grade 4, which were acceptable. All the items were recorded on a CD in Mandarin by a native Chinese speaker, and the interval between items was fixed again at five seconds. The same procedure used in the English sound detection tests was used in the Chinese sound detection tests.

Chinese Tone Detection. Because Chinese is a tonal language in which a change in tone always changes the meaning of a syllable (Ho & Bryant, 1997), tone awareness is an additional facet of Chinese PA (Li, Anderson, Nagy, & Zhang, 2002). An individually-administered tone-detection test adapted from that developed by Liao, et al (2008) was administered to all participants. Two practice items and 10 test items were given. The Cronbach's alpha coefficients in Liao et al.'s study were .71 for Grade 2 and .65 for Grade 4. The same procedure used in the English and Chinese sound detection tests was used here. A further score, termed Chinese PA, was created by adding the scores of Chinese sound detection and Chinese tone. Chinese PA measure has three tasks (initial sound detection, final sound detection, and tone detection) which had 30 items in total, but English PA measure has only two tasks (initial sound detection and final sound detection), which had 20 items altogether. The reliability coefficients of Chinese PA in Grades 2 and 4 were .88 and .78. The score was the number of correct answers and all students' scores were marks of correct answers out of 30.

Outcome Measures

English Listening Comprehension Measures (Cambridge Young Learners English (YLE) Listening). The Cambridge Young Learners English (YLE) tests for Listening were employed to assess English listening comprehension. The Cambridge YLE test is one of the most popular tests of English for speakers of

other languages throughout the world; in 2002, the tests were taken by approximately 260,000 children in 55 countries, and these numbers are said to be increasing rapidly (Cambridge ESOL, 2003). The YLE listening tests are written group-administered tests which take 20 minutes (Starters) for Grade 2 and 25 minutes (Movers) for Grade 4 students. The test includes four sections with 20 items at Grade 2 level and five sections with 25 items at Grade 4 level. Responses to short dialogues in the listening test include drawing lines, selecting, matching and coloring (Cambridge ESOL, 2007). The reliability coefficients of English listening in Grades 2 and 4 were .67 and .82 in these samples.

Control Measures

Chinese Achievement. School-issued achievement tests in Chinese from three different schools were employed to measure students' L1 achievement. Although there were different tests in different schools, the content of the tests was similar at each grade level. Pinyin identification, writing Chinese characters, making up sentences, and reading comprehension were included, and the percentage for each section varied across grades. All students' scores were based on a 100-point scale.

Mathematics Achievement in Chinese. School-issued achievement tests in mathematics in three different schools were employed to assess and control the group differences. The content of the mathematics tests was similar across schools in each grade. Both grades had sections on addition, subtraction, and logic, but the percentage for each section varied across grades. All students' scores were based on a 100-point scale.

Procedure

The school-issued achievement tests in Chinese and mathematics were administered at the end of the last term of the previous academic year. The other tests were administered by our research group. The Cambridge YLE for Listening was administered to all students before the individual PA and NS tests. The English PA and NS testing sessions were approximately 15 minutes in length, and the Chinese sessions were 20 minutes. Both were administered by four testers who were fluent in both English and Chinese. The two testing sessions were conducted consecutively. Half of the students received the English PA tests first and the Chinese PA tests second, whereas the other half of the students received the Chinese PA tests first and the English PA tests second.

RESULTS

Descriptive Statistics

The means and standard deviations of raw scores of all predictors, control measures, and outcome measures of English-immersion students in Grades 2 and 4 are shown in Table 1. We mentioned that the Chinese and mathematics achievement measures were issued by the three schools in Grade 2 and in Grade 4. Although the

curriculum of the three schools and the content of the measures of Chinese achievement and mathematics achievement were similar, the tests are not the same across schools within grade, which means that they cannot be included in the same analysis unless standardized scores based on sample means for each grade are calculated. Therefore, the raw scores of each school at the two grade levels were converted to standardized scores separately in the following data analyses. Measures whose skewness or kurtosis values fell outside of the acceptable range (i.e., the absolute value of Skewness/SE or Kurtosis/SE >3.09) were transformed according to the guidelines provided by Tabachnick and Fidell (2007). Square root, logarithmic, and inverse transformations were applied as appropriate. All transformed measures were within acceptable range.

Table 1: Descriptive Statistics of Total Scores of each Measure for Chinese English-Immersion Students at Grades 2 and 4

Variable	Grade 2 (N = 48)		Grade 4 (N = 47)	
	M	SD	M	SD
English phonological awareness	13.67	4.65	17.60	2.31
Chinese phonological awareness	17.63	6.75	22.50	4.62
English listening comprehension	7.15	3.19	7.71	4.63
Chinese achievement	97.79	2.16	94.85	4.04
Mathematics achievement	96.06	4.03	93.63	4.71

Correlations among in Grades 2 and 4 Students English and Chinese Measures

The correlation coefficients among English and Chinese measures for English immersion students in Grades 2 and 4 are shown in Table 2. For Grade 2, there are significant correlations between English PA and English listening comprehension, as well as between Chinese PA and English listening comprehension. Most notably, English PA is highly correlated with Chinese PA, $r = .81$, $p < .01$. For Grade 4, a similar pattern was found, though the correlation between the two PA scores was lower, $r = .46$, $p < .01$.

Table 2: Correlations among English and Chinese Measures in Grades 2 and 4 Students

Variable	1	2	3	4	5
1.English PA	--	.46**	.38**	.33*	.38**
2.Chinese PA	.81**	--	.33*	.43**	.38**
3.Listening Comprehension	.41**	.40**	--	.01	.17
4. Chinese Achievement	.35*	.53**	-.03	--	.59**
5. Math Achievement	.40**	.51**	.27	.25	--

Note. Grade 2 correlations are below the diagonal; Grade 4 correlations are above the diagonal. The number of students is 48 in Grade 2 and 47 in Grade 4

PA = Phonological Awareness
**$p < .01$, *$p < .05$

Prediction of Phonological Awareness from English Listening Comprehension in Immersion Students

A series of hierarchical regression analyses was conducted to assess the effect of English listening comprehension on English PA in the Chinese English-immersion students. In the first analysis (see Table 3, steps 1 and 2), Chinese and mathematics achievement were entered first into the regression equation at step 1 to control for students' general background and prior achievement. In the second step, English listening comprehension explained a further 10% and 13% of the variance in Grades 2 and 4 English PA, respectively.

Table 3: Regression Analyses Predicting English PA from English LC and Chinese PA for Students in Grades 2 and 4

Step, Predictor variable	Grade 2			Grade 4		
	β (step)	β (final)	ΔR^2	β (step)	β (final)	ΔR^2
1. Chinese achievement	.25*	.31*		.13	.15	
Math achievement	.38**	.26*	.27**	.31*	.21	.16*
2. English LC	.33*	.33*	.10*	.37**	.37**	.13**
2A. Chinese PA	.89**	.85**	.40**	.36*	.25	.10*
3A. English LC	.08	.08	.01	.29*	.29*	.07*

Note. **$p < .01$, *$p < .05$
LC = Listening Comprehension; PA = Phonological Awareness

In the second analysis (see Table 3, steps 1, 2A, and 3A), Chinese and mathematics achievement were again entered first into the regression equation at step 1. Chinese PA was entered in the second step to control for L1 PA. This model accounted for a further 40% and 10% of the variance in English PA in Grade 2 and Grade 4, respectively. Then in the third step, English listening comprehension was entered and it significantly predicted a further 7% of the variance in English PA in Grade 4.

Prediction of English Listening from Phonological Awareness in Immersion Students

A series of hierarchical regression analyses was then conducted to assess the contribution of English and Chinese PA to English listening comprehension and to search for evidence of cross-linguistic transfer. These analyses are summarized in Table 4. To control for the variance attributed to the students' first language achievement and other academic factors that influence listening comprehension, Chinese and mathematics achievement were entered first into the regression equation at step 1. In step 2, English PA was entered in the equation. Chinese PA was

forced into the regression equation at the final step 3. English listening comprehension was the dependent variable. In a second analysis, the order of steps 2 and 3 was reversed.

Table 4: Regression Analyses Predicting Listening Comprehension from English and Chinese PA for Students in Grades 2 and 4

Step, Predictor variable	Grade 2			Grade 4		
	β (step)	β (final)	ΔR^2	β (step)	β (final)	ΔR^2
1. Chinese achievement	-.16	-.35*		-.05	-.16	
Math achievement	.37*	.16	.27**	.27	.11	.06
2. English PA	.39*	.18	.11*	.41**	.32*	.14**
3. Chi PA	.34	.34	.03	.26	.26	.05
2A. Chinese PA	.50**	.34	.13**	.38*	.26	.11*
3A. English PA	.18	.18	.01	.32*	.32*	.08*

Note. The number of students is 48 in Grade 2 and 47 in Grade 4
*$p < .05$, **$p < .01$

In the first analysis (See Table 4, steps 1, 2, and 3.), the results indicate that English PA significantly predicted English listening comprehension and explained a further 11% and 14% of the variance in English listening comprehension in Grades 2 and 4, respectively. However, Chinese PA did not add further significant variance to English listening comprehension after English PA.

In the second analysis (See Table 4, steps 1, 2A, and 3A.), Chinese PA significantly accounted for a further 13% and 11% of the variance in English listening comprehension in Grades 2 and 4, respectively. The most striking part of this analysis is that English PA still added an extra 8% of the variance to English listening comprehension beyond that contributed by Chinese PA in Grade 4, but not in Grade 2. This demonstrates that English PA is a unique predictor of English listening comprehension in Grade 4 even if Chinese (L1) and mathematics achievement and Chinese (L1) PA are controlled.

DISCUSSION

This study investigates the relationship between English PA and English listening comprehension and further explores the evidence for cross-linguistic transfer of PA for Chinese English-immersion students.

Relationship between PA and listening comprehension in English (L2)

The results of hierarchical regression analyses showed an association between English PA and English listening comprehension. Not only did English listening comprehension have an effect on English PA development, but also English PA played a role in the development of English listening comprehension.

This study indicates that English listening comprehension made a contribution to English PA after controlling for Chinese and mathematics achievement in both Grade 2 and Grade 4. This effect held even after controlling Chinese PA in Grade 4 (but not in Grade 2), which suggests that the English proficiency of the immersion students has improved to the point at which it is exerting a language-specific effect on PA in Grade 4. The results are consistent with those of previous studies in which spoken language had an effect on the development of PA (Caravolas & Bruck, 1993; Cheung et al., 2001). The representation underlying phonological awareness is associated with and shaped by spoken language experience. Our results suggest that spoken language experience affects phonological awareness development at the onset-rime level (the level at which PA was measured).

The results from our study also indicate that English PA is a significant predictor of English listening comprehension for Chinese English-immersion students. Because PA deals with speech sounds and helps listeners distinguish different phonological representations associated with the oral language input (Cheung, 2007), it should facilitate listening comprehension. For example, the phonological representation derived from listening to the spoken word /meik/ would result in the word "make" being recognized by the listener, after which the listener will retrieve the meaning of this word and further process the sentence in listening comprehension. In addition, English PA accounted for more variance in listening comprehension in Grade 4 than in Grade 2. In Grade 2, these students had just begun to learn English, that is, to learn to recognize whole English words but without having attention directed to their internal details (e.g., spelling). By Grade 4, they had learned spelling and phonological decoding and had paid more attention to sounds and letters in an analytic way—processes which increased PA. These results suggest that PA is an important component of listening skills that allow children to make sense of spoken language.

With regard to the relationship between English PA and English listening comprehension, the most important finding in our study is the unique effect of English listening comprehension on English PA and the unique effect of English PA on English listening comprehension, after controlling for Chinese and mathematics achievement, as well as Chinese PA in Grade 4. These results mean that English PA and Chinese PA become more distinct constructs after students grasp more English skills in later grades. The English of immersion students had improved to the point that it had a language-specific effect on PA; the English-specific PA skill is more important especially at the higher grade level.

Although the literature on factors contributing to listening comprehension suggests that prior knowledge, phonological memory skill, vocabulary knowledge, and metacognitive knowledge can predict growth in listening comprehension (French, 2003; Long, 1990; Mecartty, 2000; Vandergrift, 2006), limited research has been done to explore the role of PA in listening comprehension for English immersion students. In order to control the above potential factors which could influence listening comprehension, we controlled for Chinese (L1) and

mathematics achievements because these two achievement scores should be related to these academic factors. The findings add a new predictor to the development of listening comprehension for L2 learners. PA is the ability to manipulate sound structures, and it helps identify the words in spoken language. Furthermore, it allows participants to identify, interpret, and attach meaning to sound. As students listen to a text, they need to be aware of different sounds in words to help them recognize the meanings of these words. Listening comprehension depends on the details of word recognition, and it cannot be successful without the identification of words and the subsequent retrieval of their meanings (Perfetti et al., 2005). In the bottom-up process of listening comprehension, L2 listeners are expected to discriminate sounds in order to build up a mental representation of a text message (Hulstijn, 2001), which also highlights the importance of PA in L2 listening comprehension.

As we indicated in the literature review, L1 listeners can process L1 listening materials unconsciously and effortlessly because they have advanced oral language proficiency. However, for L2 listeners, the case is probably not the same. They need to concentrate on the details of individual words given the speed of speech and the inability of working memory to process all the information within the time limitations (Vandergrift, 2007). The important result of the current study is that L2 PA is a significant predictor of L2 listening comprehension. This is consistent with the results of previous research that L2 listeners tend to use more bottom-up processing in comprehending listening when they construct meaning by gradually combining larger units of meaning from the phoneme-level up to discourse-level (Davis & Bistodeau, 1993; Lund, 1991)—a fact that is particularly true for beginning L2 learners.

Taken together, our results demonstrate a bidirectional relationship between PA and listening comprehension. Individual differences in sensitivity to the sound structure of spoken language influence the development of listening comprehension. Likewise, individual differences in listening comprehension influence the development of PA. Longitudinal studies will be required to test the details and time course of these causal connections.

Cross-linguistic transfer from PA in Chinese to listening comprehension in English

In the present study, there is a high correlation between English PA and Chinese PA. English PA proved to be a strong predictor of English listening comprehension at both grade levels; therefore, we are interested in whether Chinese PA would also predict English listening comprehension.

We have indicated in the literature review that two different methods have been used to address this issue. The liberal method controls only background factors, such as L1 achievement (Chinese) and general mental ability. The second method is more conservative because it also controls for PA in the language of the outcome achievement variable. When we used the liberal method, Chinese

PA significantly predicted English listening comprehension in both Grades 2 and 4, after controlling for Chinese achievement (L1) and mathematics achievement. This may be due to the instruction of children in pinyin in the early grades. Every Chinese child spends the first ten weeks of Grade 1 learning pinyin. Pinyin is a Latin alphabetic system that represent the sounds of Chinese characters and helps in pronouncing characters before Chinese character instruction begins. Research has indicated that the pinyin system improves phonological awareness (Cheung et al., 2001; Siok & Fletcher, 2001). For example, Cheung et al. (2001) reported that children in mainland China who had learned the pinyin system performed better than their Hong Kong counterparts, who had not been taught pinyin, on an onset and coda matching task. According to Comeau et al. (1999), PA is considered to be a general language ability which can be transferred across languages. Research also suggests that Chinese children's PA can transfer to their English reading because the pinyin system uses the same Latin alphabet as English, though Chinese and English are in different orthographies (Chow et al., 2005; Gottardo et al., 2001).

On the other hand, when we used the conservative method, Chinese PA did not contribute to the prediction of English listening comprehension at either grade level after controlling for English PA. The lack of cross-linguistic transfer in the conservative method may be a result of controlling for too many variables: For example, if L1 PA contributes to L2 PA, then controlling for L2 PA may eliminate the effect of L1 PA. Possibly, the effect of L1 PA is mediated by L2 PA (See Table 3, step 2A). Chinese (L1) PA is strongly associated with English (L2) PA, especially in the earlier grade. Therefore, according to the two different results obtained from the two methods of exploring cross-linguistic transfer, it is difficult to provide a firm conclusion. The best way to resolve this is through an experimental design, in which L1 PA is taught explicitly to ascertain whether it improves L2 PA and then L2 listening comprehension and reading.

Our study indicates that the relationship between L1 PA and L2 listening comprehension may be indirect and that little evidence exists to indicate cross-linguistic transfer of students' Chinese PA to their English listening comprehension. Existing literature has focused only on cross-linguistic transfer from Chinese PA to English reading (Chow et al., 2005; Gottardo et al., 2001; Knell et al., 2007). If we accept the liberal analysis, our results suggest that PA may be transferred from one language to the other, though these two languages share completely different oral languages. Thus, our study demonstrates that cross-linguistic phonological transfer could also occur in listening development.

CONCLUSIONS AND LIMITATIONS

This study examines the relationship between PA and listening comprehension and explores whether cross-linguistic transfer exists in Chinese English-immersion students. We found evidence consistent with a bidirectional relationship between

English PA and English listening comprehension. English listening comprehension has an effect on English PA in both Grades 2 and 4, and this effect holds even after controlling Chinese PA in Grade 4. English PA is a stronger predictor for English listening comprehension in Grade 4 than in Grade 2. Some evidence exists of cross-linguistic transfer that enabled students' L1 (Chinese) PA to contribute to their L2 (English) listening comprehension, but the evidence is not strong.

Some limitations of this study are worth mentioning, and these should be addressed in future investigations. First, the sample size was relatively small. Therefore, our findings require replication to establish their generality, not only at Grade 2 and Grade 4 but also at other grade levels. The relatively small sample size may have concealed the effects of PA, especially in the cross-linguistic transfer analysis; greater sample numbers would have provided more evidence and stability. Second, the Chinese and mathematics achievement measures used in this study at the two grade levels were different for the three schools and were from school-issued exams. The reliability and validity of these measures have not been calculated because we had only the total scores of each achievement test from schools, and no criterion measures were available to which the scores could be compared. Third, this study did not control for students' prior knowledge, memory, vocabulary knowledge, and strategies, etc. Although we used L1 and mathematics achievement to control these variables in a general way, future research is needed to examine the relationship between PA and listening comprehension with more explicit consideration of these factors. Fourth, the present study measured only one type of PA using the task of sound detection; thus, in future research, different levels of PA tasks, and more tasks, should be included to obtain a more complete understanding of how PA relates to listening comprehension for Chinese students. Finally, it is important to remember that our design was correlational in nature. In showing existing relationships among factors, we have not uncovered the causal mechanisms; this goal will require further and different studies.

Despite these shortcomings, this study has provided empirical evidence on the relationship between PA and listening comprehension. The findings have implications for the rapidly growing immersion programs around the world and in China particularly. To enhance conventional literacy teaching focusing on visual and contextual cues, educators could use PA instruction, such as rhyming, segmenting, and blending sound units (Adams, Foorman, Lundberg, & Beeler, 1998), in early grades to support both listening and reading activities. The cross-linguistic transfer evidence suggests that this instruction could begin in Chinese (L1) but should progress to English (L2) to capture its unique effect. Although PA instruction may not provide an immediate effect, it should be beneficial in facilitating students' language learning in the long term.

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