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Developmental trends and precursors of English spelling in Chinese children who learn English-as-a-second language: Comparisons between average and at-risk spellers

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ABSTRACT

Background: Invented spelling has been viewed as a window to young children's spelling development.

Aims: This longitudinal study investigated the developmental trends in invented spelling as a function of phoneme position in very young ESL children. It also investigated cognitive-linguistic precursors of L2 spelling difficulties.

Methods and procedures: We identified 2 groups of spellers in kindergarten based on their invented spelling performances at the end of kindergarten: average spellers and at-risk spellers. The two groups were compared on invented spelling performance at varied phoneme positions of a word. They were also administered a battery of cognitive-linguistic tasks, including letter knowledge, phonemic awareness, vocabulary and rapid automatized naming at an earlier time-point.

Outcomes and results: Both groups performed better in invented spelling on initial consonants than on medial vowels, which in turn were better than final consonants at two time points. In addition, the average spellers improved significantly more than the at-risk spellers at all phoneme positions. Vocabulary was a significant predictor of spelling difficulties when other crucial cognitive-linguistic variables were taken into consideration simultaneously.

Conclusions and implications: The current findings suggest the unique features of invented spelling development in L2 learners and identified precursors to L2 spelling difficulties. Very young average and at-risk L2 spellers showed differential gains in L2 invented spelling. Implications of the present study are (1) invented spelling at kindergarten is able to differentiate average and at-risk spellers and (2) invented spelling training and vocabulary intervention could be useful in the remediation of spelling difficulties.

What this paper adds?

Unlike previous spelling studies, focusing mostly on the spelling development of L1 English learners, we examined this phenomenon in young children learning English-as-a-second-language (ESL). We investigated the spelling developmental trends in two groups: average and at-risk spellers. Past research has suggested the importance of phonology in learning to spell. Specifically, L1 children's invented spelling in initial and final consonants comes earlier than in the middle sound. The novel contribution of this

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study is its examination of whether the developmental trend in ESL children is the same as that in L1 children. This was done by analyzing spelling data using a fine-grained scoring system taking phonological features into account. The results suggested that ESL children in both groups performed more poorly on final consonants than on beginning and middle sounds. The patterns of performance in invented spelling at varied phoneme positions are different for L1 and L2 learners of English. The reasons could be that, for the L2 learners, the ending consonant is absent in their L1 spoken language (i.e. Cantonese) or it could be due to limited L2 linguistic input. In addition, we found that average spellers outperformed at-risk spellers on invented spelling at varied phoneme positions and improved significantly over time, suggesting that invented spelling can differentiate these two groups of spellers before they can spell conventionally. Another important aspect of the current study is that we identified vocabulary as a significant precursor of spelling difficulties above other crucial cognitive-linguistic skills in Chinese ESL young children.

1. Introduction

Spelling is an important foundation skill in literacy development (Treiman, 1998). Spelling a word requires the integration of different aspects of linguistic information pertaining to the word, including phonological, orthographic, morphological and semantic information. For young children, invented spelling is a window for looking at the utilization of linguistic knowledge of words (Read & Treiman, 2013). Children at the age of 5 or 6 start to represent sounds in spoken words when they are asked to spell (Ehri, 1998; Treiman, 2017). It was anticipated that this examination of young children's invented spelling would provide insights about spelling development and future literacy skills (Treiman, Kessler, Pollo, Byrne, & Olson, 2016).

While spelling development is understood better for first language (L1) learners of English, much less is known about how it occurs in young children learning English-as-a-second-language (ESL). L1 spelling studies have demonstrated the importance of phonology in learning to spell (Treiman, 1993). L2 learners' spelling may be influenced by the phonology of the L2 as well as their L1 (Wang & Geva, 2003) and limited L2 linguistic input (Hong & Chen, 2011). For instance, L2 children may mix up some sounds easily (e.g. /r/ -/l/ contrast; Miyawaki et al., 1975) or be unable to represent phonemes that are absent in their L1 (e.g., Wang & Geva, 2003). However, no prior study has examined the invented spelling performance as a function of phoneme position (initial consonant vs. vowel vs. final consonant) in young ESL learners. The first aim of this study was to examine developmental trends in invented spelling at varied phoneme positions in Chinese ESL children who were average or at-risk spellers.

Given the importance of early identification and intervention to address literacy difficulties (Partanen & Siegel, 2014), the second goal of the study was to investigate cognitive-linguistic precursors of L2 spelling difficulties. Past studies have shown that the cognitive-linguistic precursors of literacy skills are possibly different for L1 and L2 learners of English (Yesil-Dagli, 2011; Yeung, 2018), and recent research has demonstrated the unique role of vocabulary in Chinese ESL children's beginning reading and spelling (Liu, Yeung, Lin, & Wong, 2017; Yeung, Liu, & Lin, 2017). Therefore, we wanted to examine if earlier vocabulary skills would be a unique precursor of future spelling difficulties in young Chinese ESL children and able to differentiate average and at-risk spellers when other important cognitive-linguistic skills were taken into account.

1.1. Invented spelling in a second language

Invented spelling generally refers to children's efforts to represent words in print (Read, 1971). Prior to receiving formal education, young children often attempt to create novel spellings to represent what they hear (Ouellette & Sénéchal, 2017). Such early pre-conventional spellings progress gradually over time from initial scribbling to representations of words that capture phonological and orthographic features (Sénéchal, Ouellette, Pagan, & Lever, 2012; Treiman, 1993). These early spelling attempts, referred to as invented spelling, are children's spontaneous efforts rather than memorization or recall of conventional spellings (Ouellette & Sénéchal, 2008b). Though non-conventional in nature, invented spelling provides a window showing children's early literacy development (Treiman, 1993). An example of invented spelling task is one in which children are asked to spell several words which are presented orally by the experimenter, such as *dog*, *boot* and *train*. Ouellette, Sénéchal and colleagues demonstrated, in a series of studies, that invented spelling contributed uniquely to reading and spelling beyond well-researched cognitive-linguistic skills such as phonological awareness and letter knowledge (Ouellette & Sénéchal, 2008a, 2017; Sénéchal, 2017; Sénéchal et al., 2012). Their studies also showed that invented spelling predicted future conventional spelling and future reading and was a mediator between phonological awareness and early reading.

Studies have shown that invented spelling training is more effective than phonological awareness training in promoting word-reading skills (Ouellette, Sénéchal, & Haley, 2013). Invented spelling training generally involves encouraging children to try their best to spell dictated words and then providing individualized feedback on their attempts (e.g., Ouellette & Sénéchal, 2008a; Sénéchal et al., 2012). Unlike spelling training, which emphasizes error-correction procedures or repeated practice, invented spelling training focuses on analytical strategies and allows children to create their own spellings, albeit incorrect attempts (Gettinger, 1993). Invented spelling tasks can also be used to identify children with reading difficulties (Mehta, Ding, Ness, & Chen, 2018). Recently, evidence has emerged about the significant role of ESL children's invented spelling of English in predicting conventional spelling and reading (Ding et al., 2018).

For L1 learners of English, it has been found that invented spelling of consonants in the initial and final positions of one-syllable words come earlier than that of the middle sound (Ehri, 2005; Lee & Scanlon, 2015; Morris, Bloodgood, Lomax, & Perney, 2003). Initial phonemes are easy to spell, possibly because they require less of a processing load to store them in working memory while mapping them to graphemes almost simultaneously (Stage & Wagner, 1992). The ending phonemes are spelled more accurately than medial phonemes due to the recency effect. There are several possible explanations for poor performance on medial vowels. Treiman,

Berch, and Weatherston (1993) pointed out that vowels tend to appear in the middle of words (e.g., consonant-vowel-consonant; CVC words), which contributes to spelling difficulty. Although phoneme positions appear to be a cause of difficulty, the vowel status also seems to affect children's spelling performances. According to Hanna, Hanna, Hodges, and Rudorf (1996), vowel phonemes often have more possible spellings than consonant phonemes, leading to confusion. Besides, due to the co-articulation effect, it is hard to distinguish vowels when they are overlapped with other phonemes (Stage & Wagner, 1992). To our best knowledge, few studies have looked into ESL children's invented spelling as a function of the phoneme position in a word. This study examined whether previous findings about native-English speaking children could be generalized to other ESL populations.

Typological differences between L1 and L2 may affect L2 spelling performance (Wang & Geva, 2003). For Chinese ESL learners with a nonalphabetic L1, differences in the phonological features in the Chinese and English spoken languages should be considered when attempting to understand the L2 spelling (Leong, 2009; Wang & Geva, 2003). Wang and Geva (2003) reported that Chinese ESL children in elementary grades had difficulty representing phonemes absent from the spoken phonology of the participants by examining their spelling errors.

Hong and Chen (2011) demonstrated that final phonemes were spelled more poorly than initial phonemes and medial phonemes in a non-word spelling task given to Chinese ESL children in Grade 6 in Taiwan. They suggested that children might not be able to distinguish voiced consonants from voiceless consonants in the final position. Given that voiced sounds appear to be voiceless in the final position in English, L2 children were likely to omit the sound easily. This omission may also be attributed to the absence of this kind of differentiation (voiced consonants vs. voiceless consonants) in their L1 phonology. Alternatively, Hong and colleagues argued that limited oral linguistic input may be another factor that accounts for the difference between L1 and L2 children's spelling development at varied phoneme positions. Due to insufficient oral linguistic input for L2 children, mapping between phonemes and graphemes in the initial and middle positions imposed substantial processing loads, which limited the L2 children's ability to process the final phonemes.

The participants in the present study were young Chinese children whose spoken L1 was Cantonese. In Cantonese, while there are some similar phonemes such as /m/, /p/ and /s/ as in English, stop consonants in the final positions are absent from spoken Cantonese. The goal of the present study was to examine whether the difficulty in representing phonemes in different positions (initial, middle or final) for Chinese ESL young children would be the same as their English monolingual counterparts. We argue that, with the influence of L1 spoken language phonology, it would be easier for Chinese ESL children to represent phonemes in the middle position (i.e. the vowel a CVC words) than in the final position. Although there is evidence showing the influence of L1 phonology on L2 spelling, no studies, to our best knowledge, have examined invented spelling performance at varied phoneme positions by very young ESL children who are at-risk of spelling difficulties.

1.2. Invented spelling development of at-risk children

Spelling has increasingly been regarded as a cognitive and analytical process whereby oral language is represented in print (Shahar-Yames & Share, 2008; Treiman & Bourassa, 2000). It draws upon the integration of phonological, orthographic and morphological skills as children decode words into phonemes, translate phonemes into a grapheme and synthesize letters and orthographic representations (Treiman, 1993). Given such complex cognitive processing, young children often make mistakes in spelling words (Treiman et al., 2016). Thus, examining invented spelling and spelling errors can provide a valuable way to index children's spelling difficulties as well as screen at-risk spellers from typically developing spellers.

A handful of studies has examined invented spelling development in children who are at-risk of reading or spelling difficulties. Invented spelling has been shown to be able to differentiate struggling readers from typical readers (Clemens, Oslund, Simmons, & Simmons, 2014; Mehta et al., 2018; Ouellette & Sénéchal, 2008a). Clemens et al. (2014) demonstrated that invented spelling scores in kindergarten predicted reading skills one year later in monolingual English readers who were at-risk for reading difficulty at school entry. Interestingly, struggling readers of Chinese in Grade 4 performed significantly worse on invented spelling in Chinese than their peers with average reading levels (Ding, Liu, McBride, & Zhang, 2015). Taken together, children who struggle with invented spelling in early years seems to be at-risk for reading and or spelling difficulties across languages. Many related studies have examined the spelling performances of children with reading difficulties (Clemens et al., 2014) or other developmental challenges (Asberg Johnels, Kopp, & Gillberg, 2014; Cordewener, Bosman, & Verhoeven, 2012). Very limited research has focused on invented spelling difficulties in the early years from a developmental perspective. The present study extended the current understanding of invented spelling difficulties over time in young L2 learners.

1.3. Precursors of spelling difficulties

Early reading and reading-related skills tend to predict future literacy outcomes. The identification of the precursors of reading, spelling and writing difficulties is important for early identification and intervention. Numerous studies have examined differences in language and cognitive skills in typical children and those at-risk of literacy difficulties.

While most of this research focused on predicting reading difficulties, much less research has been conducted specifically on spelling difficulties. From a handful of studies focusing on spelling development, past research has found that letter knowledge (Cordewener et al., 2012; Torppa, Georgiou, Niemi, Lerkkanen, & Poikkeus, 2017), phonological awareness (Furnes & Samuelsson, 2010; Wimmer & Mayringer, 2002) and rapid automatized naming (RAN; Furnes & Samuelsson, 2010; Lervåg & Hulme, 2010) are important precursors of invented spelling as well as conventional spelling.

For ESL children's spelling development, research to date has found that spelling development draws on similar cognitive and

linguistic skills irrespective of ESL status (Geva, 2006). Similar to the findings from L1 children, Harrison et al. (2016) reported that phonological awareness and RAN predicted single-word spelling performances of ESL children in third grade. Li, McBride-Chang, Wong, and Shu (2012) found RAN to be the only important predictor when compared to vocabulary and phonological awareness of L2 spelling of Chinese ESL children at age 10. Yeung et al. (2017) demonstrated the significance of initial level and growth in phonemic awareness in predicting spelling skills in this group of children.

In this study, we were especially interested to investigate the role of vocabulary as a precursor of spelling difficulties, as this issue in relation to Chinese ESL children is less understood for several reasons. First, due to irregular grapheme-phoneme correspondence in English, children's vocabulary is probably important for reading and spelling English beyond phonological awareness and letter knowledge, especially for irregular words (Ricketts, Nation, & Bishop, 2007). However, the role of vocabulary in spelling has received little research attention (Ouellette & Sénéchal, 2008a, 2008b). Existing findings have shown weak to moderate relationships between vocabulary and spelling in English monolinguals (Caravolas, Kessler, Hulme, & Snowling, 2005; Sénéchal & LeFevre, 2002). No studies, to our best knowledge, have examined the role of vocabulary over and above phonological awareness and letter knowledge in young ESL children's spelling. Second, vocabulary is a significant predictor of reading for young Chinese ESL children (Liu et al., 2017; Yeung & Chan, 2013). Chinese ESL children who are at-risk of reading difficulties have been shown to have smaller receptive and expressive L2 vocabularies than typical readers (Yeung, 2018). Therefore, we argue that vocabulary may be a significant precursor of spelling difficulties. Third, Chinese ESL children tend to have weak phonological skills, as compared to other ESL groups and monolinguals (McBride-Chang, Bialystok, Chong, & Li, 2004; Yeong, Fletcher, & Bayliss, 2017). In reading and spelling, children may rely more on lexical knowledge based on the influential triangle model of reading and spelling, which describes phonology, orthography and semantics as three critical component processes (Seidenberg, 2005; Treiman, 1993).

1.4. Research questions and hypotheses

In this 1-year longitudinal study, we examined the developmental trajectory of invented spelling when children were in their final year of kindergarten, by following them for a year. We focused on Chinese ESL children and administered a battery of cognitive-linguistic measures to them. There were three research questions and three hypotheses in this study:

- (1) What is the spelling performance of average and at-risk Chinese ESL spellers as a function of phoneme position? We hypothesized that for both average and at-risk Chinese ESL spellers, given the linguistic features of spoken L1, invented spelling performance would be better for the initial consonant, followed by the vowel, and then the final consonant.
- (2) Do average and at-risk Chinese ESL spellers show differential growth in invented spelling over the last year of kindergarten? We hypothesized that at-risk spellers would perform significantly worse over time than average spellers on invented spelling of all phoneme positions.
- (3) What are the significant cognitive-linguistic precursors of L2 spelling difficulties? We hypothesized that vocabulary would be a significant predictor of Chinese ESL children's L2 spelling difficulties when phonemic awareness, letter knowledge, and RAN were considered statistically.

2. Method

2.1. Participants

The whole sample of the present study consisted of 338 children (176 boys and 166 girls) who were in their final year of kindergarten education. They came from 12 kindergartens located in different geographic districts in Hong Kong in which Cantonese was the medium of instruction. All the schools implemented a voucher system in which tuition was subsidized by the Hong Kong government. Therefore, the participating children in each school came from similar socioeconomic backgrounds. All children were Chinese ESL learners whose daily communication language was Cantonese. Their mean age was 63.27 months ($SD = 3.70$). At-risk spellers were identified based on their performances on the invented spelling task at the end of the school year. Children who scored in the bottom 20% on the invented spelling task were identified as at-risk ($n = 62$). Sixty-one average spellers were chosen randomly from the remaining sample to form the comparison group. Table 1 shows the invented spelling performances of children in the two groups (at-risk vs. typical spellers). The two groups were not significantly different on age ($p = .9$) and non-verbal intelligence ($p = .2$) as shown in Table 2.

In Hong Kong, children start to learn read and write Chinese and English simultaneously in kindergarten, commonly starting around age 2–3. Formal reading and writing instruction usually begin at the age of 5. By the final year of kindergarten education, children are expected to be able to name all letters of the English alphabet and write simple English sentences in preparation for formal education. English is learnt as a school subject and children, on average, receive around 60–90 minutes of instruction per week (Ng & Rao, 2013). Parental expectations about second language learning are high because of its importance for future academic success (Lau & Rao, 2013).

2.2. Measures

Measures of cognitive-linguistic skills and invented spelling were administered. The internal consistency coefficients for all of the measures are presented in Table 2.

Table 1

Means and Standard Deviations for Coding Results in Percentages from Invented Spelling Task by Groups (Average Spellers vs. At-risk Spellers) at Time 1 and Time 2.

	Average speller			At-risk spellers		
	T1	T2	Change over time	T1	T2	Change over time
<i>Invented Spelling</i>						
<i>Initial Consonant</i>						
M	.58	.80	.22	.25	.32	.7
SD	.34	.23		.30	.32	
<i>Medial Vowel</i>						
M	.34	.61	.27	.04	.14	.10
SD	.28	.26		.09	.18	
<i>Final consonant</i>						
M	.30	.59	.29	.00	.03	.3
SD	.31	.25		.00	.07	
<i>Total</i>						
M	.42	.67	.25	.11	.18	.7
SD	.27	.22		.13	.17	
<i>Conventional Spelling</i>						
M	1.13	3.00	1.87	.00	.00	0
SD	1.50	1.65		.00	.00	

Table 2

Means, Standard Deviations, Reliabilities and Independent t-tests results for all cognitive-linguistic measures by groups (Average Spellers vs. At-risk Spellers).

Measures	Max	Range	Reliability				<i>t</i>	<i>p</i>	
				Average spellers	At-risk spellers				
M	SD	M	SD						
Age in months	N/A	57-76	N/A	63.53	3.95	63.43	3.58	.16	.88
Non-verbal intelligence	12	1-11	0.77	5.98	2.67	5.45	2.59	1.02	.21
Letter knowledge	26	0-26	0.94	23.07	4.38	15.98	7.14	6.62	.001
Vocabulary	36	5-35	0.91	24.95	7.11	14.42	5.48	9.21	.001
Phonemic awareness	8	0-8	0.93	5.05	3.09	1.52	2.19	7.34	.001
RAN	N/A	10.50-44.00	N/A	18.06	5.83	23.63	6.44	5.03	.001

2.2.1. Letter knowledge

The children were presented with 26 lowercase alphabet letters arranged in random order and asked to say their names one-by-one. One point was given for each correct identification of a name; thus, the maximum score was 26.

2.2.2. Phonemic awareness

The measure of the phonemic awareness was a phoneme identification task (Muter, Hulme, Snowling, & Taylor, 1997). This task was used in previous studies to evaluate Chinese ESL children's phonemic sensitivity (e.g., Liu et al., 2017; Yeung, 2018; Yeung & Chan, 2013). The children were presented orally with a word and required to identify its first phoneme. To reduce cognitive load, corresponding pictures were shown. For example, for the item "dog" (the practice item), children first heard the word and were expected to say /d/. Two practice items with corrective feedback were provided before the actual testing with 8 items. Each correct identification of a phoneme received 1 point (maximum 8).

2.2.3. Vocabulary

Two measures of vocabulary (receptive vocabulary and expressive vocabulary) were administered. The Peabody Picture Vocabulary Test-Revised (PPVT) Form M (Dunn & Dunn, 1997) was used as a measure of receptive vocabulary. The children were asked to identify the picture, from four alternatives, that represented the word stimuli spoken by the experimenter. This task consisted of 24 English words from 2 to 6 year-old subsets. One point was assigned to each correct response (maximum 24). The expressive vocabulary was measured by a picture-naming task (Learning Disabilities Association of Alberta, 2009). Twelve pictures of common objects or animals were presented one-by-one. The children were asked to name each of them. One point was given for each correct answer. The maximum possible score was 12. A composite score of children's vocabulary was calculated by adding up the scores on receptive and expressive vocabulary.

2.2.4. Rapid automatized naming (RAN)

A digit RAN task was used. The children were asked to name 5 digits 5 times arranged in a random order as quickly as they could in Cantonese. Two trials were given and the average times needed for the two trials were calculated. Before the timed task, the children were asked to name the 5 digits to ensure they could name them at the time of assessment.

2.2.5. Invented spelling

A research-developed spelling task which has been used to measure spelling ability in young Hong Kong Chinese ESL children was adopted (Lin, Liu, Sun, Wong, & Yeung, 2017; Yeung et al., 2017). The task required children to write down the spelling of single-syllable English words which had been covered in their English curriculum as much as possible. There were 6 CV or CVC items in this task. For each item, the children were first presented with the word orally and then given a sentence containing the word to be spelled. We derived a conventional spelling score for each participant by evaluating the accuracy of spelling for each word in the task (the maximum score was 6), and thus the scores reflected the ability to dictate the words presented.

To reflect the invented spelling ability, the coding based on the Feature Points (FP) scoring system designed by Lee (2012), was used. This is similar to the well-known Developmental Spelling Test (DST; Tangel & Blachman, 1992). We used FP, but not DST, because the former allows for scoring phonetic feature points which can provide more fine-grained scales than the DST scoring system. The FP system allows the scoring on three dimensions: phonologically-based spelling, orthographic spellings, and emergent spelling characteristics. As the present study focused on the invented spelling at varied phoneme positions, we only adopted the scoring scheme for phonologically-based spelling. Three levels of the phonetic points were given to the alphabetic spelling of each phoneme. One point was given for the use of phonetically related letters (e.g., B for the /p/ in *pig*). Two points were given for the writing of a letter with a name or pronunciation similar to the phoneme (e.g., U for /o/ in *dog*). Three points were given for the correct or phonetically correct writing of a letter for the target phoneme (C or K for /k/ in *cow*). The scoring system was applied for each phoneme of the spelling task, and a total score was compiled for each phoneme position (initial consonant, final consonant and vowel). The full score of the present scoring system was 48. The full score for the initial consonant and medial vowel was 18 and the maximum score for the final consonant was 12. All spellings were rated by two independent raters. Inter-rater reliability for the phonetically-based scoring system was $r = .99, p < .001$.

2.2.6. Non-verbal intelligence

Raven's Colored Progressive Matrices (Raven, Court, & Raven, 1976) was adopted as a control measure to estimate the children's non-verbal intelligence. For each item, the children were shown a visual matrix with a part missing. Then they were instructed to choose the one that best fitted the matrix from among six alternatives. The maximum possible score was 12.

2.3. Procedures

Parental consent was sought for each participating child. All participants were assessed individually twice in their attending schools. Each assessment took around 60 min to complete. All the assessments were conducted by trained research assistants. The participating children were assessed twice for their invented spelling, at the beginning (September and October) and the end (May and June) of their final year of kindergarten education. The cognitive-linguistic skills and the control measure of non-verbal intelligence were administered only at the first time point of assessment. The instructions were given in Cantonese.

3. Results

The invented spelling scores derived from the coding system and conventional spelling scores of the two groups at T1 and T2 are presented in Table 1. Table 2 summarizes the means and standard deviations for the cognitive-linguistic measures at T1 and age of the two groups. Examination of the scores showed good variability in all measures. Independent t-tests were performed on various cognitive-linguistic measures and non-verbal reasoning. Results showed significant differences on all the cognitive-linguistic measures between the two groups. However, the two groups were comparable on age and non-verbal intelligence at pretest.

3.1. Research questions 1 and 2: invented spelling performance as a function of the phoneme position by time and group

To address the first and second research questions on the spelling performance as a function of phoneme position (initial consonant, final consonant and medial vowel) by time and group, we performed 3 (phoneme positions) X 2 (time) Repeated Measure Analysis of Co-Variance (ANCOVA) with non-verbal IQ entered as the covariate and group as the between-subject factor. The results indicated the main effect of phoneme position ($F = 11.41, p < .001$, Wilks' Lambda = .84), indicating that the invented performances on varied phoneme positions were significantly different. A post-hoc mean analyses of invented spelling at different phoneme positions using Bonferroni adjustment for Type I errors indicated that the initial consonant was spelled correctly more often than the medial vowel, which was spelled significantly better than the final consonant ($ps < .001$; See Table 1). The interaction effect of phoneme position X group was marginally significant ($F = 2.34, p = .10$, Wilks' Lambda = .96). Therefore, we examined further whether the same pattern of results emerged in the two groups of spellers at Time 1 and Time 2 and pair-wise comparisons using Bonferroni adjustment were conducted. The results showed that, for at-risk spellers at both time points, the invented spelling performance on initial consonants was better than that of the medial vowels, which in turn was better than the spelling performance on the final consonants ($ps < .001$). For average spellers, the initial phoneme was spelled better than the medial vowel and final phoneme at T1 and T2 ($ps < .002$), however, the differences in the performances on the medial vowel and the final phoneme at both time points were not significant, at both time points ($p > .08$).

The main effect of time ($F = 6.74, p = .01$, Wilks' Lambda = .95) was significant, showing that invented spelling performance at Time 2 was significantly better than at Time 1. The between-subject effect of group was also significant ($F = 165.78, p < .001$), showing that the two groups were highly different in their invented spelling performance. The interaction effect of time X group

Table 3
The logistic regression model for predicting group membership of spelling difficulties.

Step	Variables	R ²	B	SE	Observed p
Step 1	Non-verbal intelligence	.04	.07	.10	.48
Step 2	Letter name knowledge	.60	.07	.06	.22
	Phonemic awareness		.18	.10	.05
	RAN		.05	.05	.35
	Vocabulary		.17	.05	.001

($F = 25.24$, $p < .01$, Wilks' Lambda = 0.82) was also significant. We then performed separate follow-up repeated measure ANCOVAs for different phoneme positions and examined the interaction effect (Time X Group) in each model. The results showed that the interaction effects in all the models were significant, indicating that the average spellers improved significantly more than the at-risk spellers at all phoneme positions. The results supported the second hypothesis of the study, that average spellers would improve their invented spelling at varied phoneme positions significantly more than the at-risk spellers.

3.2. Research question 3: precursors of invented spelling performance

A logistic regression was conducted to predict group membership using all the cognitive-linguistic skills measured at Time 1. In the model, non-verbal intelligence was entered into the first step and letter name knowledge, phonemic awareness, RAN and vocabulary were entered in the second step. The Nagelkerke R² was used to indicate the percentage of explanation. Table 3 shows the results of the logistic regression model. Of all the measures, phonemic awareness ($B = .18$, $S.E. = .10$, $p = .05$) and vocabulary ($B = .17$, $S.E. = .05$, $p = .01$) were significant predictors of group membership, indicating that they were precursors of invented spelling difficulties. The final model was able to classify 80.5% of children. The results supported the hypothesis of the study, that vocabulary would be a significant predictor of spelling difficulties when other well-researched variables were taken into account.

4. Discussion

The present longitudinal study investigated invented spelling performance in the L2 of Chinese ESL children. We identified at-risk children based on their invented spelling performances at the end of kindergarten education and compared their spelling performances at varied phoneme positions of words with CV or CVC structures to the performances of average spellers. The results supported our hypothesis. In terms of developmental trends in invented spelling, for both average and at-risk spellers, invented spelling developed from initial consonants, to medial vowels, and to final consonants. Group differences were observed at all phoneme positions. Specifically, we found at-risk spellers performed significantly worse than average spellers on invented spelling at different phoneme positions. In addition, we identified vocabulary as a significant precursor of invented spelling difficulties when other well-researched variables, including phonological awareness, letter knowledge and RAN, were considered. Given the significant relationship between invented and conventional spelling, the present study has important educational implications for school curricula and educational support given to children who are at-risk for spelling difficulties.

4.1. Phoneme position and invented spelling: the case of Chinese ESL children

We have demonstrated that the pattern of invented spelling performance at varied phoneme positions in Chinese ESL learners was different from the pattern of L1 learners of English (Treiman, 1993; Treiman et al., 1993). Our results also suggested that the final phonemes were particularly difficult for at-risk spellers while, for average spellers, the invented spelling performances at the medial and final phonemes were comparable. As discussed, these differences could be attributed to the linguistic features of the ESL children's native language (Sun-Alperin & Wang, 2008; Wang & Geva, 2003), given the fact that the final consonant phoneme is absent in spoken Cantonese. However, there are other possible reasons underlying the differences in invented spelling. For example, Hong and Chen (2011) attributed the difficulty that Chinese ESL learners have in representing the final phoneme in a non-word spelling task to the limited L2 linguistic input, which lowered the automaticity in phoneme-grapheme conversion in L2 learners. The present study was not able to delineate the underlying mechanisms of the invented spelling performance at varied phoneme positions. Future studies should investigate such mechanics by comparing L2 learners with different L1 learners in varied linguistic environments. The results of the study have implications for instructional practice. In spelling instruction, children's attention should be drawn to the articulation of the final consonants of words, which is absent from Cantonese phonology.

4.2. Invented spelling of average and at-risk spellers

The present study demonstrated a robust difference between average and at-risk spellers across time and phoneme positions. Average spellers not only performed better on invented spelling at varied phoneme positions, but also improved significantly more over time during the kindergarten period. The findings echo the claims in the literature that invented spelling can be used to identify at-risk children (Clemens et al., 2014; Lombardino et al., 1999) before they are able to spell conventionally. Invented spelling training at kindergarten level has been shown to improve reading skills and thus reduce the risk of future reading failure (Sénéchal et al.,

2012). Therefore, the findings would have implications for the early identification of both reading and writing difficulties in young children, so that timely and appropriate educational support can be given to them.

4.3. Cognitive-linguistic precursors of invented spelling

Our finding that vocabulary was a significant predictor of the at-risk status when other cognitive-linguistics skills were considered is consistent with recent studies showing the importance of vocabulary for young Chinese ESL children in predicting literacy outcomes (e.g., Liu et al., 2017; Yeung, 2018). A larger vocabulary might be related to more clearly specified phonological representations, which could be utilized in the process of translating phonemes to graphemes (Ouellette & Sénéchal, 2017).

In addition, our findings have added to the existing evidence that the cognitive-linguistic processes underlying young ESL children's spelling is different from that of L1 learners or ESL learners with alphabetical L1 (Yeong & Rickard Liow, 2011). This accorded with prior research that showed L1 properties and L1-L2 typological differences in phonological and orthographical structures may influence L2 spelling performance (e.g., Wang & Geva, 2003). Studies focusing on the cognitive-linguistic processes in English spelling used by ESL children with non-alphabetic L1 are relatively limited and future research should examine the role of a range of cognitive-linguistic variables in spelling development.

Integrating the current findings and related studies (Liu et al., 2017; Yeung, 2018), it is clear that early English instruction for Chinese ESL learners should focus on the development of oral vocabulary as a foundation skill for literacy development. In the educational context of the present study, English instruction, by the age of 4–5, tends to focus on reading and writing and thus the development of vocabulary might be undermined.

4.4. Limitations

This study had a number of limitations worth noting. First, the invented spelling tasks only included 6 single-syllable words. Future research should examine the invented spelling of English words with more complex structures (e.g., CCVC, or CCVCC) and multi-syllable words, so that a fuller picture of invented spelling development, for example the performance of medial consonants, can be examined. Second, due to the absence of a monolingual comparison group in the current study, we were not able to delineate the cause of the demonstrated invented spelling performance at varied phoneme positions. Future studies should address this limitation and include other important cognitive skills for spelling as control variables such as working memory. Third, we have only investigated the role of several cognitive-linguistic skills in predicting spelling difficulties. Due to the participants' limited English proficiency, we were not able to include tasks like morphological awareness or orthographic awareness. Finally, some of the measures used in this study were research-developed or designed for L1 learners in Western educational settings. The validity of the measures may have been compromised. However, it should be noted that these measures were used in past studies and showed good reliability.

5. Conclusion

To conclude, the findings in this study advance our understanding of young ESL children's invented spelling performance as a function of phoneme position by time and groups. The evidence showed a developmental difference in the rate of invented spelling between average and at-risk spellers, underscoring the hypothesis that invented spelling is a key to understanding spelling difficulties in Chinese ESL children. In addition, the present study found that the Hong Kong Chinese children's weaknesses in their invented spelling, in terms of phoneme positions, were different from those in L1 children, and that vocabulary is a significant precursor of ESL children's spelling difficulties. We hope this study will prompt future investigations into at-risk children's spelling difficulties taking ESL status into account.

References

- Asberg Johnels, J., Kopp, S., & Gillberg, C. (2014). Spelling difficulties in school-aged girls with attention-deficit/hyperactivity disorder: Behavioral, psycholinguistic, cognitive and graphomotor correlates. *Journal of Learning Disabilities, 47*(5), 424–434.
- Caravolas, M., Kessler, B., Hulme, C., & Snowling, M. (2005). Effects of orthographic consistency, frequency, and letter knowledge on children's vowel spelling development. *Journal of Experimental Child Psychology, 92*(4), 307–321.
- Clemens, N. H., Oslund, E. L., Simmons, L. E., & Simmons, D. (2014). Assessing spelling in kindergarten: Further comparison of scoring metrics and their relation to reading skills. *Journal of School Psychology, 52*(1), 49–61.
- Cordewener, K. A., Bosman, A. M., & Verhoeven, L. (2012). Predicting early spelling difficulties in children with specific language impairment: A clinical perspective. *Research in Developmental Disabilities, 33*(6), 2279–2291.
- Ding, Y., Liu, R. D., McBride, C. A., Fan, C. H., Xu, L., & Wang, J. (2018). Pinyin and English invented spelling in Chinese-speaking students who speak English as a second language. *Journal of Psycholinguistic Research, 47*, 1163–1187.
- Ding, Y., Liu, R. D., McBride, C., & Zhang, D. (2015). Pinyin invented spelling in Mandarin Chinese-speaking children with and without reading difficulties. *Journal of Learning Disabilities, 48*(6), 635–645.
- Dunn, L. M., & Dunn, L. M. (1997). *Peabody picture vocabulary test* (3rd ed.). Circle Pines, MN: American Guidance Service.
- Ehri, L. (1998). Grapheme-phoneme knowledge is essential for learning to read words in English. In J. Metsala, & L. Ehri (Eds.). *Word recognition in beginning literacy* (pp. 3–40). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
- Ehri, L. C. (2005). Learning to read words: Theory, findings, and issues. *Scientific Studies of Reading, 9*(2), 167–188.
- Furnes, B., & Samuelsson, S. (2010). Predicting reading and spelling difficulties in transparent and opaque orthographies: A comparison between Scandinavian and US/Australian children. *Dyslexia, 16*(2), 119–142.
- Gettinger, M. (1993). Effects of invented spelling and direct instruction on spelling performance of second-grade boys. *Journal of Applied Behavior Analysis, 26*, 281–291.
- Geva, E. (2006). Learning to read in a second language: Research, implications, and recommendations for services. *Encyclopedia on early childhood development*. Retrieved Apr 25, 2009, from <http://www.enfant-encyclopedie.com>.

- Hanna, P. R., Hanna, J. S., Hodges, R. E., & Rudorf, E. H., Jr. (1996). *Phoneme-grapheme correspondences as cues to spelling improvement*. Washington, DC: US Government Printing Office USDOE publication no. 32008.
- Harrison, G. L., Goegan, L. D., Jalbert, R., McManus, K., Sinclair, K., & Spurling, J. (2016). Predictors of spelling and writing skills in first-and second-language learners. *Reading and Writing, 29*(1), 69–89.
- Hong, S. C., & Chen, S. H. (2011). Roles of position, stress, and proficiency in L2 children's spelling: A developmental perspective. *Reading and Writing, 24*, 355–385.
- Lau, C., & Rao, N. (2013). English vocabulary instruction in six early childhood classrooms in Hong Kong. *Early Child Development and Care, 183*, 1363–1380.
- Learning Disabilities Association of Alberta (2009). *Reading readiness screening tool*. Edmonton, AB: Author.
- Lee, S. H. (2012). *The effects of Interactive Strategies Approach on at-risk kindergarten children's spelling development*. Unpublished doctoral dissertation. University at Albany.
- Lee, S. H., & Scanlon, D. M. (2015). The effects of the Interactive Strategies Approach on at-risk kindergartners' spelling. *Reading and Writing, 28*(3), 313–346.
- Leong, C. K. (2009). Chinese language learners of English word reading and spelling use more orthographic-lexical than phonological strategies. In A. Y. Durgunoglu, & M. Gerber (Eds.). *Challenges in language and literacy issues*. New York: Guilford.
- Lervåg, A., & Hulme, C. (2010). Predicting the growth of early spelling skills: Are there heterogeneous developmental trajectories? *Scientific Studies of Reading, 14*(6), 485–513.
- Lí, T., McBride-Chang, C., Wong, A. M.-Y., & Shu, H. (2012). Longitudinal predictors of spelling and reading comprehension in Chinese as an L1 and English as an L2 in Hong Kong Chinese children. *Journal of Educational Psychology, 104*(2), 286–301.
- Lin, D., Liu, Y., Sun, H., Wong, R. K. S., & Yeung, S. S. (2017). The pathway to English word reading in Chinese ESL children: The role of spelling. *Reading and Writing, 30*, 87–103.
- Liu, Y., Yeung, S. S., Lin, D., & Wong, K. S. W. (2017). English expressive vocabulary growth and its unique role in predicting English word reading: A longitudinal study involving Hong Kong Chinese ESL children. *Contemporary Educational Psychology, 49*, 195–202.
- Lombardino, L. J., Morris, D., Mercado, L., DeFillipo, F., Sarisky, C., & Montgomery, A. (1999). The Early Reading Screening Instrument: A method for identifying kindergartners at risk for learning to read. *International Journal of Language & Communication Disorders, 34*(2), 135–150.
- McBride-Chang, C., Bialystok, E., Chong, K. K., & Li, Y. P. (2004). Levels of phonological awareness in three cultures. *Journal of Experimental Child Psychology, 89*(2), 93–111.
- Mehta, S., Ding, Y., Ness, M., & Chen, E. C. (2018). Invented spelling, word stress, and syllable awareness in relation to reading difficulties in children. *Journal of Psycholinguistic Research, 47*(3), 585–606.
- Miyawaki, K., Strange, W., Verbrugge, R., Liberman, A. M., Jenkins, J. J., & Fujimura, O. (1975). An effect of linguistic experience: The discrimination of /r/ and /l/ by native speakers of Japanese and English. *Perception & Psychophysics, 18*, 331–340.
- Morris, D., Bloodgood, J. W., Lomax, R. G., & Perney, J. (2003). Developmental steps in learning to read: A longitudinal study in kindergarten and first grade. *Reading Research Quarterly, 38*(3), 302–328.
- Muter, V., Hulme, C., Snowling, M., & Taylor, S. (1997). Segmentation, not rhyming, predicts early progress in learning to read. *Journal of Experimental Child Psychology, 65*, 370–396.
- Ng, M. L., & Rao, N. (2013). Teaching English in Hong Kong kindergartens: A survey of practices. *The International Journal of Literacies, 19*(3), 25–47.
- Ouellette, G. P., & Sénéchal, M. (2008a). A window into early literacy: Exploring the cognitive and linguistic underpinnings of invented spelling. *Scientific Studies of Reading, 12*(2), 195–219.
- Ouellette, G. P., & Sénéchal, M. (2008b). Pathways to literacy: A study of invented spelling and its role in learning to read. *Child Development, 79*(4), 899–913.
- Ouellette, G., & Sénéchal, M. (2017). Invented spelling in kindergarten as a predictor of reading and spelling in Grade 1: A new pathway to literacy, or just the same road, less known? *Developmental Psychology, 53*(1), 77–88.
- Ouellette, G., Sénéchal, M., & Haley, A. (2013). Guiding children's invented spellings: A gateway into literacy learning. *Journal of Experimental Education, 81*(2), 261–279.
- Partanen, M., & Siegel, L. S. (2014). Long-term outcome of the early identification and intervention of reading disabilities. *Reading and Writing, 27*(4), 665–684.
- Raven, J. C., Court, J. H., & Raven, R. (1976). *Manual for Raven's progressive matrices and vocabulary scales. Section III: Standard progressive matrices*. London, UK: Hong Kong Lewis.
- Read, C. (1971). Pre-school children's knowledge of English phonology. *Harvard Educational Review, 41*, 1–34.
- Read, C., & Treiman, R. (2013). Children's invented spelling: What we have learned in forty years. In M. Piattelli-Palmarini, & R. C. Berwick (Eds.). *Rich languages from poor inputs* (pp. 197–211). New York, NY: Oxford University Press.
- Ricketts, J., Nation, K., & Bishop, D. V. (2007). Vocabulary is important for some, but not all reading skills. *Scientific Studies of Reading, 11*(3), 235–257.
- Seidenberg, M. S. (2005). Connectionist models of word reading. *Current Directions in Psychological Science, 14*(5), 238–242.
- Sénéchal, M. (2017). Testing a nested skills model of the relations among invented spelling, accurate spelling, and word reading, from kindergarten to grade 1. *Early Child Development and Care, 187*(3–4), 358–370.
- Sénéchal, M., & LeFevre, J. A. (2002). Parental involvement in the development of children's reading skill: A five-year longitudinal study. *Child Development, 73*(2), 445–460.
- Sénéchal, M., Ouellette, G., Pagan, S., & Lever, R. (2012). The role of invented spelling on learning to read in low-phoneme awareness kindergartners: A randomized-control-trial study. *Reading and Writing, 25*(4), 917–934.
- Shahar-Yames, D., & Share, D. L. (2008). Spelling as a self-teaching mechanism in orthographic learning. *Journal of Research in Reading, 31*, 22–39.
- Stage, S. A., & Wagner, R. K. (1992). Development of young children's phonological and orthographic knowledge as revealed by their spellings. *Developmental Psychology, 28*(2), 287–296.
- Sun-Alperin, M. K., & Wang, M. (2008). Spanish-speaking children's spelling errors with English vowel sounds that are represented by different graphemes in English and Spanish words. *Contemporary Educational Psychology, 33*(4), 932–948.
- Tangel, D. M., & Blachman, B. A. (1992). Effect of phoneme awareness instruction on kindergarten children's invented spelling. *Journal of Reading Behavior, 24*, 223–261.
- Torppa, M., Georgiou, G. K., Niemi, P., Lerkkanen, M. K., & Poikkeus, A. M. (2017). The precursors of double dissociation between reading and spelling in a transparent orthography. *Annals of Dyslexia, 67*(1), 42–62.
- Treiman, R. (1993). *Beginning to spell: A study of first-grade children*. New York: Oxford University Press.
- Treiman, R. (1998). Why spelling? The benefits of incorporating spelling into beginning reading instruction. In J. L. Metsala, & L. C. Ehri (Eds.). *Word recognition in beginning literacy* (pp. 289–313). Mahwah, NJ: Erlbaum.
- Treiman, R. (2017). Learning to spell words: Findings, theories, and issues. *Scientific Studies of Reading, 21*(4), 265–276.
- Treiman, R., & Bourassa, D. C. (2000). The development of spelling skill. *Topics in Language Disorders, 20*, 1–18.
- Treiman, R., Berch, D., & Weatherston, S. (1993). Children's use of phoneme-grapheme correspondences in spelling: Roles of position and stress. *Journal of Educational Psychology, 85*(3), 466–477.
- Treiman, R., Kessler, B., Pollo, T. C., Byrne, B., & Olson, R. K. (2016). Measures of kindergarten spelling and their relations to later spelling performance. *Scientific Studies of Reading, 20*(5), 349–362.
- Wang, M., & Geva, E. (2003). Spelling acquisition of novel English phonemes in Chinese children. *Reading and Writing: An Interdisciplinary Journal, 16*, 325–348.
- Wimmer, H., & Mayringer, H. (2002). Dysfluent reading in the absence of spelling difficulties: A specific disability in regular orthographies. *Journal of Educational Psychology, 94*(2), 272–277.
- Yeong, S. H., & Rickard Liow, S. J. (2011). Cognitive–linguistic foundations of early spelling development in bilinguals. *Journal of Educational Psychology, 103*(2), 470.
- Yeong, S. H., Fletcher, J., & Bayliss, D. M. (2017). Impact of early home language exposure on phonological and orthographic skills and their contributions to English literacy abilities in English monolingual and Chinese–English bilingual adults. *Applied Psycholinguistics, 38*(1), 181–210.
- Yesil-Dagli, U. (2011). Predicting ELL students' beginning first grade English oral reading fluency from initial kindergarten vocabulary, letter naming, and phonological awareness skills. *Early Childhood Research Quarterly, 26*, 15–29.
- Yeung, S. S. (2018). Second language learners who are at-risk for reading disabilities: A growth mixture model study. *Research in Developmental Disabilities, 78*, 35–43.
- Yeung, S. S., & Chan, C. K. K. (2013). Phonological awareness and oral language proficiency in learning to read English among Chinese kindergarten children in Hong Kong. *The British Journal of Educational Psychology, 83*(4), 550–568.
- Yeung, S. S., Liu, Y., & Lin, D. (2017). Growth of phonemic awareness and spelling in a second language. *International Journal of Bilingual Education and Bilingualism* online, first.