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Prosodic Reading and Reading Comprehension in Chinese and English among Hong Kong Cantonese-English Bilingual Children: A Longitudinal Study

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Abstract

This longitudinal study examined the relationship between early prosodic reading skills and later reading comprehension ability in Hong Kong Cantonese-English bilingual children. A group of 50 2nd graders completed Chinese and English prosodic reading, nonverbal reasoning, and reading comprehension tasks over two consecutive years. Spectrographic analysis was conducted on six types of syntactic structures in Cantonese and English prosodic reading with a focus on pitch pattern and pause structure. Our results showed that Cantonese-English bilingual children's prosodic reading skills improved from Grade 2 to Grade 3. Moreover, early prosodic reading skills predicted later reading comprehension ability both within language and across languages. However, this prediction was observed in English but not in Chinese. Specifically, only L2 English pause structure but not pitch pattern significantly predicted later L2 English and L1 Chinese reading comprehension. These findings shed light on the application of the automaticity theory and the lexical quality hypothesis in Cantonese-English bilingual context, and demonstrate the possible interference between L1 and L2 reading comprehension development in Hong Kong Cantonese-English bilingual readers.

Index Terms: prosodic reading, reading comprehension, Cantonese-English bilingual children, L1-L2 interference effect

1. Introduction

Over the past decade, a great number of studies have identified a robust relationship between speech prosody and word reading development [1, 2]. Recent studies on English monolingual readers have extended these findings by showing the contribution of prosody to English reading comprehension skill [3, 4, 5]. However, these studies have largely focused on monolingual English readers [6, 7], with little attention paid to bilingual readers, such as Hong Kong Cantonese-English bilingual children who learn to read Chinese and English simultaneously. Thus, this 2-year longitudinal study examined the developmental change of prosodic skills and their contribution to reading comprehension within and across languages among Cantonese-English bilingual children.

1.1. Prosodic difference in Cantonese and English

Prosody is suprasegmental in nature, i.e., it can be localized in single words or across utterances [8]. A universal property of prosody is the interface between syntactic and prosodic breaks, where syntactic parsing is facilitated by chunking connected speech into comprehensible units [9]. Such segmentations reduce a listener's memory load for retaining utterances until more complex semantic and syntactic analyses occur [10]. Through intonation, prosody also conveys semantic, grammatical, and pragmatic functions across languages [11, 12].

Language-specific prosodic differences are evident between tonal and non-tonal languages. For tonal languages like Cantonese, lexical tones play a prominent role in conveying the meaning of identical syllables [13]. Since lexical tone cannot be altered by intonation in order to preserve the meanings of words, the availability of phonetic space for intonation is limited in Cantonese [14]. For stress languages like English, prosody is mainly used at a higher level, where intonation that carries semantic information of the utterances is expressed by sentence stress located on word units [14, 15]. Given these differences in prosody that exist between Cantonese and English, we postulate that the contribution of prosody to reading comprehension may be different in Chinese and English. To examine this hypothesis, we evaluated both within and cross-language contributions of prosody.

1.2. Prosody, automaticity, and reading comprehension

The lexical quality hypothesis posits that words with higher lexical quality can be retrieved more efficiently and that the quality of lexical representation is determined by the specificity and redundancy of orthographic, phonological, and semantic constituents of word representations [16, 17]. High prosodic sensitivity facilitates phonological awareness and contributes to more precise phonological representation [18], thus enhancing word retrieval.

Moreover, according to the automaticity theory [19], when automatic word decoding is achieved, more cognitive capacity can be allocated to higher levels of comprehension processes, such as inferencing and retrieving word knowledge [16]. In brief, as greater prosodic sensitivity enhances the lexical quality of words and facilitates decoding, more resources can be reserved for higher levels of cognitive processes underlying comprehension.

1.3. The role of prosody in reading comprehension

With appropriate phrasing, intonation, and stress considered indicators of fluent reading, prosodic reading is widely considered a hallmark of achieving reading fluency [20, 21, 22]. Growing evidence shows an important role of prosodic reading in reading comprehension among English monolingual readers [6, 22, 23]. For example, an adult-like intonation contour in text reading was positively correlated with reading comprehension ability [22]. Also, another study showed that skilled 3rd grade readers utilized larger pitch changes and larger sentence final declinations than their less skilled counterparts [6].

1.4. Purpose of present study

Previous research on English and other alphabetic language readers demonstrates that prosodic reading plays a role in text

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reading comprehension. However, most of these studies have largely focused on L1 or L2 only [23, 24]. Since prosody is different across languages [25], the relationship between prosodic reading development and reading comprehension remains unclear, especially across languages with different prosodic features, such as Chinese and English. Also, our systematic review showed that most of the previous studies adopted a cross-sectional design [3, 22, 26], which precludes the causal inference of the relationship between prosodic reading and reading comprehension. To fill in these research gaps, this study adopts a longitudinal approach to evaluate the developmental change of prosodic skills and the contribution of early prosodic skills to reading comprehension among Cantonese-English bilingual children.

2. Method

2.1. Participants

A group of 50 Hong Kong Cantonese-English bilingual children (18 boys, 32 girls) were followed from Grade 2 (Phase 1: M = 7.90 years; SD = 4.08 months) to Grade 3 (Phase 2: M = 8.98 years; SD = 3.72 months). All children were native Cantonese speakers with at least three years of English language education, normal intelligence, and no speech-language-hearing problem or learning difficulty. Parental consent was obtained prior to the testing.

2.2. Reading prosody assessment and procedures

One Chinese and one English passage were designed to assess reading prosody. The words contained in the passages were carefully selected based on Hong Kong Chinese Lexical Lists for Primary Learning [27] and Wordlists for the Primary English Language Curriculum [28], which ensure that all participating children can read all of the words accurately. The Chinese passage contained 225 words and comprised 18 sentences with three occurrences of each of the following six types of structures: (1) basic declaratives, (2) clause-final commas, (3) wh questions, (4) yes-no questions, (5) complex adjectival phrase commas, and (6) basic quotatives. The English passage contained 99 words and comprised 12 sentences with two occurrences of each type of structure listed above.

Prior to testing, participants were provided a demonstration of expressive reading of one practice passage. Participants were then instructed to read the test passages expressively, and their production was recorded. The recording sessions were conducted in a quiet room at the child's school. Each participant's production was recorded via an Edirol USB Audio Capture UA-25, a Lenovo ThinkPad E450 Laptop, and an AKG SE300 B microphone pre-amplifier with a CK91 cardioid condenser microphone capsule. Praat Version 6.0.21 [29] was used to create individual digital .wav files for each participant. Five questions were asked upon the completion of recording to ensure participants' comprehension of the passage. The order of the recording of English and Chinese passages was counterbalanced across participants.

2.3. General reading assessments and procedures

Nonverbal intelligence. The matrix reasoning subtest from WASI-II [30] was administered. Participants were required to select the correct option to complete an incomplete matrix.

Word reading efficiency assessment. One Minute Chinese Reading subtest from HKT-P (II) [31] and TOWRE (2nd Edition) Form A [32] were administered to assess Chinese and English word reading efficiency, respectively.

Oral reading fluency assessment. Children's connected text reading fluency was measured by the number of words correctly read per minute (WCPM) during the production of both Chinese and English read-aloud passages.

Reading comprehension assessment. For Chinese, four passages were used: two translated from the YARC Passage Reading [33] and two adopted from a prior study [34]. Eight multiple-choice questions were asked at the end of each passage. For English, Grades 1 and 2 Comprehension subtests of the GMRT, 4th Edition [35] were administered. There were 39 multiple-choice questions for each subset.

2.4. Acoustic analysis

Spectrographic analysis was performed on the six target syntactic types in both Cantonese and English using Praat [29]. The $f0$ measurements and pause durations were extracted and analyzed for each syntactic structure for each participant in the two testing phases (see Figure 1).

2.4.1. Pitch measurement

The four $f0$ parameters ($f0$ onset, offset, maximum, and minimum) were obtained for each syntactic structure for each participant at Phase 1 and Phase 2. The $f0$ onset and $f0$ offset determine the direction of pitch contour (i.e., rises when F0 offset > F0 onset; falls when $f0$ offset < $f0$ onset). The value of pitch contour is determined by maximum and minimum $f0$. For declaratives, the $f0$ values were obtained at the final word of the sentence. For wh questions, yes-no questions, and quotatives, the $f0$ values were measured at the final word of the tag. For clause-final commas and complex adjectival phrase commas, $f0$ values were obtained at the word before the comma. All $f0$ parameters were averaged across the occurrences and converted into ERB-rate scale (a perceptual scale) for statistical analysis.

2.4.2. Pause measurement

For pause duration measurement, the inclusion criterion of pause duration was between 100 to 3000 milliseconds as stated in Gray Oral Reading Tests protocol [36]. For basic declaratives, the pause durations (in *ms*) were obtained by marking the end of the declarative until the beginning of the next sentence in the spectrographs. For clause-final commas and complex adjectival phrase commas, the pause durations were measured from the end of the word prior to the comma until the beginning of the next word. For wh questions, yes-no questions, and basic quotatives, the pause durations were marked from the end of the last word in the tag until the beginning of the next sentence in English since the question words were located after the tags. In Cantonese prosodic reading, pause durations for wh questions, yes-no questions, and basic quotatives were measured from the end of the word preceding the tag until the beginning of the tag since the question words were located before the tags.

3. Results

3.1. Developmental pattern of prosodic production

Given that each participant was tested twice for prosodic reading, we compared the means of pitch change and pause length of each syntactic structure at Phase 1 and Phase 2 using the paired sample t-test. For Cantonese, significant developmental differences were found for declarative pause length, $t(47) = 2.420$, $p < .05$, $d = .349$, and quotative pitch change, $t(45) = 2.054$, $p < .05$, $d = .303$. For English, significant developmental differences were found for yes-no question pitch change, $t(48) = 2.071$, $p < .05$, $d = .296$, wh question pitch change, $t(47) = 3.485$, $p < .01$, $d = .312$, wh question pause length, $t(47) = 2.159$, $p < .05$, $d = .503$, complex adjectival phrase pause length, $t(48) = 3.518$, $p < .01$, $d = .502$, and quotative pitch change, $t(43) = -2.445$, $p < .05$, $d = -.369$.

3.2. Within-language prediction

The correlation analyses revealed a positive correlation between Phase 1 Cantonese wh question pitch change and Phase 2 Chinese reading comprehension, $r = .291$, $p < .05$, and a negative correlation between Phase 1 Cantonese declarative pause duration and Phase 2 Chinese reading, $r = -.335$, $p < .05$.

To examine the longitudinal prediction of Phase 1 Chinese prosodic reading to Phase 2 Chinese reading comprehension, a three-step multiple hierarchical regression was conducted to predict Phase 2 Chinese reading comprehension by entering non-verbal IQ scores as the first step, Phase 1 Chinese word reading efficiency and passage reading fluency as the second step, and Phase 1 Cantonese pitch (wh question pitch change) and pause factor (declarative pause) as the third step (see Table 1). As shown in Table 1, Phase 1 Cantonese prosodic factors were not significant predictors of Phase 2 Chinese reading comprehension.

Table 1: *Hierarchical regression predicting Phase 2 Chinese reading comprehension from Phase 1 Chinese prosodic reading measures*

Variable and order		R^2	ΔR^2	β
Step1	Nonverbal IQ	.238***	.238***	.412**
Step2	Phase 1 Chinese WR	.439**	.201**	.423*
	Phase 1 Chinese RF			-.124
Step3	Chinese pause factor	.461	.022	-.167
	Chinese pitch factor			.037

Note. WR = word reading; RF = reading fluency. *$p < .05$, **$p < .01$, ***$p < .001$.

Bivariate correlation between Phase 1 English prosodic variables and Phase 2 English reading comprehension revealed moderate negative correlations between English reading comprehension and (1) English yes-no question pause duration, $r = -.544$, $p < .001$, and (2) English complex adjectival comma pause length, $r = -.644$, $p < .001$.

Table 2: *Hierarchical regression predicting Phase 2 English reading comprehension from Phase 1 English prosodic reading measures*

Variable and order		R^2	ΔR^2	β
Step1	Nonverbal IQ	.265***	.265***	.170
Step2	Phase 1 English WR	.686***	.422***	.638***
	Phase 1 English RF			-.112
Step3	English pause factor	.748**	.062**	-.330**

Note. WR = word reading; RF = reading fluency. **$p < .01$, ***$p < .001$.

We conducted the same set of regression analysis predicting Phase 2 English reading comprehension from Phase 1 English prosodic reading measures. As shown in Table 2, Phase 1 English pause factor explained 6.2% of variance in Cantonese-English bilingual children's Phase 2 English reading comprehension after controlling for non-verbal IQ, and Phase 1 English word reading efficiency and passage reading fluency.

3.3. Cross-language prediction

The correlation analyses showed that both Phase 1 English clause final pitch change, $r = -.328$, $p < .05$, and English complex adjectival comma pause duration, $r = .309$, $p < .05$, correlated significantly with Phase 2 Chinese reading comprehension. There was significant positive correlation between Phase 1 Chinese wh question pitch change and Phase 2 English reading comprehension, $r = .292$, $p < .05$.

To explore the longitudinal prediction of Phase 1 English prosodic reading to Phase 2 Chinese reading comprehension, a three-step hierarchical regression was conducted with Phase 2 Chinese reading comprehension as the predicting variable, non-verbal IQ score as the first step, Phase 1 English word reading efficiency and passage reading fluency as the second step, and Phase 1 English pitch (clause-final comma pitch change) and pause factor (clause-final comma pause) as the third step (see Table 3). As displayed in Table 3, only early English pause factor was a significant predictor of later Chinese reading comprehension, $\beta = .352$, $p < .01$, and it explained 7.4% of variance in Chinese reading comprehension.

Table 3: *Hierarchical regression predicting Phase 2 Chinese reading comprehension from Phase 1 English prosodic reading measures*

Variable and order		R^2	ΔR^2	β
Step1	Nonverbal IQ	.238***	.238***	.249
Step2	Phase 1 English WR	.289	.050	.229
	Phase 1 English RF			.158
Step3	English pause factor	.426*	.137*	.352**
	English pitch factor			-.122

Note. WR = word reading; RF = reading fluency. *$p < .05$, **$p < .01$, ***$p < .001$.

Another three-step hierarchical regression was conducted with Phase 2 English reading comprehension as the predicting variable, non-verbal IQ score as the first step, Phase 1 Chinese word reading efficiency and passage reading fluency as the second step, and Phase 1 Cantonese pitch factor (wh question pitch change) as the third step. As shown in Table 4, Phase 1 Cantonese pitch factor was not a significant predictor of Phase 2 English reading comprehension.

Table 4: *Hierarchical regression predicting Phase 2 English reading comprehension from Phase 1 Chinese prosodic reading measures*

Variable and order		R^2	ΔR^2	β
Step1	Nonverbal IQ	.265***	.265***	.461**
Step2	Phase 1 Chinese WR	.304	.039	-.035
	Phase 1 Chinese RF			.169
Step3	Chinese pitch factor	.333	.030	.196

Note. WR = word reading; RF = reading fluency. **$p < .01$, ***$p < .001$.

4. Discussion

The primary goal of this study is to examine the longitudinal relationship between prosodic reading (as measured by the pitch and pause) and reading comprehension within and across languages among Hong Kong Cantonese-English bilingual children. Our spectrographic and statistical analyses revealed children's prosodic reading skills improved from Grade 2 to Grade 3. Moreover, some early prosodic reading skills predicted later reading comprehension ability both within and across languages. However, such prediction was limited to English prosodic reading, in which only English pause structure but not pitch pattern was significant in predicting later English and Chinese reading comprehension. These results were discussed in the context of Chinese and English bilingual reading development.

4.1. Within-language prediction

One striking finding is that early prosodic reading uniquely predicted later reading comprehension in L2 English, but not in Chinese. Moreover, L2 pause structure, but not pitch pattern, predicted L2 English reading comprehension. These results suggest the importance of L2 pause structure in L2 reading comprehension among Cantonese-English bilingual children.

The lack of prediction from L1 prosodic reading to L1 Chinese reading comprehension can be explained by the Stage of Reading Development [37], which claims that native readers achieve automaticity during the end of Grade 1 through Grade 3. In the present study, we found that the variation of Cantonese prosodic reading among children was minimal between Grades 2 and 3, which may limit the prediction of prosodic reading skills to reading comprehension. In contrast, a greater variation of L2 English prosodic reading was observed among Cantonese-English bilingual children because they are still developing their L2 English prosodic reading skills. Thus, the distinct prediction pattern of prosodic reading to reading comprehension in Chinese and English is a result of developmental differences between L1 and L2 language skills.

The prediction of English pause structure to English reading comprehension can be explained by Lexical Quality Hypothesis, which suggests that resources become available for prosodic reading once automatic word decoding is achieved [16, 17]. The application of pause reflects children's ability in segmentation of texts into appropriate and comprehensible units to facilitate comprehension [38]. Therefore, pause structure in prosodic reading can significantly predict reading comprehension.

In contrast, English pitch factor failed to predict English reading comprehension. This could be accounted for by Cantonese speakers' insensitivity to English prosodic structures. Specifically, due to the interaction between tone and intonation in their L1 language, Cantonese speakers generally perceive English stress as high tones and thus fail to identify stressed words from utterances [39, 40]. Moreover, such insensitivity to the stressed words often leads to a failure to realize that other words in the utterances are contrasted or highlighted; thus, Cantonese speakers tend to mark the final word of English utterances with an accent [41]. Such accented English prosodic production cannot be utilized for highlighting prominent information in utterances, and cannot be effectively segmented into comprehensible syntactic components. Thus, English pitch production of Cantonese speakers is not an effective prosodic cue for parsing written text to facilitate comprehension.

4.2. Cross-language prediction

Only Grade 2 English pause structure, but not pitch pattern, uniquely predicted Grade 3 Chinese reading comprehension, but not vice versa. Such a cross-language prediction suggests that those children who made more pauses in their English prosodic reading tended to have better Chinese reading comprehension skills. However, our within-language analyses showed that children who made more pauses in their early English prosodic reading tended to develop worse English reading comprehension skills. These results together point to the possible interference between L1 Chinese and L2 English reading comprehension development, which can be explained by the imbalanced L1 and L2 language inputs. Specifically, the dominant Cantonese exposure and instruction may limit Cantonese-English bilingual children's access to spoken and written English materials, which may lead to imbalanced development in L1 Chinese and L2 English reading comprehension. These results also underscore the importance of English pause structure in Chinese and English reading comprehension. Future research may set out to further explore the factors affecting the interference between L1 and L2 reading development in bilingual children.

The lack of significant prediction of Chinese prosody to English reading comprehension can be explained by the difference between L1 and L2 reading systems. Since Chinese and English have completely different lexical and orthographic systems, the language knowledge cannot be readily transferred between these two distinct languages [42]. Specifically, despite achieving automatization in reading the L1, the skills required to read an L1 logographic language, like Chinese, may be too specific and well-established for them to be transferred to an L2 alphabetic language like English [42]. Therefore, it is not surprising to observe non-significant prediction of English reading comprehension from Cantonese prosodic reading.

5. Conclusions

The present study showed that Hong Kong Cantonese-English bilingual children's prosodic reading skills, as indexed by pitch change and pause length, improved significantly from Grade 2 to Grade 3. Also, early L2 English pause structure significantly predicted both L2 English and L1 Chinese reading comprehension skills. Specifically, Cantonese-English bilingual children who tend to make more pauses in their early English prosodic reading may have worse English reading comprehension skills. In contrast, more English pauses in early English prosodic reading contributes to better Chinese reading comprehension skills in Cantonese-English bilingual children. These findings extend Automaticity Theory and Lexical Quality Hypothesis, which are developed on the basis of English monolingual readers [6, 7, 22], to Cantonese-English bilingual readers, and highlight possible cross-language interference between L1 and L2 reading in bilingual readers.

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