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Chapter

The Heterogeneity of Reading-Related Difficulties in Chinese

Connie Suk-Han Ho, Edmond Hong-Kei Cheung and Jocelyn Ching-Yan Kwok

Abstract

The present chapter reviews cognitive-linguistic skills which are associated with various reading-related difficulties in Chinese. Research findings have showed that rapid naming and orthographic deficits are the unique marker deficits of Chinese developmental dyslexia. However, studies have indicated overlapping and dissociative deficits in dyslexia and spelling difficulties. Findings on dissociation between word reading and spelling difficulties suggest that weaknesses in orthographic processing may specifically cause difficulties in Chinese word spelling. Deficits in rapid naming are more associated with word reading fluency than reading accuracy. Beyond word level processing, there are children who encounter difficulties in reading comprehension even with adequate decoding skills. This group of specific poor comprehenders was found to be weak in some discourse-level skills, like comprehension monitoring and inferencing. Knowledge of these findings will inform us about effective identification of and intervention for children with difficulties in one or a combination of several reading-related difficulties in Chinese.

Keywords: cognitive-linguistic profile, dyslexia, spelling difficulties, reading comprehension difficulties, Chinese

1. Introduction

At least 10% of individuals may encounter disorders in oral and/or written languages, and this may hamper their long-term learning, social and psychological well-being. Since reading and writing are language-based activities, impairments on reading and writing may be rooted in some language difficulties. According to the Simple View of Reading [1, 2], decoding and language comprehension are the two core components of reading comprehension with empirical support in alphabetic (see Florit and Cain's meta-analysis study [3]) and non-alphabetic writing systems like Chinese (e.g., [4, 5]). This framework is also useful for classifying various types of reading difficulties. Dyslexic children are often found mainly to have decoding problems, while poor comprehenders have difficulties in language comprehension (e.g., [6, 7]). There appears to be differential impairments in decoding and comprehension skills in different poor reader groups (e.g., [8, 9]). The present chapter will discuss the heterogeneity of reading-related difficulties in word reading, spelling, and reading comprehension among Chinese readers.

2. Cognitive profiles of reading and spelling difficulties in Chinese

2.1 Developmental dyslexia: decoding difficulties in Chinese

About a century ago, developmental dyslexia (DD) was called "word blindness," which suggested that for some unknown reasons individuals having this disorder could not recognize words efficiently like people having blindness. Generally speaking, around 3–5% of the school population in a Western country has DD, a severe and persistent difficulty in reading and spelling, which is not a result of any apparent intrinsic or extrinsic causes. Research findings have informed us that DD is a specific genetic language-based disorder and at-risk children may have difficulties learning the spoken language before they formally learn to read. Although there are genetic-basis and neurological differences in DD, our discussion in the present chapter will mainly focus on the cognitive functioning of individuals with reading difficulties.

For people with DD reading an alphabetic writing system, their major cognitive deficits appear to be phonologically based. When reading an opaque language like English, DD readers tend to have weak phonological awareness particularly at phonemic level and in reading nonwords [10–12]. On the other hand, DD readers of more transparent alphabetic systems like Spanish and German, deficit in rapid naming of familiar visual stimuli, instead of phonological awareness, has been found to be a core cognitive deficit (e.g., [12–14]). One possible reason is that with highly regular grapheme-phoneme conversion rules, reading these transparent writing systems does not require strong sensitivity in phonemes as in opaque systems. However, fluent and automatic name retrieval is especially important for reading transparent scripts, especially in reading long words.

There has been an early belief that DD is only a problem for people who speak a Western language (e.g., English, German, and Italian). Early surveys reported a very low incidence of DD among Asian populations (e.g., [15–17]). However, current research findings inform us that children who speak an Asian language (e.g., Chinese, Korean, and Japanese) also have difficulties in reading (e.g., [18–20]). Since Chinese is the major non-alphabetic language with the largest reader population in the world, we would like to understand whether people with DD in Chinese show a cognitive profile different from those reading other alphabetic languages. Before we discuss the cognitive profile of Chinese DD, we will first give a brief account of the Chinese writing system below.

The Chinese writing system is famous for its visually complex orthography. The basic graphic unit in Chinese is a character, and characters are made up of different strokes. In terms of visual complexity, the average number of strokes of 2000 commonly used Chinese characters is 11.2 for the traditional script used in Hong Kong and Taiwan, and 9.0 for the simplified script used in mainland China [21]. Strokes are combined to form stroke-patterns (also called radicals) which may give meaning or sound cues to a character. There are a large number of orthographic units (about 200 semantic radicals and 800 phonetic radicals in Chinese characters [22]) as well as different degrees of positional, semantic, and phonological regularities for these orthographic units.

In terms of phonological structure, Chinese language is special for its monosyllabic nature and its presence of lexical tones, unlike alphabetic languages which are most often multi-syllabic and non-tonal. Each Chinese character is pronounced as a syllable with a fixed grouping of onset, rhyme, and tone. Each Chinese character also represents a morpheme and a much greater proportion of words in Chinese are formed by compounding (e.g., "foot-ball," "basket-ball," "hand-ball," etc.) than in European languages like English. The Chinese writing system is therefore visual-orthographically complex, and more meaning-based than sound-based.

According to the "triangle" model of word reading [23], reading words primarily involves the computation of three types of codes: orthographic, phonological, and semantic. Therefore, orthographic skills, phonological awareness, phonological retrieval, and morphological awareness have been found to be important for word reading both in Chinese and in English [24–28]. It is reasonable to expect that having deficits in these cognitive areas may lead to DD. With the specific characteristics of the Chinese writing system, we would like to identify the cognitive markers which may cause DD in Chinese.

So what constitutes a unique marker deficit for DD? We consider that the marker deficits have to be present only in DD but not in other learning or developmental disorders, for example, specific language impairment or attention-deficit/hyperactivity disorder (ADHD), etc. There may be some common cognitive deficits shared among associated disorders but cognitive deficits unique to DD may better inform us about etiology of the disorder.

Given the orthographic complexity and salience of word compounding morphology in Chinese, orthographic deficits and morphological deficits are expected to be potential candidates of cognitive markers of Chinese DD. Ho and her colleagues have reported that an orthographic deficit and a rapid naming deficit are the major reading-related cognitive deficits in Chinese DD [29, 30]. They have suggested that Chinese dyslexic children show problems in learning orthographic regularities and developing stable and strong orthographic representations that allow rapid retrieval. Although orthographic difficulty may also be found in some English children with dyslexia, this difficulty is more dominant among Chinese dyslexic individuals.

Other studies have shown that morphological awareness is an important predictor of reading success and failure in Chinese (e.g., [31, 32]). For instance, morphological awareness was found to contribute significantly and uniquely to Chinese character reading in kindergarten and grade 2 children, even after controlling for the effects of age, phonological awareness, speeded naming, and vocabulary [27]. Chinese dyslexic children were also found to perform significantly less well than age controls in morpheme production and judgment [32]. Morphological awareness appears to be more important in learning to read Chinese than in learning to read alphabetic languages [31].

To address the issue of unique marker deficits in Chinese DD, we may look into studies which compare the cognitive profile of DD with other learning or developmental disorders. However, this issue was not well examined in past studies. Among the few relevant studies, Ho and her colleagues compared some reading-related cognitive skills in children with different learning or developmental disorders, namely DD, ADHD, developmental coordination disorder (DCD), and borderline intelligence (BI) [33]. They reported that the DD-only group was most impaired in orthographic processing and rapid naming than all other pure groups. They suggested that these two cognitive deficits were unique marker deficits for Chinese DD.

Another study compared some cognitive skills of Chinese first graders with DD, specific language impairments (SLI), and DD + SLI [34]. They reported that orthographic skills and rapid naming were associated with dyslexia; phonological memory and morphological awareness were associated with SLI; and phonological awareness was associated with both. In other studies of lexical tone awareness, both children with DD [35] and children with SLI [36] were found to be weak in tone discrimination and production (a unique phonological feature of the Chinese language). Findings of these studies together appear to show that orthographic deficit and rapid naming deficit are unique marker deficits of DD in Chinese, but morphological or phonological deficit is probably not.

Morphological awareness is first developed in oral language when a child begins to pay attention to how some meaning units (morphemes) can be combined to form

different words. Like other oral language skills, morphological awareness may affect development of word reading. However, morphological deficit may be rooted in some language impairments, for example, SLI, instead of a unique cognitive deficit of DD in Chinese. Therefore, difficulty in learning and remembering complicated orthographic patterns and automatic retrieval of arbitrary script-sound associations appear to be unique marker deficits in Chinese DD. This matches well with the characteristics of the Chinese writing system. Since studies on this topic is scarce, more future studies are required to validate this tentative conclusion.

2.2 Dissociation between reading and spelling difficulties in Chinese

Apart from exploring the various marker deficits of DD in Chinese, investigation of manifestations of other reading-related difficulties in Chinese also enhance our understanding of literacy acquisition and difficulties in Chinese. While DD is defined as decoding difficulties (i.e., word reading difficulties), it has an entangled relationship with "encoding" difficulties (i.e., difficulties in spelling). In both research and practice, the concept of "dyslexia" is often conveniently conceptualized as difficulties in both reading and spelling (e.g., [37–39]). Although reading and spelling are highly associated skills, the observed developmental asynchrony of the two skills indicates that they could be non-parallel processes with two partially independent systems [40]. Studies on the dissociation of reading and spelling difficulties have attempted to identify differences between the two systems and provide us with a more comprehensive understanding of reading-related difficulties.

Research has shown that some children experience reading difficulties without having spelling difficulties [41] or vice versa [42]. The prevalence of such dissociated difficulties varies across languages. For Finnish, an orthographically transparent language, it is estimated that 3% of the children have both reading and spelling difficulties (RSD), 1.8% of the children have reading difficulties only (RD), and 2.1% of them have spelling difficulties only (SD). The estimated prevalence rates of RSD, RD, and SD observed in Finnish children are comparable among each other [43]. In contrast, in a study of French users, a relatively less transparent orthography, Fayol et al. [44] have identified a much lower prevalence of RD and SD (both around 4%) as compared with the estimated prevalence of RSD (17.6%). Mixed results were found in studies on languages with high grapheme-to-phoneme consistency (forward regularity) and low phoneme-to-grapheme consistency (backward regularity). Reading is argued to be easier than spelling in these languages because of such asymmetry between forward and backward regularity [45]. As expected, Manolitsis and Georgiou [46] found more SD (8.1%) than RD (5.1%) in their sample of native Greek-speaking children. However, the estimated prevalence rates of SD and RD were comparable in Moll and Landerl's [47] study (SD: 7%; RD: 6.4%) and Wimmer and Mayringer's [41] study (SD: 3.4–5.1%; RD: 4.3–6.4%) with native German-speaking children. Both Greek and German are considered to a high forward regularity (Greek: 95.1%; German: 84%; English as a comparison: 70%) and a relatively lower backward regularity (Greek: 80.3%; German: 47%; English as a comparison: 28%) [41, 46]. Although a larger discrepancy is observed between forward and backward regularity in German, a smaller difference has found between the estimated prevalence rates of SD and RD in German-speaking samples. Such observation does not fully support the hypothesis of Manolitsis and Georgiou [46] that difference in forward and backward regularity has a direct relationship with the resulting prevalence of dissociated difficulties. While the effect of orthographic depth on reading and spelling dissociation is inconclusive, it is evident that much lesser is known about orthographically opaque languages. Under a strict definition, Chinese is not considered as an "opaque orthography" because Chinese is not

alphabetic [48]. However, similar to an opaque orthography, Chinese has a very low sound-to-symbol correspondence compared with other languages [49]. The examination of reading and spelling dissociation phenomenon in Chinese complements our understanding of literacy acquisition and difficulties across languages.

The estimated prevalence rates of RSD, RD, and SD among Chinese primary school children are 9.2, 7, and 6.6%, respectively, according to a recent study with a representative sample of Hong Kong grade 4 to grade 6 children [50]. The RSD group was found to perform significantly worse than an age-matched control group of normally achieving children in all the cognitive-linguistic skills measured in the study, including rapid naming speed, phonological memory, morphological awareness, and orthographic skills. All three groups with difficulties were found to perform worse in linguistic comprehension (syntactic skills and discourse skills) when compared with the control group.

The SD group only fell behind the control group in orthographic skills and no significant differences were observed between the two groups on other domains of cognitive-linguistic skills. The SD group also performed the worst on orthographic skills among all four groups in the study. Consistent with past findings, this result supports the essential role of orthographic processing in spelling and impairments in developing efficient orthographic skills and quality orthographic representation may lead to SD. Frith [42] has observed that English-speaking children with SD have a habitual inattentiveness toward words. She has proposed that such inattentiveness may lead to inefficient processing of orthographic information and resulting in an incomplete mental representation of orthographic information, which may be sufficient for reading but not for spelling. Holmes and Quinn [51] have also reported converging evidence indicating inefficient processing of orthographic information in English-speaking individuals with SD. Cheung [52] has replicated Frith's [42] experiment and has found support for both the inefficient orthographic processing hypothesis and the habitual inattentiveness hypothesis in Chinese-speaking children. Consistent with findings from Cheung [50], the SD group in Cheung's [52] study showed no deficits in rapid naming speed or phonological memory. The reported distinctive pattern of deficits of SD highlights a possible independent spelling system in Chinese, which calls for a need for further research on spelling development and difficulties.

The RD only group was found to have difficulties in morphological awareness, phonological memory, and a mild inadequacy in orthographic processing, but not in rapid naming speed [50]. Naming speed deficit is a unique marker deficit for DD in Chinese, it is also consistently found to be present in RD for alphabetic readers [41, 43, 44, 53]. The absence of naming speed deficit in the RD group of Cheung [50] study could partially be explained by differences in measures used in defining the groups. A reading accuracy measure was employed to assess children's reading ability in Cheung's [50] study while the studies on alphabetic readers mentioned earlier used reading fluency measures with/without the addition of reading accuracy measures to assess reading skills of participants because reading accuracy measures are often found to be insensitive in languages with high grapheme-to-phoneme consistency [47]. DD in studies of Chinese is often defined with measures on reading accuracy, reading fluency, and spelling (e.g., [29, 30]).

Cheung's [50] study has also reported another analysis using a combined score of reading accuracy and reading fluency for measuring reading ability. The resulting SD group and the RSD group were found to demonstrate similar characteristics for using reading accuracy score only as the definition. In contrast, the new RD group was found to be slower in naming speed and weaker in morphological awareness when compared with the control group, and the difficulties in phonological memory were no longer observed. The presence of naming speed deficit in the new

RD group but not in the original RD group of this study supports past findings of a stronger association of naming speed with reading fluency but a weaker association with reading accuracy in both alphabetic languages [54] and Chinese [55]. However, it is noteworthy that the participants in Cheung's [50] study are senior graders. Rapid naming, reflecting both paired-associate learning ability and automatic retrieval, may be more associated with word reading accuracy in Chinese junior graders, and with word reading fluency in senior graders.

Conversely, phonological memory deficit was presence in the RD group categorized with reading accuracy measure but not the RD group identified with a combined reading score. Phonological memory is considered to be particularly important in Chinese literacy acquisition because of the emphasis of paired-associate learning in learning Chinese characters [30]. Chinese has a much lower grapheme-to-phoneme correspondence and a much larger pool of distinct graphemes to learn when compared with alphabetic orthographies [49]. Therefore, efficient storage of phonological information would be crucial for learning to read Chinese as the phonological cues from grapheme are relatively ineffective and more associations are needed to be learnt. In Cheung's [52] study on reading and spelling dissociation, he showed that phonological memory has a unique contribution to reading accuracy but not to spelling. These results suggest a unique role of phonological memory on the development of accurate word recognition in Chinese but may play a lesser role in reading fluency and spelling accuracy.

Under both reading assessment conditions of Cheung and colleagues' study, morphological awareness deficit was only found in the RD group and the RSD group but not in the SD group [50]. Morphological awareness was considered to be one of the core cognitive constructs that predict both reading and spelling abilities in Chinese [32, 56]. The absence of morphological awareness deficit in the SD group diverges from our current understanding of the relationship between morphological awareness and spelling development in Chinese. Such a discrepancy indicates a need for further research on the topic.

The distinctiveness between the cognitive profile of RD and SD in Chinese supports the hypothesis of two partially independent systems for reading and spelling. Although there may be some degree of overlap, somewhat different cognitive-linguistic skills are required in acquiring and developing the skills in reading and spelling Chinese words. The non-coinciding profile of deficits of RD and SD reveals the relative importance of morphological awareness and phonological memory on reading and orthographic processing on spelling in Chinese. Naming speed deficit appears to be more associated with word reading fluency than reading accuracy in Chinese. Findings of dissociation studies have enlightened us about the specific roles of some cognitive-linguistic skills on reading and spelling. These conclusions, however, are tentative and further research is required.

2.3 Reading comprehension difficulties in Chinese

Beyond the decoding level, some children experience difficulties in comprehending text. Decoding and reading comprehension processes are inter-related to some extent. Decoding and language comprehension are two important components of reading comprehension as specified by the Simple View of Reading. A number of studies showed that reading comprehension difficulties of children could be attributed to problems in lower order processing, such as word recognition accuracy and speed of word processing although the underlying cognitive processes could be different regarding the types of script of different languages (e.g., [5, 57–59]). In particular, word recognition is more dependent on phonological skill in English than in Chinese as Chinese exhibits a relatively lower word-to-sound correspondence as mentioned earlier [60, 61].

Apart from decoding skill, research in alphabetic languages stressed the importance of language comprehension, defined as "the ability to comprehend spoken language" ([62], p. 369), in reading comprehension. Syntactic awareness, discourse skills, and vocabulary knowledge are the major oral language skills that consistently found to affect reading comprehension even after controlling for word recognition (e.g., [63, 64]). For example, Mokhtari and Thompson [65] examined the relationship of syntactic awareness and reading comprehension performance of fifth graders and found that children's understanding of grammatical structure directly related to reading comprehension performance with a $r = 0.70$ correlation. Another study done by Griffin et al. [66] indicated that oral discourse skills of preschoolers is a significant predictor of reading comprehension performance in later years. In addition to syntactic and discourse skills, vocabulary knowledge is also associated considerably with reading comprehension [67, 68]. Ouellette [68] found that depth of vocabulary knowledge significantly predicted reading comprehension of fourth graders. Furthermore, the amount of receptive and expressive vocabularies a child acquired is linked to decoding proficiency [68].

Research regarding reading comprehension in Chinese suggested that language comprehension skills important for reading comprehension in alphabetic language systems are equally important for Chinese [5, 59, 69]. A model of reading comprehension in Chinese was constructed by Yeung and colleagues [5] through examining the contribution of several reading-related and language comprehension skills, including rapid naming, morphological awareness, verbal working memory, syntactic skills, and discourse skills, to Chinese reading comprehension. Results showed that syntactic and discourse skills predicted Chinese reading comprehension similar to that in alphabetic languages. However, discourse skills measured orally through story-telling and picture arrangement was not as predictive as discourse skills assessed in written format to reading comprehension [5]. One possible reason suggested by the authors was that oral Cantonese and written Chinese were less consistent than many alphabetic languages [5]. Other than syntactic and discourse skills, oral vocabulary was also found to significantly predict reading comprehension of Chinese children. For instance, Chik et al. [69] found that oral vocabulary was a strong predictor of Chinese reading comprehension for children in junior grades although its contribution reduced from senior grades onwards. Altogether, these studies suggested reading comprehension difficulty is not only limited to decoding of scripts but is also highly related to individuals' language comprehension skills no matter in alphabetic languages or Chinese.

Despite the clear links between decoding, language comprehension and reading comprehension, recent research suggested that reading comprehension difficulties could not be merely explained by the decoding efficiency and oral language skills. In fact, researchers found that some children demonstrated adequate decoding skills but still experience difficulties in reading (e.g., [9, 58, 70, 71]). Such word reading and comprehension dissociation have been recently referred to as specific reading comprehension difficulties (S-RCD). In a review done by Landi and Ryherd [72], adolescents with S-RCD displayed weakness in oral language specifically in vocabulary and grammatical processing. Spencer and Wagner [62] conducted a meta-analysis to further investigate the language comprehension skills of children aged 4–12 with reading comprehension difficulties as compared with typical readers. The sample was a mixture of alphabetic and non-alphabetic language speakers with a majority of the data involved English speakers. The results revealed that although the language comprehension skills of children with S-RCD were relatively weak, such weakness could not fully account for the reading comprehension problems, which was found to be more severe than the language comprehension problems [62].

Thus, the specific reading comprehension problems might involve skills beyond the scope of the Simple View of Reading.

Another branch of research investigated the contribution of higher order language skills to reading comprehension which is not theorized in the Simple View of Reading, such as the processing of prosodic information, comprehension monitoring, and inference-making (e.g., [73–79]). For instance, reading comprehension could be impaired if individuals fail to recognize appropriate prosodic features and construct meaningful oral expression [80]. Among the many contributors, comprehension monitoring—an individual's ability to "evaluate his/her understanding of information" [78]—stands out to be uniquely associated with S-RCD. Children with S-RCD was found to be less sensitive to inconsistency and ambiguity in texts than typical readers that they were less able to identify unreasonable information embedded in a passage [73]. Furthermore, they did not display typical slowing in eye movement when encountered ambiguous words in passages as found by an eye-tracking study done by van der Schoot and colleagues [81]. Although some researchers found that individuals with S-RCD exhibit weak inferencing skill—the ability to integrate sentence meaning and make logical deduction—other researchers argued that the inference failure of S-RCD may be more related to the automaticity in integrating information and language comprehension weakness than a deficit in inferencing ability [72, 82]. Thus, the contribution of inferencing skills to S-RCD is yet to be explored.

One important issue to note is that research specifically focused on S-RCD in Chinese is relatively scarce. Zhang et al. [59] attempted to search for the early precursors of reading comprehension difficulties in Chinese children and found that poor comprehenders did not necessarily exhibit word reading deficits, especially later in the development. Thus, they concluded that similar to previous findings on alphabetic language, S-RCD might be present in Chinese but further exploration is needed given some major differences between Chinese and alphabetic languages, such as route of semantic access and processing of grammatical information [59].

To conclude this section, reading comprehension difficulties are multifaceted and heterogeneous in nature. The difference in the manifestations of reading comprehension difficulties could be traced to multiple distinct roots, from word decoding, oral language to higher order language processing, such as comprehension monitoring. Yet, the heterogeneity of reading comprehension difficulties in Chinese remains to be explored in the future.

3. Conclusions

We have reviewed in this chapter the causes and patterns of reading, spelling, and comprehension difficulties in Chinese are heterogeneous. Various research findings together have suggested that rapid naming and orthographic deficits are the unique marker deficits of DD in Chinese. Since DD has been defined by impairments in word reading accuracy, reading fluency, and spelling in Chinese, research on the dissociation between word reading and spelling difficulties has enlightened us about the specific mechanism of word reading and spelling development. Research findings so far suggest that weaknesses in orthographic processing, including inattentiveness to word details, inefficient orthographic processing, and incomplete mental representation of orthographic information, may specifically cause difficulties in word spelling in Chinese. Deficits in automatic name retrieval appear to be more associated with word reading fluency than reading accuracy in Chinese. This is especially true for senior graders who may have learned a basic set of written characters and are beginning to develop automaticity in retrieving the

characters for higher level processing, like understanding syntactic relationships and text comprehension. Inefficient word decoding and weak oral language skills (e.g., morphological awareness, vocabulary knowledge, syntactic skills, and discourse skills) have been found to contribute to difficulties in text comprehension. However, some discourse-level skills may contribute to reading comprehension in addition to these two components of the Simple View of Reading. We believe that knowledge about the specific associated cognitive-linguistic skills for word reading, spelling, and text comprehension will inform us how to effectively identify children early with various reading-related difficulties and design timely and appropriate intervention for each specific group.

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