Education Journal《教育學報》, *Vol. 30, No. 2, Winter 2002*

Developmental Dyslexia in Hong Kong: An Overview and Lessons from an International Perspective

DAVID W. CHAN
Department of Educational Psychology, The Chinese University of Hong Kong

The study of developmental dyslexia was briefly reviewed through tracing its historical origin, addressing the issues in definitions, summarizing well-accepted epidemiological findings, and highlighting some of the recent research on the neurological and cognitive basis of dyslexia. By introducing developmental dyslexia in different languages, including the Chinese language, it was recognized that different cognitive deficits might be differentially prominent in different language settings. The recent progress on studying the cognitive deficits of Chinese dyslexic children in Hong Kong and the development of assessment instruments for identification of dyslexia laid the foundation for further research. The need for translating research into evidence-based practice in developing interventions for dyslexic children was discussed.

Learning to read and write is not easy for children, and most require some years to do it well. However, it has puzzled educators and researchers for decades that this seemingly easy challenge does elude a number of children who seem normal and intelligent in every other way. Thus, the concept of dyslexia could be viewed as arising from the clinical need to recognize the occurrence of marked reading difficulties in children who were otherwise healthy, well-nurtured, earnest and cognitively advanced. Interestingly, the earliest explanations, intended to attribute the cause for disturbances in information processing to underlying deficits in functioning in specific brain areas, were largely unfounded from a contemporary perspective (see Vellutino, 1979). In the past decades, through advances in genetics, neurobiological and psychological research, dyslexia has emerged from being

a hidden disability to one that is acknowledged in academic and professional fields (e.g., Miles & Miles, 1999; Snowling, 2000). Yet, the issues about how best to define dyslexia and to provide interventions to dyslexic children remain controversial. Although recent basic research studies have shed much light on these topics, there is still a wide gap between clinical intuition, research-based diagnosis, and optimal treatment. Further, since dyslexia encompasses language-based learning difficulties, questions may be raised as to whether research findings based on the English language and other languages with alphabetic scripts can be applied to helping dyslexic children in settings using languages with nonalphabetic or morphemic scripts.

This issue is particularly relevant in Hong Kong where the population is largely not English-speaking but Chinese-speaking or Cantonese-speaking. With a growing worldwide interest and conceptual understanding of dyslexia among researchers, there is also an increasing awareness among teachers and parents in Hong Kong regarding the needs to identify and help Chinese children with dyslexia. Thus, an overview from a historical perspective and an introduction on recent research in the academic and professional fields will help set the stage for stimulating further research in dyslexia based on the Chinese language as well as for exploring evidence-based practice to help dyslexic children in Hong Kong.

A Historical Perspective on Dyslexia

The term “dyslexia” has been in use since the 1880s when Berlin first employed it to describe patients whose ability to read was impaired by brain injury (see Clark & Uhry, 1995; Sutherland & Smith, 1991). Subsequently, the concept was further developed independently by Morgan and by Kerr in the 1890s to suggest a form of developmental dyslexia in their description of apparently bright and intelligent children, who demonstrated a remarkable inability to learn to read despite being given every educational opportunity (Sutherland & Smith, 1991). However, while the emphasis appeared to be on poor reading, the researchers’ interest was not restricted to reading difficulty. As Critchley (1981) aptly remarked, “the etymology of the term dyslexia expresses admirably a difficulty — not in reading — but in the use of words, how they are identified, what they signify, how they are handled in combination, how they are pronounced, and how they are spelt …” (p. 2). It has to be noted that the term “developmental dyslexia" is used to refer to a developmental disorder of suspected congenital or hereditary origin and the disorder might extend across the life span. Conceptualized in this manner,

developmental dyslexia is distinguished from acquired dyslexia that results from brain injury after the onset of reading (Frith, 1986).

The observations of Morgan and Kerr also sparked the search for a neurological explanation to dyslexia in the medical profession. Hinshelwood (1917), for example, suggested that dyslexia was a result of pathological damage to a particular area of the cortex (the left angular gyrus). In contrast, rather than viewing dyslexia as resulting from an anatomical deficit, Orton (1937) viewed dyslexia as caused by a peculiarity of brain organizations or a result of a failure in establishing cerebral dominance based on the evidence of the particularly distinctive reading and spelling mistakes made by dyslexics. Orton was also among the first to associate dyslexia with language disorders (see Geschwind, 1982). Nonetheless, recent research studies seem to suggest that there is no simple neurological explanation for developmental dyslexia, and that the manifestations of difficulties are inevitably complicated by different orthographies in different languages (see Helmuth, 2001; Paulesu et al., 2001).

Issues in Defining Dyslexia

These pioneering clinical work by medical specialists and many other subsequent research studies have gradually led to a better understanding of the features and difficulties associated with dyslexia. However, there is as yet no consensus on the definition of dyslexia among professionals. Perhaps, one of the early formal definitions was the one that emerged from the meeting of the World Federation of Neurology in 1968 (see Critchley, 1970):

> [Dyslexia is] a disorder manifested by difficulty in learning to read despite conventional instruction, adequate intelligence and sociocultural opportunity. It is dependent upon fundamental cognitive disabilities which are frequently of constitutional origin. (p. 26)

This definition was however found to be unsatisfactory because of the ill-defined terms of conventional instruction, adequate intelligence, and sociocultural opportunity, and its exclusionary nature of not including criteria for positive diagnosis other than fundamental cognitive disabilities.

Inevitably, the definition of dyslexia bore directly on education practice, as one major concern of schools and teachers was the identification of dyslexic students as distinguished from other poor readers so that appropriate and timely interventions could be provided. In response to this pragmatic concern, the IQ and reading attainment discrepancy definition was often

used. Essentially, poor readers were identified as having specific reading difficulties or dyslexia if their reading attainments were significantly below the levels expected from their IQ. Evidently, this approach had multiple problems, but the important reason for its falling from favor had to do with its reliance on the global construct of IQ, which masked the importance of the roles of variables of cognitive processes in dyslexia (see Stanovich, 1996).

With the above issues in mind, the Orton Dyslexia Society (1994), now renamed as the International Dyslexia Association, offered a more research-based definition (see also Lyon, 1995):

> Dyslexia is one of several distinct learning disabilities. It is a specific language-based disorder of constitutional origin characterized by difficulties in single word decoding, usually reflecting insufficient phonological processing. These difficulties in single word decoding are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalized developmental disability or sensory impairment. Dyslexia is manifested by variable difficulty with different forms of language, often including, in addition to problems with reading, a conspicuous problem with acquiring proficiency in writing and spelling. (Orton Dyslexia Society, 1994, p. 5)

While this definition may have its shortcomings, it does make clear that dyslexia is a kind of learning disabilities or difficulties, often co-occurs with other disorders, and encompasses spelling and writing problems. More importantly, it highlights the importance of phonological processing and stresses problems of word-decoding rather than reading comprehension skills. In addition, it serves to bring into research focus the studies on cognitive processes.

Alternatively, education practitioners are more likely to find the definition provided by the British Dyslexia Association (2002) in *The Dyslexia Handbook 2002* practical and educationally oriented:

> Dyslexia is best described as a combination of abilities and difficulties that affect the learning process in one or more of reading, spelling, writing. Accompanying weaknesses may be identified in areas of speed of processing, short-term memory, sequencing and organisation, auditory and/or visual perception, spoken language and motor skills. It is particularly related to mastering and using written language, which may include alphabetic, numeric and musical notation. Some dyslexics have outstanding creative skills. Others have strong oral skills. Some have no outstanding talents. They all have strengths. Dyslexia can occur despite normal intellectual ability and teaching. It is independent of socio-economic or language background. (p. 67)

This practical definition contains no explicit reference either to neurological findings or to cognitive science, and can be assumed to direct specifically to the education profession. While the emphasis is on reading, spelling and writing, mathematics and music are included. Presumably, references are made to difficulties and abilities as well as weaknesses and strengths to avoid negative labeling of dyslexia.

In reviewing the various definitions, E. Miles (1995) pointed out that different definitions serve different purposes. Thus, one might expect that a definition based on neurological and psychological findings will necessarily be different from one that focuses on teaching and learning needs, and different again from one that attempts to specify the rights of dyslexic children in education and in law. Accordingly, a single all-purpose definition that commands general acceptance, even if one were possible, would hardly be appropriate. Nonetheless, it is important to explicate the divergences and the implications of narrow and inclusive definitions for research and practice, bearing in mind that different and sometimes apparently inconsistent findings from different studies might be a result of the different definitions of dyslexia adopted in different studies.

Epidemiological Findings and Recent Neurobiological Research on Dyslexia

Findings from various studies have now revealed that between 2% and 4% of the population may have severe dyslexia, while a further 6% may be mildly or moderately dyslexic (see Badian, 1994). Depending on the definitions and criteria that one adopts, the incidence rates reported for school-age children around the world ranges from 1% to 11% (Salter & Smythe, 1997). These estimated rates however must be viewed in the context of the nature of orthography. For example, the prevalence of dyslexia in Italy was found to be much lower than that in the U.S., but the difference might be accounted for by the shallow or transparent orthography of Italian when compared with that of English (see Paulesu et al., 2001). While it appears that developmental dyslexia recognizes no intellectual, social or educational boundaries, there are reports of gender differences (see Miles, Haslum, & Wheeler, 1998). There are relatively consistent findings that dyslexia may be more common in males than in females, the ratio being 4 to 1. Boys tend to have more pronounced defects in reading and spelling than girls. However, this gender imbalance has been called into question in some studies, yielding a gender ratio of 2 to 1 or even close to 1 to 1. The

gender difference could be readily explained by the differences in selection criteria that included clinic samples or samples from broad groups of children with reading disability (see Miles et al., 1998).

While it is increasingly acknowledged that developmental dyslexia has a strong genetic basis, recent twin, adoption, genetic linkage and association studies have highlighted the complex and possibly interactive effects of genes and environments on language impairments, including dyslexia (see Plomin, Owen, & McGuffin, 1994). For example, recent studies have suggested a possible link between dyslexia and chromosome 6 as well as chromosome 15 (e.g., Cardon et al., 1994; Smith, Kimberling, Pennington, & Lubs, 1983; Smith, Pennington, Kimberling, & Ing, 1990). However, it has to be noted that there are several distinct genetic loci, and no individual genes have been identified that contribute substantially to dyslexia. More importantly, one has to recognize that genetic factors can be influenced by or even ameliorated by environmental factors, the case of phenylketonuria being a good example (Hellekson, 2001). In another line of studies, researchers aiming to understand the neurological basis of the disorder have recently concentrated their efforts on, among others, the magnocellular pathway, the planum temporale, and the cerebellum (see Best & Demb, 1999; Nicolson et al., 1999; Vidyasagar & Pammer, 1999). This area of neurological studies and the studies on behavioral genetics have developed and progressed very rapidly, and the brief mention here not only does not do justice to the complex issues involved but also might misguide readers. Therefore, interested readers are well advised to consult original and more current sources.

Apart from the neurological level of description, dyslexia as a disorder of development can be expected to have underlying cognitive mechanisms and behavioral manifestations that will change with maturation and in response to environmental interactions. Therefore, it is important to seek explanations not only at the biological level but also at the cognitive and behavioral levels in order to develop a comprehensive explanation of why some children fail to learn to read (Frith, 1997).

Cognitive Explanations of Dyslexia

The search for cognitive explanations of dyslexia continues from the 1960s, and focuses on efforts to explore the causal links between cognitive skills and written language abilities. There is now abundant evidence that phonological processing deficits might constitute a core deficit that underlies the failure to acquire adequate word recognition skills among dyslexic

English readers (see Snowling, 2000; Stanovich, 1988). Accordingly, dyslexic children whose main difficulties lie in phonological processing are generally classified as the phonological dyslexia subtype, and they usually perform poorly in reading nonwords but adequately in reading exception words (see e.g., Castles & Coltheart, 1993; Manis, Seidenberg, Doi, McBride-Chang, & Petersen, 1996; Morris et al., 1998).

Over the years, some researchers have diverged from this strict phonological view as they attempted to explain the consistent presence of naming-speed deficits in severely impaired readers and the relationship between naming speed and reading failure. There is research evidence that naming speed is not associated with word and nonword identification as is phonological skills, suggesting that naming-speed deficit could represent a second core deficit in dyslexia (see e.g., Bowers & Wolf, 1993; McBride-Chang & Manis, 1996; Wolf & Bowers, 1999). However, this double-deficit hypothesis has not gone unchallenged (see e.g., Pennington, Cardoso-Martins, Green, & Lefly, 2001). Nonetheless, under this double-deficit hypothesis, compared with the phonological deficit subtype and the naming-speed deficit subtype, the double-deficit subtype of dyslexia represents the most impaired readers across all dimensions of reading, presumably because the co-occurrence of phonological and naming-speed deficits allows limited compensatory routes.

On the basis of the double-deficit hypothesis, Badian (1997) added an orthographic factor to phonological deficits and naming-speed deficits, extending the double-deficit hypothesis to a triple-deficit hypothesis. Under the triple-deficit hypothesis, visual processing of orthographic information such as letter sequences and spatial position patterns in words is included as an independent factor contributing to word recognition (see Bowers & Wolf, 1993; Corcos & Willows, 1993). The research evidence also substantiates that more impaired reading is associated with triple deficits in phonological, naming speed, and orthographic skills (e.g., Hultquist, 1997; Roberts & Mather, 1997).

Apart from these three deficits, researchers have also suggested further deficits that might contribute to poor reading. Despite that there are arguments against including visual perception and visual memory as important in dyslexia, there is also a body of evidence supporting that dyslexic readers could be deficient in basic visual processes (see Lovegrove, 1993; Willows, Corcos, & Kershner, 1993). Nonetheless, continued exploration in uncovering further cognitive deficits is important to clarify whether students of different subtypes of dyslexia could have marked deficits in different

cognitive processes. The delineation of different cognitive deficits and the identification of different subtypes have implications for the provision of appropriate interventions to different dyslexic children with different cognitive deficits.

Developmental Dyslexia in Different Languages

Parallel to research studies indicating that there could be multiple cognitive core deficits underlying dyslexia, questions may be raised as to whether phonological weaknesses as features of the dyslexic pattern of difficulties are only predominant in English-speaking populations, that is, in Australia, Canada, the U.K., and the U.S. Since research on the cognitive weaknesses of dyslexics in other languages is limited, researchers have often compared findings with dyslexics in non-English-speaking populations against those with dyslexics in English-speaking populations. In making these comparisons, it is convenient to view languages with alphabetic scripts as more transparent or opaque than English is, or to contrast languages with alphabetic and morphemic scripts. Interestingly, the characteristics of a language appear to contribute differences in the types of deficits experienced by dyslexic readers.

Essentially, more transparent languages are languages with relatively greater regularity in the grapheme-phoneme correspondence, and more opaque languages are those with relatively greater irregularity. For example, Czech, German, Italian, Maltese, Spanish, and Welsh are all more transparent than English. In general, dyslexic children who have a transparent language can master the basic grapheme-phoneme correspondence of the language on a level almost equal to that of their peers. While they might have less of a problem with accuracy, they might be slow in handling the alphabetic script, especially when cumbersome clusters of consonants or long polysyllablic words are involved. An example can be found in Wimmer (1993), who found significant deficit in naming speed for objects, colors, and digits among German-speaking Austrian children. Thus, even in transparent languages, there can be various other complexities that are likely to cause problems to the dyslexic children. For more opaque languages, readers perhaps have to rely more on grammatical understanding than on phonological awareness.

More different from English are Chinese and Japanese (kanji), which are nonalphabetic and have scripts that represent morphemes (see e.g., Leong & Tamaoka, 1998). At one time, it was even thought that Chinese and

Japanese children could be less prone to literacy problems as they could adopt a logographic approach rather than a phonological one, assuming that phonological deficit was the root cause of dyslexia. However, this view was not substantiated. In a cross-cultural study, Stevenson, Stigler, Lucker, and Lee (1982) compared the reading scores of fifth graders, aged about 10 to 11 years, from Minneapolis (U.S.), Sendai (Japan), and Taipei (Taiwan). They found that the proportions of children of average ability in the lowest 10% of reading scores were very similar for the three cities. Thus, dyslexia might not be less prevalent in populations with environments using languages with nonalphabetic scripts. The lack of difference however does not imply that reasons for reading difficulties have to be the same for the three languages.

Admittedly, there might be, apart from phonological deficits, multiple reasons accounting for the lack of difference in prevalence rates of reading disabilities in the three language settings. In the case of Japanese, for example, the detailed visual appearance of very similar characters could be a source of errors (Yamada, 1995). In the case of Chinese, researchers have examined closely the phonological component in the Chinese characters that represent morphemes. Despite the logographic appearance of the Chinese characters, there is a phonological element, and each character represents a syllable. It is estimated that up to 80% or more of characters include a "phonetic" (or sound symbol) as a guide to pronunciation, the other radical being the semantic or meaning element. However, these phonetic components do not always provide constant and reliable cues to pronunciation (see Chen, 1996). In addition, Chinese characters usually appear as two-character words, and sound and meanings of Chinese characters in such combinations are also complicated by the different tones in pronunciation and reading (see Leong, 1986; Leong, Cheng, & Lam, 2000; Wu & Liu, 1996).

Recognizing the importance of phonological element in the Chinese language, Leong (1997) maintains that Chinese children are taught to read with an integrative approach connecting *xing* (shape), *sheng* (sound), *yi* (meaning) and with phonological and orthographical processing, reading, composition and spelling all equally emphasized. Thus, it is likely that paired-associate learning is involved, and that phonology could be less important than in the case of an alphabetic script. Further, the child may need to call on a visual-spatial type of short-term memory system rather than a phonological working memory system (see e.g., Gathercole & Baddeley, 1993). In summary, while there is also a phonological element in Chinese characters, for the dyslexic child, there may be other difficulties that are

connected with the complexity of the characters and the different combinations that they form.

Developmental Dyslexia Among Chinese Children in Hong Kong

Compared with the voluminous literature of research studies on developmental dyslexia in the English language and other languages with alphabetic scripts, there is relatively little research on developmental dyslexia in the Chinese language. In Hong Kong, the majority of Chinese children are Cantonese-speaking. Thus, while they have the same written Chinese language (putting aside whether they are taught the simplified characters or the traditional characters), they do not speak Putonghua (Mandarin), and it is unknown to what extent the script-sound correspondence is similar between Putonghua and Cantonese. In this connection, caution must be exercised in the interpretation of findings from different Chinese societies where different dialects are spoken.

Perhaps, one of the pioneering studies was by Woo and Hoosain (1984), who found that Chinese dyslexic children made more visual-distracter errors in Chinese character recognition than the average readers, supporting the common conception that visual skills could be important in learning to read Chinese. Subsequent studies on Chinese children have also provided evidence that visual skills were related to reading performance (e.g., Huang & Hanley, 1995; McBride-Chang & Chang, 1995). However, it has to be noted that "visual skills" in reading Chinese should be understood along the line of orthographic processing, which is related to the components of Chinese characters and words, and their relation to sound.

Ho and Bryant (1997a, 1997b), in view of the script-sound regularities in the Chinese language, focused their study to examine phonological skills among Chinese children. In their longitudinal study, they found that Chinese children's pre-reading phonological awareness skills were significant in predicting reading performance two and three years later (Ho & Bryant, 1997b). They also found that many Chinese first- and second-graders spontaneously used the phonetic component of Chinese characters for sound cues in reading Chinese pseudo-characters (Ho & Bryant, 1997a). Since children in Hong Kong learn to read Chinese by the whole-word approach starting at around 3 without the aid of any phonetic or *pinyin* system, they could pick up rules of script-sound correspondence only implicitly. It seems that Chinese children in Hong Kong use phonological clues as a result of

learning to read Chinese characters and have not been taught about such correspondence. Ho and Bryant's (1997a, 1997b) study also indicated that first graders made many over-regularization errors than second graders who made little advance in phonological awareness, presumably as the irregularities became more recognized. Other researchers also reported similar findings on the importance of phonological skills. For example, in a Taiwan study, Hu and Catts (1998) found that the performance of Chinese first graders on three phonological processing measures (memory, awareness, and retrieval) correlated significantly with their reading performance. In another study in Hong Kong, So and Siegel (1997) also found that word recognition was highly correlated with phonological skills and semantic processing among grades 1 to 4 Chinese children. Thus, it is likely that phonological awareness is indeed important in the very early stages of learning to read in Chinese children.

Extending the findings to Chinese developmental dyslexia, Ho and her colleagues started a series of studies to test the various cognitive-deficit hypotheses in Hong Kong. Specifically, Ho, Law, and Ng (2000) sought to test the phonological deficit hypothesis. They found that children with both reading and writing difficulties perform significantly worse on all phonological awareness and phonological memory tasks than average readers of the same age and average readers of the same reading level, and that children with reading difficulties also performed significantly worse than their age peers. They concluded that Chinese dyslexic readers at 8 or 9 have started to use the phonetic components for sound cues in reading Chinese characters, and suggested that phonological awareness and phonological memory could be crucial to the long-term learning of script-sound or orthography-phonology rules in Chinese.

In another study with the same design employing similar controls, Ho and Lai (1999) examined naming deficits of Chinese dyslexic children. They found that Chinese dyslexic children had significantly slower naming speed in naming digits, colors, pictures, and Chinese characters, and performed significantly worse in all phonological memory tasks in digit repetition, word repetition, and nonword repetition than their controls. Based on these findings and findings from previous studies, Ho and Lai suggested that phonological memory could be Chinese dyslexic children's most prominent problem, followed by phonological awareness and naming speed.

In yet another study with similar design, Ho, Chan, Tsang, and Lee (2002a) tested Chinese dyslexic children's various cognitive deficits using multiple tasks that included phonological, naming speed, orthographic, and

nonmotor visual tasks. Dyslexic children performed significantly worse than average readers of the same age on most of the cognitive tasks, but the cognitive profile was similar to the average readers about two years younger, suggesting that reading problem of dyslexic children could be one of delay. The dominant type of cognitive deficit was naming speed, which was significantly associated with orthographic, visual, and phonological memory skills. The number of cognitive deficits that a child had was in turn associated with the child's degree of impairment in performance in reading and dictation. Taken together, the findings supported the multiple-deficit hypothesis in Chinese developmental dyslexia, suggesting that cognitive deficits in naming speed, orthographic, visual, and phonological processing all contributed significantly to reading and spelling failures in Chinese children with dyslexia.

From Research to Practice in Chinese Developmental Dyslexia in Hong Kong

The increasing recognition and growing interest in developmental dyslexia in Hong Kong have led to issues regarding reliable and valid assessment, early identification, and appropriate interventions and remediation. All these areas require efforts to translate research evidence in Chinese developmental dyslexia, both overseas and locally, into effective practice. While such efforts are nothing but daunting, there are reasons for optimism, as some initial groundwork has been laid in Hong Kong in the past decade.

In recent years, various interest and advocacy groups have been formed to voice the needs for special provisions for dyslexic children. Particularly worthy of note is the Hong Kong Society of Child Neurology and Developmental Paediatrics (HKCNDP), which gathers a group of parents, developmental pediatricians, and child neurologists from the Department of Health. Through organizing professional meetings and symposia, the Society has provided a forum and opportunities for exchange of views, dissemination of knowledge, and sharing of experience among clinicians and professionals working with dyslexic children. Pediatricians and psychologists in the Child Assessment Centres under the Department of Health have also made observations and gathered data on children diagnosed with dyslexia. A group of papers arising from the Society's meeting have been published in the *Hong Kong Journal of Paediatrics* (e.g., Lam, 1999; Leong, 1999). With samples of clinic-referred children with dyslexia, teaching materials have also been specially prepared to help teachers teach

children systematically the composition of the Chinese characters with their constituent phonetic and semantic radicals using games, songs, rhymes, alliterations, and other linguistic activities designed to enhance their word identification skills. While the effectiveness of these exploratory programs and activities based on knowledge from empirical findings needs to be carefully and rigorously evaluated, they highlight the need to design and implement evidence-based practice for dyslexic children in Hong Kong.

While the ultimate concern of teachers teaching dyslexic children is to devise the best and most appropriate learning programs for these students to address their specific needs, the more immediate concern is to determine how best to assess and identify these students. In Hong Kong, there is as yet no standard procedure for identification. For government educational psychologists, apart from an educational history, and sample scripts of homework and dictation, the assessment process typically involves a full IQ test using the Hong Kong Wechsler Intelligence Scale for Children (HK-WISC; Psychological Corporation, 1984), and tests on word copying, word matching, and word reading. The Bender-Gestalt Test (Bender, 1946) may also be employed. However, prior to referral for psychoeducational assessment by educational psychologists, schoolteachers and parents have to rely on their own observations of students' performance in reading and dictation. Increasingly, this identification process is deemed to be somewhat unsatisfactory, as it yields a small number of identified students with dyslexia each year, the incidence rate of less than 1% being much lower than would be expected from figures reported around the world (see Ho, Chan, Tsang, & Lee, 2000b).

One possible reason accounting for the misleadingly low incidence of dyslexia in Hong Kong perhaps has to do with the lack of appropriate instruments designed to assess the specific cognitive deficits of dyslexic children. With this view, psychologists in Hong Kong have great interest in developing a battery of tests for this purpose. In 1998, psychologists from the University of Hong Kong, The Chinese University of Hong Kong, the Education Department of the Hong Kong Special Administrative Region Government, and the Hong Kong Institute of Education have joined forces to form the Hong Kong Specific Learning Difficulties Research Team (HKSLDRT). The broad aims of HKSLDRT are to promote assessment, research, and evidence-based practice on developmental dyslexia in Hong Kong. Specifically, on the basis of the findings of multiple deficits of dyslexia (Ho et al., 2002a), HKSLDRT has developed a battery of tests, the Hong Kong Test of Specific Learning Difficulties in Reading and Writing

(HKT-SpLD). The battery includes three literacy tests (Chinese Word Reading, One Minute Reading, and Chinese Word Dictation), one rapid naming test (Digit Rapid Naming), two phonological awareness tests (Rhyme Detection, and Onset Detection), three phonological memory tests (Word Repetition I, Non-Word Repetition, and Word Repetition II), and three orthographic knowledge tests (Light-Left Reversal, Lexical Decision, and Radical Position). Apart from these tests, HKSLDRT also recommends the use of four nonmotor visual-perceptual tests (Visual Discrimination, Visual Memory, Visual-Spatial Relationship, and Visual Closure). The visual-perceptual tests are not developed by HKSLDRT, but are tests from Gardner's (1996) Test of Visual-Perceptual Skills (Non-Motor). A norming study on the battery and the nonmotor visual-perceptual test has been conducted with 704 children in Hong Kong (Ho et al., 2000b). It is anticipated that with the widespread use of this battery, children with dyslexia can be more accurately identified with their profiles of cognitive deficits. As an extension, HKSLDRT has also developed a training package of three videodiscs specifically targeted to train dyslexic children in reading Chinese characters and words (Ho, Chan, Tsang, Lee, & Chung, 2003). On the basis of the results of assessment using, for example, the HKT-SpLD, children who are specifically weak in orthographic skills, phonological processing skills, and naming speed can be trained using the three corresponding videodiscs respectively. A preliminary study with 23 dyslexic children has yielded promising results. Further studies are warranted in order that the efficacy and effectiveness of this training package can be rigorously evaluated.

While psychologists' assessment of dyslexic children using the HKT-SpLD and HK-WISC will yield cognitive profiles for accurate diagnosis and appropriate interventions based on these specific cognitive deficits, the full diagnostic assessment is typically a costly and time-consuming process. Since teachers interact with children on a daily basis, they are well placed to notice any difficulties encountered by their students. Thus, a screening test based on teachers' observations of students' behaviors will allow teachers to determine whether or not a referral is necessary for a full assessment by psychologists. With this view, HKSLDRT has also developed a behavior checklist for teacher use. The Hong Kong Specific Learning Difficulties Behaviour Checklist (HKSLDBC) covers twelve areas, including reading, spelling and dictation, writing, general performance, mathematics, language, memory, attention, sequencing, motor coordination, spatial orientation, and social emotional adjustment. A norming study has

also been conducted based on 353 primary two to four students (Ho, Chan, Tsang, & Lee, 2000a) and 216 primary one students (Ho, Chan, Tsang, & Lee, 2002b).

In summary, in the past decade, Hong Kong has made notable progress in research on the cognitive deficits of dyslexic children, and in the development of assessment instruments based on empirical findings for use by psychologists and teachers for diagnosis and identification. Some initial work has also been done for dyslexic children in terms of intervention and remediation. These advances and developments shed light on Chinese developmental dyslexia and provide optimistic grounds for further work on research, practice, and evaluation of practice in Hong Kong.

References

Badian, N. A. (1994). Preschool prediction: Orthographic and phonological skills and reading. *Annals of Dyslexia*, *44*, 3–25.

Badian, N. A. (1997). Dyslexia and the double deficit hypothesis. *Annals of Dyslexia*, *47*, 69–87.

Bender, L. (1946). *Instructions for the use of the Visual Motor Gestalt test*. New York: American Orthopsychiatric Association.

Best, M., & Demb, J. B. (1999). Normal planum temporale asymmetry in dyslexics with a magnocellular pathway deficit. *NeuroReport*, *10*(3), 607–612.

Bowers, P. G., & Wolf, M. (1993). Theoretical links among naming speed, precise timing mechanisms and orthographic skill in dyslexia. *Reading and Writing: An Interdisciplinary Journal*, *5*(1), 69–85.

British Dyslexia Association. (2002). *The dyslexia handbook 2002*. Reading, England: Author.

Cardon, L. R., Smith, S. D., Fulker, D. W., Kimberling, W. J., Pennington, B. F., & DeFries, J. C. (1994). Quantitative trait locus for reading disability on chromosome 6. *Science*, *266*, 276–279.

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. *Cognition*, *47*(2), 149–180.

Chen, H. C. (1996). Chinese reading and comprehension: A cognitive psychology perspective. In M. H. Bond (Ed.), *The handbook of Chinese psychology* (pp. 43–62). Hong Kong: Oxford University Press.

Clark, D. B., & Uhry, J. K. (1995). *Dyslexia: Theory and practice of remedial instruction* (2nd ed.). Baltimore, MD: York Press.

Corcos, E., & Willows, D. (1993). The role of visual processing in good and poor readers' utilization of orthographic information in letter strings. In S. F. Wright & R. Groner (Eds.), *Facets of dyslexia and its remediation* (pp. 95–106). Amsterdam: North-Holland.

Critchley, M. (1970). *The dyslexic child.* London: William Heinemann Medical Books.

Critchley, M. (1981). Dyslexia: An overview. In G. T. Pavlidis & T. R. Miles (Eds.), *Dyslexia research and its application to education* (pp. 1–11). Chichester, England: Wiley.

Frith, U. (1986). A developmental framework for developmental dyslexia. *Annals of Dyslexia*, *36*, 69–81.

Frith, U. (1997). Brain, mind and behaviour in dyslexia. In C. Hulme & M. J. Snowling (Eds.), *Dyslexia: Biology, cognition and intervention* (pp. 1–19). London: Whurr.

Gardner, M. F. (1996). *Test of Visual-Perceptual Skills (Non-Motor)–Revised.* Hydesville, CA: Psychological and Educational Publications.

Gathercole, S. E., & Baddeley, A. D. (1993). *Working memory and language*. Hove, England: L. Erlbaum.

Geschwind, N. (1982). Why Orton was right. *Annals of Dyslexia*, *32*, 13–30.

Hellekson, K. L. (2001). NIH consensus statement on phenylketonuria. *American Family Physician*, *63*(7), 1430–1432.

Helmuth, L. (2001). Dyslexia: Same brain, different languages. *Science*, *291*, 2064–2065.

Hinshelwood, J. (1917). *Congenital word blindness.* London: H. K. Lewis.

Ho, C. S. H., & Bryant, P. (1997a). Learning to read Chinese beyond the logographic phase. *Reading Research Quarterly*, *32*(3), 276–289.

Ho, C. S. H., & Bryant, P. (1997b). Phonological skills are important in learning to read Chinese. *Developmental Psychology*, *33*(6), 946–951.

Ho, C. S. H., Chan, D. W., Tsang, S. M., & Lee, S. H. (2000a). *The Hong Kong Specific Learning Difficulties Behaviour Checklist (For Primary School Pupils) Manual.* Hong Kong: Hong Kong Specific Learning Difficulties Research Team.

Ho, C. S. H., Chan, D. W., Tsang, S. M., & Lee, S. H. (2000b). *The Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD) Manual.* Hong Kong: Hong Kong Specific Learning Difficulties Research Team.

Ho, C. S. H., Chan, D. W., Tsang, S. M., & Lee, S. H. (2002a). The cognitive profile and multiple-deficit hypothesis in Chinese developmental dyslexia. *Developmental Psychology*, *38*(4), 543–553.

Ho, C. S. H., Chan, D. W., Tsang, S. M., & Lee, S. H. (2002b). *The Hong Kong Specific Learning Difficulties Behaviour Checklist (For Primary One Pupils) Manual.* Hong Kong: Hong Kong Specific Learning Difficulties Research Team.

Ho, C. S. H., Chan, D. W., Tsang, S. M., Lee, S. H., & Chung, K. K. H. (2003). *Training in reading of Chinese characters and words* [Three videodiscs in Chinese]. Hong Kong: Hong Kong Specific Learning Difficulties Research Team.

Ho, C. S. H., & Lai, D. N. C. (1999). Naming-speed deficits and phonological memory deficits in Chinese developmental dyslexia. *Learning and Individual Differences*, *11*(2), 173–186.

Ho, C. S. H., Law, T. P., & Ng, P. M. (2000). The phonological deficit hypothesis in Chinese developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal*, *13*(1–2), 57–79.

Hu, C. F., & Catts, H. W. (1998). The role of phonological processing in early reading ability: What we can learn from Chinese. *Scientific Studies of Reading*, *2*(1), 55–79.

Huang, H. S., & Hanley, J. R. (1995). Phonological awareness and visual skills in learning to read Chinese and English. *Cognition*, *54*(1), 73–98.

Hultquist, A. M. (1997). Orthographic processing abilities of adolescents with dyslexia. *Annals of Dyslexia*, *47*, 89–114.

Lam, C. C. C. (1999). Developmental dyslexia and other specific learning disabilities. The state of practice: International and Hong Kong perspective. *Hong Kong Journal of Paediatrics (New Series)*, *4*, 145–150.

Leong, C. K. (1986). What does accessing a morphemic script tell us about reading and reading disorders in an alphabetic script? *Annals of Dyslexia*, *36*, 82–102.

Leong, C. K. (1997). Paradigmatic analysis and Chinese word reading: Research findings and classroom practice. In C. K. Leong & R. M. Joshi (Eds.), *Cross-language studies of learning to read and spell: Phonologic and orthographic processing* (pp. 379–418). Dordrecht, Holland; Boston: Kluwer Academic Publishers.

Leong, C. K. (1999). Psychological and educational aspects of specific learning disabilities. *Hong Kong Journal of Paediatrics (New Series)*, *4*, 151–159.

Leong, C. K., Cheng, P. W., & Lam, C. C. C. (2000). Exploring reading-spelling connection as locus of dyslexia in Chinese. *Annals of Dyslexia*, *50*, 239–259.

Leong, C. K., & Tamaoka, K. (1998). Cognitive processing of Chinese characters, words, sentences and Japanese kanji and kana: An introduction. *Reading and Writing: An Interdisciplinary Journal*, *10*(3–5), 155–164.

Lovegrove, W. (1993). Do dyslexics have a visual deficit? In S. F. Wright & R. Groner (Eds.), *Facets of dyslexia and its remediation* (pp. 33–49). Amsterdam: North-Holland.

Lyon, G. R. (1995). Toward a definition of dyslexia. *Annals of Dyslexia*, *45*, 3–27.

Manis, F. R., Seidenberg, M. S., Doi, L. M., McBride-Chang, C., & Petersen, A. (1996). On the basis of two subtypes of developmental dyslexia. *Cognition*, *58*(2), 157–195.

McBride-Chang, C., & Chang, L. (1995). Memory, print exposure, and metacognition: Components of reading in Chinese children. *International Journal of Psychology*, *30*(5), 607–616.

McBride-Chang, C., & Manis, F. R. (1996). Structural invariance in the associations of naming speed, phonological awareness, and verbal reasoning in good and poor readers: A test of the double deficit hypothesis. *Reading and Writing: An Interdisciplinary Journal*, *8*(4), 323–339.

Miles, E. (1995). Can there be a single definition of dyslexia? *Dyslexia: An International Journal of Research and Practice*, *1*, 37–45.

Miles, T. R., Haslum, M. N., & Wheeler, T. J. (1998). Gender ratio in dyslexia. *Annals of Dyslexia*, *48*, 27–55.

Miles, T. R., & Miles, E. (1999). *Dyslexia: A hundred years on* (2nd ed.). Buckingham, England; Philadelphia, PA: Open University Press.

Morris, R. D., Stuebing, K. K., Fletcher, J. M., Shaywitz, S. E., Lyon, G. R., Shankweiler, D. P., Katz, L., Francis, D. J., & Shaywitz, B. A. (1998). Subtypes of reading disability: Variability around a phonological core. *Journal of Educational Psychology*, *90*(3), 347–373.

Nicolson, R. I., Fawcett, A. J., Berry, E. L., Jenkins, I. H., Dean, P., & Brooks, D. J. (1999). Association of abnormal cerebellar activation with motor learning difficulties in dyslexic adults. *The Lancet*, *353*, 1662–1667.

Orton, S. T. (1937). *Reading, writing, and speech problems in children.* London: Chapman & Hall.

Orton Dyslexia Society. (1994). A new definition of dyslexia. *Perspectives in Dyslexia*, *30*, 5.

Paulesu, E., Demonet, J. F., Fazio, F., McCrory, E., Chanoine, V., Brunswick, N., Cappa, S. F., Cossu, G., Habib, M., Frith, C. D., & Frith, U. (2001). Dyslexia: Cultural diversity and biological unity. *Science*, *291*, 2165–2167.

Pennington, B. F., Cardoso-Martins, C., Green, P. A., & Lefly, D. L. (2001). Comparing the phonological and double deficit hypotheses for developmental dyslexia. *Reading and Writing: An Interdisciplinary Journal*, *14*(7–8), 707–755.

Plomin, R., Owen, M. J., & McGuffin, P. (1994). The genetic basis of complex human behaviors. *Science*, *264*, 1733–1739.

Psychological Corporation. (1984). *Hong Kong Wechsler Intelligence Scale for Children Manual.* New York: Author.

Roberts, R., & Mather, N. (1997). Orthographic dyslexia: The neglected subtype. *Learning Disabilities: Research and Practice*, *12*(4), 236–250.

Salter, R., & Smythe, I. (Eds.). (1997). *The international book of dyslexia.* London: World Dyslexia Network Foundation and European Dyslexia Association.

Smith, S. D., Kimberling, W. J., Pennington, B. F., & Lubs, H. A. (1983). Specific reading disability: Identification of an inherited form through linkage analysis. *Science*, *219*, 1345–1347.

Smith, S. D., Pennington, B. F., Kimberling, W. J., & Ing, P. S. (1990). Familial dyslexia: Use of genetic linkage data to define subtypes. *Journal of the American Academy of Child and Adolescent Psychiatry*, *29*(2), 204–213.

Snowling, M. J. (2000). *Dyslexia* (2nd ed.). Oxford; Malden, MA: Blackwell Publishers.

So, D., & Siegel, L. S. (1997). Learning to read Chinese: Semantic, syntactic, phonological and working memory skills in normally achieving and poor Chinese readers. *Reading and Writing: An Interdisciplinary Journal*, *9*(1), 1–21.

Stanovich, K. E. (1988). Explaining the differences between the dyslexic and the garden-variety poor reader: The phonological-core variable-difference model. *Journal of Learning Disabilities, 21*(10), 590–604, 612.

Stanovich, K. E. (1996). Towards a more inclusive definition of dyslexia. *Dyslexia: An International Journal of Research and Practice, 2*, 154–166.

Stevenson, H. W., Stigler, J. W., Lucker, G. W., & Lee, S. Y. (1982). Reading disabilities: The case of Chinese, Japanese, and English. *Child Development, 53*(5), 1164–1181.

Sutherland, M. J., & Smith, C. D. (1991). Assessing literacy problems in mainstream schooling: A critique of three literacy screening tests. *Educational Review, 43*(1), 39–48.

Vellutino, F. R. (1979). *Dyslexia: Theory and research.* Cambridge, MA: MIT Press.

Vidyasagar, T. R., & Pammer, K. (1999). Impaired visual search in dyslexia relates to the role of magnocellular pathway in attention. *NeuroReport, 10*(6), 1283–1287.

Willows, D. M., Corcos, E., & Kershner, J. R. (1993). Perceptual and cognitive factors in disabled and normal readers' perception and memory of unfamiliar visual symbols. In S. F. Wright & R. Groner (Eds.), *Facets of dyslexia and its remediation* (pp. 163–177). Amsterdam: North-Holland.

Wimmer, H. (1993). Characteristics of developmental dyslexia in a regular writing system. *Applied Psycholinguistics, 14*(1), 1–33.

Wolf, M., & Bowers, P. G. (1999). The double-deficit hypothesis for the developmental dyslexia. *Journal of Educational Psychology, 91*(3), 415–438.

Woo, E. Y., & Hoosain, R. (1984). Visual and auditory functions of Chinese dyslexics. *Psychologia, 27*(3), 164–170.

Wu, J. T., & Liu, I. M. (1996). Chinese lexical access. In M. H. Bond (Ed.), *The handbook of Chinese psychology* (pp. 30–42). Hong Kong: Oxford University Press.

Yamada, J. (1995). A case study of developmental dyslexia in Japanese. *Dyslexia: An International Journal of Research and Practice, 1*, 120–122.