Running head: INCIDENCE AND DIFFERENT CRITERIA OF DYSLEXIA

Estimating Incidence of Developmental Dyslexia in Hong Kong: What Differences Do Different Criteria Make?

David W. Chan

The Chinese University of Hong Kong

Connie Suk-han Ho

The University of Hong Kong

Suk-man Tsang Suk-han Lee

Education Bureau, Hong Kong SAR Government

and

Kevin H. H. Chung

Hong Kong Institute of Education

Correspondence concerning this article should be addressed to:

David W. Chan
Department of Educational Psychology
Faculty of Education
The Chinese University of Hong Kong
Shatin, NT, Hong Kong
Phone: 852-26096947
Fax: 852-26036921
E-mail: davidchan@cuhk.edu.hk

Estimating Incidence of Developmental Dyslexia in Hong Kong: What Differences Do Different Criteria Make?

Abstract

Based on the data of a school-referred sample of Cantonese-speaking Chinese children who met the Hong Kong criterion of dyslexia, we estimated for developmental dyslexia of Chinese children aged between 6 and 10 ½ in Hong Kong an incidence rate of 0.66% and a gender ratio of 3.29 boys to 1 girl over a four-year period. We also explored the differences in estimates based on this Hong Kong criterion that emphasizes cognitive markers with more conventional discrepancy-based criteria. In view of the possible biases in self-selection and underreporting in the data of the school-referred sample, we compared the figures with those derived from the sample of the normative study of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing, which yielded an estimate of 9.7% in prevalence rate and boy-girl gender ratio of 2 to 1 over a one-year period. The differences in estimates based on the two samples and implications of the findings are discussed in light of the limitations of the study.

Estimating Incidence of Developmental Dyslexia in Hong Kong: What Differences Do Different Criteria Make?

In commonsense conceptualization, dyslexia can be described as the unexpected yet marked difficulties in reading, writing, and spelling in children who are otherwise healthy, well-nurtured, earnest and cognitively advanced. Interestingly, this notion not only fits well into the experience of many practitioners in the field of learning difficulties (see Coltheart & Prior, 2007), it also underlies the discrepancy-based criteria frequently employed to define and identify dyslexia in North America (see Mercer et al., 1996) and the United Kingdom (see Ashton, 1997; Pumfrey, 1995). However, over the years, this customary practice has not gone unchallenged (e.g., Siegel, 1992; Siegel & Smythe, 2005). Some researchers have severely criticized the use of such criteria because of conceptual as well as methodological problems (e.g., Stanovich, 1996, 2005). Others have even argued that dyslexia should be defined solely on the basis of low reading achievement (e.g., Fletcher et al., 1989; Siegel, 1989). It has to be noted that not all writers use the term “dyslexia,” and other terms denoting difficulties or disabilities have been used. In this connection, Reason (2002) suggested that it was to avoid the focus on within-child causative factors, which might draw attention away from instructional circumstances, that “specific learning difficulties” was preferred at one time in the UK, as was “learning disabilities” and “reading disabilities” in the US, but the term “dyslexia” has now been “well embedded in popular language” (p. 188). Indeed, “specific learning difficulties” and “dyslexia” are often used interchangeably in Hong Kong (see Lee, 2004).

Presumably, it is plausible that the use of different terms might engender slightly different conceptions of dyslexia, leading researchers to define dyslexia more broadly or more narrowly. Conversely, the choice of using one term over another might also reflect to some extent the different conceptions of dyslexia advocated by the researchers concerned. Nonetheless, irrespective of the use of different terms, differences in diagnostic criteria distinguishing children with dyslexia from those without seem to arise from how a child’s deviation from expected reading achievement is operationalized, which might or might not involve IQ (see Bishop & Snowling, 2004; Francis et al., 2005).

Specifically, one simple approach is to base the identification criterion on low reading achievement (e.g., < 25th percentile) in the absence of mental retardation, or on a reading achievement score below a certain cutoff point, the score being standardized with age or grade norms (see Dykman & Ackerman, 1992; Fletcher et al., 1994; Stanovich & Siegal, 1994). More complicated than this low achievement criterion are discrepancy-based criteria, which involve the notion of ability-achievement discrepancy operationalized in at least two ways using scores from IQ and reading achievement. The simple approach is to include children as dyslexic when their standardized ability measures or IQ scores exceed their standardized scores on reading achievement by a specified difference (e.g., 1.5 *SD* units). However, this approach does not take into account the correlation between ability and achievement, thus failing to adjust the ability-achievement difference for the effect of regression toward the mean, which results in the over-identification of dyslexia at upper levels of IQ and under-identification at lower levels. To introduce appropriate adjustments, the regression-based method using the difference between predicted achievement and observed achievement is generally preferred (see Francis et al., 2005). Despite these improvements, the ability-achievement discrepancy as a defining feature of dyslexia has been criticized based on research evidence that poor readers could not be differentiated on the basis of IQ (see Siegel & Smythe, 2005; Stanovich, 2005), and IQ could provide an unreliable standard against which to consider reading skills as IQ could decline as a consequence of poor reading (see Shaywitz et al., 1995).

As alternatives to the discrepancy criteria, some researchers in recent years have resorted to using less stringent criteria and select children as dyslexic on the basis of low reading skills (e.g., below the 25th or 30th percentile) with an IQ or nonverbal IQ within broadly normal limits (see Bishop & Snowling, 2004). Such diagnostic criteria however would encompass a heterogeneous group of children, including some who might have nonspecific reading difficulties. Other researchers have advocated a more specific approach, arguing that dyslexia should be identified on the basis of the underlying cognitive deficit (Frith, 1997; Snowling, 2000). In this connection, Stanovich and Siegal (1994) have proposed that dyslexia should be defined using a core phonological deficit based on the accumulating evidence of a strong association between dyslexia and phonological deficit. While this cognitive marker approach is more likely to identify a coherent group of children with this specific cognitive deficit, it is also suggested that relying only on phonological deficit or a single dimension of impairment might inadvertently exclude children with other reading-related cognitive deficits (see Bishop & Snowling, 2004).

Given that researchers might define and diagnose dyslexia using different criteria (see Lundberg, 1999; Lyon, Shaywitz, & Shaywitz, 2003; Stanovich, 1996), it can be expected that the estimates of the number of children with this impairment could vary depending on the criteria employed by different researchers in different specific populations (see Ellis, 1993). Despite the use of different criteria, many researchers (see Miles & Miles, 1999; Peer, 1994) have suggested a conservative estimate that between 2% and 4% of the population may have severe dyslexia, while a further 6% may be mildly or moderately dyslexic. Indeed, around the world, depending on the different definitions and criteria that one adopts, 1% to 11% of school-age children are estimated to be suffering from this impairment (see Salter & Smythe, 1997; Smythe, Everatt, & Salter, 2004). It is now generally acknowledged that, apart from attributing such differences to definitional and criterion differences, many other important factors need to be considered in the estimation of these rates (see Snowling, 2000). Perhaps, one of the more obvious important factors is the nature of orthography. For example, the much lower prevalence of dyslexia in Italy as compared with that in the United States needs to be considered in the context of the shallow or transparent orthography of Italian in comparison with that of English (see Paulesu et al., 2001). On the other hand, the extremely low prevalence rate of less than 1% estimated in Hong Kong prior to the year 2000 before the adoption for use of a new diagnostic instrument needs to be considered in connection with many factors, including but not restricted to underreporting, the stringent diagnostic criteria, and a lack of a reliable and valid instrument for identifying Cantonese-speaking Chinese children with dyslexia (see Ho et al., 2000).

In estimating the number of children with dyslexia in a population, the estimation of gender ratio is also of great interest to educators and researchers. In this regard, the general observation is that there are many more dyslexic boys than girls, the ratio being 4 to 1 or 3 to 1 (see Hier, 1980; Miles, Haslum, & Wheeler, 1998). However, some studies have called into question this gender imbalance, suggesting that the gender ratio could be 2 to 1 or even close to 1 to 1 (e.g., Shaywitz et al., 1990; Wadsworth et al., 1992). Specifically, Shaywitz and her colleagues (1990) have presented evidence that girls with reading disabilities were under-identified in the United States, reporting that a significant imbalance in gender ratio only occurred in the case of school-identified children but not in research-identified children. According to their argument, teachers were more likely to refer boys as having special problems because boys were perceived as more disruptive than girls. In a similar vein, this selection bias also applied to the clinic population where boys were more likely to be referred for service, considering that boys could be more disruptive than girls at home. Thus, the selection bias hypothesis has been used to explain the preponderance of boys over girls reported in the literature in clinic samples, school-identified samples, or samples from broad groups of children with reading disability.

Focusing on large-scale epidemiological studies that were based on neither clinic-referred nor school-referred samples, Rutter and his colleagues (2004) summarized past findings on the gender ratio in developmental reading disability and reviewed more updated findings from four relevant epidemiological studies. They concluded that boys were more likely than girls to have reading disability in the English-speaking world as represented by the United States, the United Kingdom, and New Zealand. Thus, a preponderance of boys over girls in developmental dyslexia is consistently found, at least for the English language. It remains a topic of research interest whether such gender imbalance applies to a different language and specifically to a non-alphabetic language such as Chinese.

In Hong Kong, there is relatively little information regarding incidence as well as gender ratio of developmental dyslexia (Lee, 2004), although it has been reported that there is a preponderance of boys in local clinic-referred samples (see Lam, 1999). There are at least two obvious reasons for this lack of information. One is the lingering belief that Chinese children with dyslexia are far fewer in number than those in other alphabetic language settings. The other reason is the lack of a well-accepted instrument for diagnosing dyslexia, and clear criteria to define and identify dyslexia are not specified in any assessment instruments (see Ho et al., 2000).

Recently, with the publication of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD; Ho et al., 2000) and its increasing widespread use in Hong Kong for identifying Cantonese-speaking Chinese children with dyslexia, data have slowly accumulated, providing information on developmental dyslexia in Chinese children in Hong Kong. Specifically, the battery was developed based on the belief that multiple cognitive abilities, including those involved in phonological and orthographical processing, could be involved in the reading and writing problems of Cantonese-speaking Chinese children with dyslexia (see Ho & Bryant, 1997; Ho & Lai, 1999). The individual tests in the battery have been validated in a study that compared the performance of 30 children diagnosed as dyslexic with 30 average readers of the same chronological age and 30 average readers of the same reading level

(Ho et al., 2002). Before HKT-SpLD came into use, most suspected cases of dyslexia in schools were referred to government educational psychologists for assessment and special provisions of services. Typically, the assessment process involved an IQ assessment using the tests of the Hong Kong Wechsler Intelligence Scale for Children (HK-WISC; Psychological Corporation, 1981) or Raven's Standard Progressive Matrices (SPM; Hong Kong Education Department, 1986; Raven, Raven, & Court, 1998), and other non-standardized tests assembled to assess word copying, word matching, and word reading. On the basis of these test results, together with additional information from educational history, sample scripts of homework, dictation, and free writing, the educational psychologist would exercise his or her clinical judgment to determine whether the child being assessed was a case of dyslexia eligible for services. Normally, educational psychologists have adopted relatively conservative subjective criteria for fear of negative labeling, and consequently very few children were defined as dyslexic in this procedure.

With the use of HKT-SpLD, the assessment of a Chinese child provides data that yield the child's profiles of literacy skills in reading and writing (dictation) as well as cognitive skills or deficits in naming speed, phonological awareness, phonological memory, and orthographic knowledge. Based on the HKT-SpLD profile of literacy and cognitive skills, the Hong Kong diagnostic criterion for dyslexia adopts a cognitive marker approach. However, rather than subscribing to the use of a single cognitive marker of phonological deficit, the Hong Kong criterion takes a broader approach of including the consideration of other additional cognitive deficits such as naming speed and orthographical knowledge known to be important in reading and writing Chinese (see Ho et al., 2002). Specifically, a child meets the Hong Kong criterion of dyslexia if he or she scores low in literacy skills despite an IQ within broadly normal limits and has low scores in any one of the cognitive skills assessed in HKT-SpLD, the cutoff scores for low levels of literacy as well as cognitive skills being clearly specified in the HKT-SpLD manual.

Using these cutoff scores, Chan, Ho, Tsang, Lee, and Chung (2007) examined the HKT-SpLD profiles of literacy and cognitive scores of the 690 children participating in the normative study of the test battery. They found that only 67 children (45 boys and 22 girls) with IQ scores 85 or above met the Hong Kong criterion for dyslexia, yielding a rate of 9.71% and a gender ratio of 2.05 boys to 1 girl. Considering that the normative sample of 690 children is a representative sample of the population of children aged 6 to 10 ½ at the assessment period, the 67 children could be regarded as existing cases or diagnosed children with dyslexia, and 9.71% could be considered the prevalence rate of dyslexia at the time of assessment. Using these normative data, Chan et al. also demonstrated through regression analyses that deficits in orthographic knowledge and naming speed were most salient in this sample of children with dyslexia.

Since the Hong Kong criterion for dyslexia came into use in September 2000, there has been an observed increase in referral to educational psychologists of the Education and Manpower Bureau (EMB) for dyslexia assessment, and more children have been subsequently diagnosed as meeting the Hong Kong criterion of dyslexia. While this increase might have to do with public awareness of dyslexia and the use of a new diagnostic instrument with an emphasis on the cognitive marker approach in diagnosis, the accumulating body of data could nonetheless shed light on some initial estimates of the incidence and gender ratio of dyslexia, which might in turn have great implications for intervention and the planning of services for children with dyslexia in Hong Kong.

Therefore, this study aimed to expand and extend the findings of Chan et al. (2007) with the HKT-SpLD normative sample to new data collected in the community via school referral by EMB over a period of four years since September 2000. Specifically, based on the number of reported new cases that met the Hong Kong criterion of dyslexia in this period, the incidence of dyslexia and gender ratio were estimated, and these estimates yielded by the Hong Kong diagnostic criterion were then compared with those yielded by more conventional discrepancy-based criteria, the simple ability-achievement discrepancy criterion and the regression-based discrepancy criterion.

Since the EMB data were school-referred data and might only represent more severe cases that were newly reported or came to the attention of schools for service provisions, it was deemed appropriate that some comparison could be made with the HKT-SpLD normative sample, which is a representative sample of Hong Kong schoolchildren aged 6 to 10 ½ . Accordingly, the three different criteria of dyslexia were also applied to the normative sample for analyses and comparison with the estimates based on the EMB sample.

Method

Participants and Procedures

The data set we used for analyses in this study was collected from Hong Kong Chinese schoolchildren during a period of four academic years between September 2000 and July 2004, and included simple demographic information, IQ scores, and test scores on HKT-SpLD. The children included in the data set were children referred to EMB for services because of suspected learning difficulties by parents or teachers, and they were subsequently tested by EMB psychologists. A total of 3383 of the referred children were diagnosed as dyslexic, and over 50% of these children were assessed before the age of eight. However, only 2752 children were in the defined age range from 6 to 10 ½ years, and we had gender information on 2751 of these children. Complete data on gender, IQ and HKT-SpLD test scores (including literacy) were obtained only from 1334 children out of these 2752 children. Therefore, while 2752 children (2110 boys, 641 girls, one unknown) were involved in the estimation of incidence rates and gender ratios, only 1334 children (1004 boys and 330 girls) aged 73 to 126 months (*M* = 96.23, *SD* = 10.72) with complete HKT-SpLD data were included for analyses in comparing the literacy and cognitive scores of children identified by the different diagnostic criteria.

We compared the data of the EMB sample with the data of the 67 children with dyslexia obtained in the HKT-SpLD normative sample. Specifically, the data of the HKT-SpLD normative sample was collected in the academic year of 1999-2000 based on a stratified random sample of grade 1 to grade 4 students aged between 6 and 10 ½ from 29 primary schools in Hong Kong (Ho et al., 2000). Great efforts had been made with the help from government officials to ensure that this normative sample was representative of the population of Hong Kong Cantonese-speaking Chinese children of the defined age range. A detailed description of the sampling plan, geographical locations of the selected primary schools, and gender and age of the final sample of 703 children can be found in the test manual of HKT-SpLD (Ho et al., 2000). Only 690 children (350 boys and 340 girls) aged 72 to 126 months (*M* = 98.82, *SD* = 14.83) have completed the tests of HKT-SpLD, which were individually administered, and only 67 children who met the Hong Kong criterion of dyslexia were administered IQ tests and yielded IQ scores of 85 or above. These 67 children (45 boys and 22 girls) aged 73 to 124 months (*M* = 97.45, *SD* = 15.08) were included in this second data set to be used in analyses for comparison with the analyses of the EMB data set.

Measures and Tasks

The EMB sample of 1334 schoolchildren were administered the twelve tests of HKT-SpLD individually by EMB psychologists. The majority of these children (*n* = 1194) were also tested on their IQ using HK-WISC or its short form, and a small number of children (*n* = 140) who were not tested using HK-

WISC had their IQ scores estimated from their scores on SPM. Scores on HKT-SpLD tests were available for the normative sample of 67 schoolchildren. Their IQ scores were estimated from SPM. The tests of HKT-SpLD battery are grouped under four domains: literacy, naming speed, phonological skills, and orthographic knowledge. Descriptions of the tests are detailed in the test manual (Ho et al., 2000).

For HKT-SpLD tests, Hong Kong norms are available for children from 6 years 1 month to 10 years 6 months. Raw scores of each test are converted to scaled scores according to the child's age level. The relevant scaled scores for each specific literacy or cognitive domain are then aggregated and averaged to yield a domain-specific composite score. There are one composite score on literacy and four composite scores separately on naming speed, phonological awareness, phonological memory, and orthographic knowledge. The literacy composite score was used as the index of reading achievement in the computation of scores in discrepancy-based criteria for dyslexia.

Three Diagnostic Criteria of Dyslexia

We employed three diagnostic criteria in this study for comparison. The Hong Kong criterion for identifying Cantonese-speaking Chinese children with dyslexia in the age range of 6 to 10 ½ years are specified in the manual of HKT-SpLD (Ho et al., 2000). The criterion excludes for consideration children scoring below 85 on IQ assessed by HK-WISC or SPM. Specifically, the approach is a cognitive marker approach that is based on children's HKT-SpLD composite score profiles. Using cutoff scores of 7 on these composite scores (normative standard M = 10, SD = 3), where a score of 7 or less was interpreted as indicative of weaknesses or possible deficits, children meeting the Hong Kong criterion of dyslexia are children who score 7 or less on the literacy test domain and on one or more of the cognitive test domains (naming speed, phonological awareness, phonological memory, and orthographic knowledge). For comparison, two discrepancy-based criteria were also computed. The simple discrepancy criterion defines a child as dyslexic when the difference between his or her IQ score and literacy composite score, when both scores are standardized, equals to or exceeds a specified number of standard deviation units. The regression-based criterion uses the difference between the predicted literacy composite scores predicted by IQ scores and the observed literacy composite scores for the evaluation of the specified standard deviation unit difference. We used 1.0 and 1.5 SD units to define the specified discrepancy in this study.

Results

Analyses Based on the Education and Manpower Bureau Sample

In the EMB sample collected over a period of four years, although 2752 children aged 6 to 10 1/2 years were diagnosed as children with dyslexia, test responses to the HKT-SpLD were not available to about half of the sample (1418 children). Therefore, analyses were conducted on the test responses on 1334 children. Specifically, we first scored their responses to tests of HKT-SpLD on 12 scales and then converted the scores to 5 composite scores of literacy, naming speed, phonological awareness, phonological memory, and orthographic knowledge. For the single-test domain of naming speed, the scaled score was also the domain-specific composite score. Using the Hong Kong criterion of dyslexia as specified in the HKT-SpLD manual, children with composite scores 7 or below in a specific cognitive domain were considered to have weaknesses or possible deficits in that particular cognitive domain, and children with such low scores on literacy as well as any one of the four cognitive domains were considered to have met the Hong Kong criterion of dyslexia. In this connection, all 1334 children met the criteria of dyslexia as their IQ scores were within the broadly normal limits (IQ ranged from 80 to 139). It has to be noted that in the normative sample, normal limits were defined slightly higher at 85 or above. In the EMB sample, only 43 children (3.2%) out of the 1334 scored between 80 and 85 on IQ.

To examine more closely the distribution of cognitive deficit in this sample of 1334 children who met the Hong Kong criterion of dyslexia, we adopted a more stringent cutoff score of 5.5 (i.e., 1.5 *SD* below the mean score). Table 1 shows the percentage of children who scored 5.5 or below on the four cognitive domains, and could be considered as having deficits in those domains. Thus, about half of the children had deficits in naming speed, and over 25% of them had deficits in orthographic knowledge. For comparison, we repeated our computation using the two discrepancy-based criteria, first setting the discrepancy at 1.0 *SD* unit, and then at 1.5 *SD* units. The results are also summarized in Table 1. It can be seen from Table 1 that a smaller number of children were included as dyslexic based on these discrepancy-based criteria. The results related to the Hong Kong criterion remained unchanged in using discrepancy of 1.0 *SD* unit or1.5 *SD* units, as discrepancy only applied to and entered into the computation of the discrepancy-based criteria. However, despite the subtle differences resulting from the use of different criteria, similar patterns of results emerged. Most identified children had deficits in naming speed (over 50 %), followed by orthographic knowledge (over 25%).

To estimate the incidence rate of dyslexia aged 6 to 10 ½ in Hong Kong over the four years, that is the number of new reported cases of the specified age range over the total population at risk of dyslexia in that period (see Rimm, Hartz, Halbfleisch, Anderson, & Hoffmann, 1980), we estimated that the population over the four-year period roughly corresponded to the cohort of 418,345 children in primary schools in Hong Kong in the school year of 2003-2004 (Education and Manpower Bureau, 2004). However, as to the new reported cases, out of 2752 children, we had information that 1334 children met the Hong Kong criterion of dyslexia, but we did not know whether 1418 children with no available information on HKT-SpLD scores met or did not meet the criterion. Thus, we could only compute a lower bound (assuming that none of the 1418 children met the criterion) and an upper bound (assuming that all 1418 children met the criterion). Based on these considerations, the reported incidence rate could be between 0.32% and 0.66% over the four-year period. We repeated the computation using the discrepancy-based criteria, yielding slightly lower rates as summarized in Table 1.

It was also of interest to compute gender ratios under the different criteria, and the results are also summarized in Table 1. Again, lower bound estimates were computed by excluding the 1418 children and upper bound estimates were computed by including the 1418 children. Overall, irrespective of criteria adopted, there was a preponderance of boys over girls, ranging between 3 to 1 and 3.5 to1.

Analyses Based on the Normative Sample

Since the EMB sample might be biased by self-selection, including only children who might have more severe reading difficulties and those who were more willing to come forward for assessment, we compared the findings from the EMB sample with those from the original sample on which the norms of HKT-SpLD tests were based. Since IQ scores were available only for children who were found to meet the Hong Kong criterion of dyslexia, we therefore conducted similar analyses on the 67 identified children. Table 2 summaries the results of these analyses.

Using the Hong Kong criterion, it can be seen from Table 2 that, similar to the EMB sample, the predominant deficits appeared to be naming speed, but relatively less children had such deficits (30% as opposed to 50% in the EMB sample). The percentage of children with deficits in orthographic knowledge was also much reduced (12% as opposed to 28% in the EMB sample). The percentages for phonological awareness and phonological memory were however comparable to those in the EMB sample. The gender ratio was about 2 boys to 1 girl. The prevalence rate, that is, the number of existing cases over the total population at risk (see Rimm et al., 1980) based on the total sample of 690 children was estimated to be 9.71% over the one-year period. This prevalence rate would be equal to the incidence rate if all the existing cases were regarded as reported new cases, and thus could be used for comparing the incidence rates yielded in the EMB sample.

In line with the analyses of the EMB sample, we also repeated for our normative sample of 67 identified children the same analyses using the two discrepancy-based criteria, first setting the discrepancy at 1.0 *SD* unit, and then at 1.5 *SD* units. The results are also summarized in Table 2. It can be seen from Table 2 that as expected a smaller number of children were included as dyslexic based on these discrepancy-based criteria. The results related to the Hong Kong criterion again remained unchanged in using discrepancy of 1.0 *SD* unit or1.5 *SD* units, as discrepancy only applied to and entered into the computation of the discrepancy-based criteria. While there were subtle differences resulting from the use of different criteria, similar patterns of results emerged. Most identified children had deficits in naming speed (30 to 40%). There was a preponderance of boys over girls, ranging between 2 to 1 and 2.3 to1. The prevalence rate over the one-year period was between 7% and 9% using less stringent discrepancy criteria, and between 4% and 5% using more stringent discrepancy criteria.

Comparing the EMB Sample and the Normative Sample

In comparing the EMB sample and the normative sample, we focused the analyses on the samples defined by the Hong Kong criterion. In the EMB sample, cognitive deficits in naming speed and orthographic knowledge were reported for the largest percentages of children, and the percentages were somewhat lower in the normative sample. The percentage with deficits in orthographic knowledge in the normative sample was comparable to percentages for other deficits. One possible reason was that the EMB referred children could represent more severe cases. To test this conjecture, we compared the HKT-SpLD literacy and cognitive composite scores of the two samples, and the results are presented in Table 3.

It can be seen from Table 3 that scores on literacy and naming speed were much lower in the EMB sample than in the normative sample, and scores on other reading-related cognitive abilities were comparable. Support for this observation could be found in the independent-samples *t*-test on literacy scores and the one-way multivariate analysis of variance (MANOVA) on scores of cognitive abilities using sample as the grouping variable. The results of the independent-samples *t*-test on literacy scores for unequal variances indicated significant difference for the two samples, $t(78) = -8.56$, $p < .001$, suggesting that identified children in the EMB sample had significantly lower literacy skills than identified children in the normative sample. The MANOVA results on scores of cognitive abilities also indicated significant overall main effect of sample, Wilks' $\Lambda = 0.98$, $F\ (4, 1396) = 5.91$, $p < .001$, partial $\eta^2 = .017$. As follow-up tests to the MANOVA main effect, analyses of variance (ANOVA) on each dependent variable of cognitive abilities were conducted. Using the Bonferroni method, each ANOVA was tested at the .05/4 or .0125 level. It was found that only the ANOVA on naming speed was significant, $F\ (1, 1399) = 15.89$, $p < .001$, partial $\eta^2 = .011$, suggesting that identified children of the EMB sample had significantly lower scores on naming speed than those of the normative sample, and the severity of other cognitive deficits was comparable for the two samples.

Despite the differences in the levels of literacy and cognitive skills between the two samples, substantial and significant correlations were observed between literacy scores and scores on naming speed as well as orthographic knowledge in both samples, suggesting that reading difficulties in Chinese children were more likely associated with naming speed and orthographic knowledge than other skills related to phonological processing (see Table 3).

Regarding the different gender ratios estimated from the two samples, a two-way contingency table analysis was conducted to evaluate whether gender was significantly related to sample. The results indicated nonsignificance, Pearson $\chi^2\ (1, N = 1401) = 2.22$, $p = .14$, and Cramer's $V = .04$, suggesting that the gender ratios estimated on the basis of the two samples were not significantly different.

Discussion

With the increasing public awareness on the problems in reading and writing among Chinese children in Hong Kong in the 1990s, we started to develop a battery of tests that would help identify Cantonese-speaking Chinese children with dyslexia in Hong Kong. Based on the working definition of dyslexia first proposed by the International Dyslexia Association in 1994, which highlighted the importance of cognitive deficits (see Lyon et al., 2003), we have adopted a cognitive marker approach that aims to include children with low reading achievement and weaknesses or possible deficits in at least one reading-related cognitive skill domain despite having IQ within broadly normal limits. Based on HKT-

SpLD, we have established the Hong Kong criterion of dyslexia, which has definitely helped bring some order to the scene of using diverse subjective criteria for diagnosing dyslexia in Hong Kong. Moreover, we intended that the accumulating body of data based on HKT-SpLD could help shed light on the incidence rate and gender ratio of dyslexia in Hong Kong.

Over the years, researchers have employed different diagnostic criteria of dyslexia that require the assessment of reading achievement, intellectual abilities, and more recently reading-related cognitive abilities. While the Hong Kong criterion has been generally accepted among educational professionals, and has been adopted by government psychologists in their practice for identifying dyslexia starting in 2000, questions have often been raised as to whether the Hong Kong criterion is too liberal as to include too many false positives, or too stringent as to miss children in need of services. In this regard, it is of interest to compare the Hong Kong criterion with some of the more conventional criteria in their identification of children with dyslexia and in their estimation of incidence rate and gender ratio of dyslexia in Hong Kong.

Admittedly, a planned investigation into comparing different diagnostic criteria of dyslexia, and evaluating the differences they make in the estimation of incidence as well as gender ratio presumably would start with a large-scale epidemiological survey using well-accepted standardized instruments to assess the relevant variables (e.g., reading achievement, intellectual abilities, and reading-related cognitive abilities) in the population of interest. Based on these variables, one could compute indices relevant to the criteria, and perhaps compare the number of identified children and the estimates of incidence rate as well as gender ratio when different criteria are employed. Unfortunately, we did not conduct such a study. Instead, we have access to a data set collected by government officials on a sample of children either referred to EMB psychologists for assessment and were diagnosed as meeting the Hong Kong criterion of dyslexia as specified by HKT-SpLD or referred for services after having been diagnosed as dyslexic by non-EMB psychologist. Even though it was said that all suspected cases were assessed using HKT-SpLD by EMB or non-EMB psychologists since September 2000, there were cases referred to EMB carrying the diagnosis of dyslexia but without scores reported on HKT-SpLD. Therefore, the EMB data set, which was collected for the purposes of service provision and was not intended originally for analyses in this study, had incomplete information on as many as half of the cases. We could only conduct analyses on 1334 children identified by the Hong Kong criterion as dyslexic. Assuming that the 1418 children with no available HKT-SpLD data met the different diagnostic criteria, the 1418 children could be included to compute the upper bound estimates of incidence rate and gender ratio, yielding information on a range of estimates.

Essentially, the EMB sample did not include children scoring low in IQ, and only included children with low reading achievement. Thus, the comparison of using different discrepancy-based criteria for identification of dyslexia did not involve children from the full spectrum of IQ and reading achievement. Arguably, this EMB sample was a low-reading-achievement sample, as it was likely that most low-reading-achievement children usually scored low in at least one cognitive domain. Indeed, in an unpublished study, for example, we found that there were only 4 out of 43 children with low or below-cutoff literacy scores who did not have low or below-cutoff scores in at least one cognitive domain (see Ho et al., 2000). With these limitations in mind, the discrepancy-based criteria seemed to identify a subset of children known to be low in reading achievement, and therefore were more stringent than the Hong Kong cognitive marker criterion. Nonetheless, the different criteria did not seem to yield radically different estimates of incidence rates and gender ratios. Given the controversy surrounding the use of IQ and discrepancy-based criteria in identifying children with dyslexia (e.g., Siegel & Smythe, 2005), the present study provided supportive evidence in the use of the present cognitive-marker approach in Hong Kong. Future cross-replications using a community sample of children with different levels of IQ and reading achievement should be emphasized.

Consistent with findings in past studies, the data in this study provided support for a preponderance of boys over girls in developmental dyslexia, the gender ratio being 3 or 3.5 boys to 1 girl in the EMB sample, and 2 or 2.5 boys to 1 girl in the normative sample, with slight variations when different criteria were used. The differences in the estimates of gender ratio in the two samples could also be explained by the selection bias hypothesis, which attributes gender imbalance to the greater disturbance of boys, leading to greater likelihood for referral in the school-referred EMB sample. The gender imbalance in the normative sample however cannot be readily explained by referral or selection bias, as an equal number of boys and girls were selected and tested. Nonetheless, the present findings of a preponderance of boys over girls in developmental dyslexia add to the body of consistent findings that serve to reinforce the need for further research to determine the influences that underlie such gender differences, which might shed more light on the cognitive skills and processes leading to dyslexia in both boys and girls.

Somewhat puzzling was the exceedingly low incidence rate estimated from the EMB data. While this low incidence figure of this study might reflect accurately the number of children who could be picked up by teachers, possibly because of the severity of their problems, and who would not avoid seeking government support and services, the number of children meeting the Hong Kong criterion of dyslexia and in need of services could be much higher. To highlight this possibility, we analyzed the data from a second sample of identified children collected in our normative study for comparison, and provided the perspective that the figure could be 15 times higher. There are multiple plausible reasons accounting for the difference. We speculate that it could have something to do with public awareness and knowledge, teachers' sensitivity to students' reading and writing problems, and parents' reserved attitudes in seeking help from professionals. We expect that the government's public education efforts to enhance public awareness of the commonness and severity of dyslexia among children will continue to have an effect on referral, as there have been reports of a tenfold increase from an annual 90 identified case in 1992 to 900 or more identified cases in 2001 in government assessment services (Lee, 2004). Equally encouraging is the government's adoption of using observation or behavior checklists by teachers for early screening and identification by primary schoolteachers (see Chan et al., 2004).

Perhaps the major limitation of this study was the use of the school-referred EMB sample with possible bias in self-selection to estimate incidence rate and gender ratio based on children identified as meeting the Hong Kong criterion of dyslexia. Thus, rather than comparing with other discrepancy-based criteria using a sample of children with the full spectrum of reading achievement and IQ level, the comparison was limited by the sample of identified dyslexic children who were low in reading achievement and average or above in IQ level. Because of the many possibilities of referral biases, the estimates on incidence rate and gender ratio might apply more to severe cases, and one might interpret these estimates as defining the lower bounds on incidence with a possibly exaggerated gender imbalance favoring a preponderance of boys over girls. Indeed, these estimates could be very different when the current referring practices in Hong Kong change, and when biases and limitations are reduced to approximate the conditions as those in the normative sample. Thus, the present findings emphasizing the changing estimates of incidence and gender ratio serve to remind us that there are many conditions, beyond language as well as definitional and diagnostic criterion differences, that could affect such estimates, and these conditions, including referral practices, might account to some extent for the vast differences in estimates of incidence around the world.

In the present study, the use of the normative sample of 690 children might provide some standards against which the estimates based on the EMB sample could be compared, even though we could only conduct analyses on the identified children, as IQ scores were only available for these identified children. Despite the many limitations, we believe that the EMB data is the only available data that have comprehensive coverage of all schools in Hong Kong over the past few years, and as such, the data provide valuable information on the work with dyslexic children in Hong Kong, which should help set the stage for further studies of developmental dyslexia in Hong Kong Chinese children. From a different perspective, the EMB data also bear indirectly on supporting that, even for more severe cases of Chinese children with dyslexia, the important correlates of literacy deficits are likely to be naming speed and orthographic knowledge rather than phonological awareness as documented for alphabetic languages (see Ho et al., 2004). These findings provide indirect and suggestive evidence that could resonate to certain extent with findings in other studies of non-alphabetic languages with regular orthographies beyond Chinese children with dyslexia and beyond Hong Kong (see Smythe et al., 2004). Certainly, the degree of convergence of such findings around the world and the conditions under which such convergence occurs if it does deserve future research attention and international collaboration in the field of dyslexia and learning difficulties.

References

Ashton, C. J. (1997). SpLD, discrepancies and dyslexia. *Educational Psychology in Practice, 13,* 9-11.

Bishop, D. V. M., & Snowling, M. J. (2004). Developmental dyslexia and specific language impairment: Same or different? *Psychological Bulletin, 130,* 858-886.

Chan, D. W., Ho, C. S.-H., Tsang, S., Lee, S., & Chung, K. K. H. (2004). Screening for Chinese children with dyslexia in Hong Kong: The use of the Teachers' Checklist. *Educational Psychology, 24,* 811-824.

Chan, D. W., Ho, C. S.-H., Tsang, S., Lee, S., & Chung, K. K. H. (2007). Prevalence, gender ratio and gender differences in reading-related cognitive abilities among Chinese children with dyslexia in Hong Kong. *Educational Studies, 33,* 249-265.

Coltheart, M., & Prior, M. (2007). *Learning to read in Australia. Policy Paper #6*. Canberra, Australia: The Academy of the Social Sciences in Australia.

Dyman, R. A., & Ackerman, P. T. (1992). Diagnosing dyslexia: IQ regression plus cut-points. *Journal of Learning Disabilities, 25,* 574-576.

Education and Manpower Bureau (2004). *Enrolment statistics 2003/04 (Summary)* Hong Kong: Author.

Ellis, A. W. (1993). *Reading, writing and dyslexia: A cognitive analysis.* Hove: Lawrence Erlbaum Associates.

Fletcher, J. M., Espy, K. A., Francis, D. J., Davidson, K. C., Rourke, B. P., & Shaywitz, S. E. (1989). Comparisons of cutoff and regression-based definitions of reading disabilities. *Journal of Learning Disabilities, 22,* 334-355.

Fletcher, J. M., Shaywitz, S. E., Shankweiler, D. P., Katz, L., Liberman, I. Y., Fowler, A., et al. (1994). Cognitive profiles of reading disability: Comparisons of discrepancy and low achievement definitions. *Journal of Educational Psychology, 86,* 6-23.

Francis, D. J., Fletcher, J. M., Stuebing, K. K., Lyon, G. R., Shaywitz, B. A., & Shaywitz, S. E. (2005). Psychometric approaches to the identification of LD: IQ and achievement scores are not sufficient. *Journal of Learning Disabilities, 38,* 98-108.

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

Hier, D. B. (1980). Sex differences in hemispheric specialization: Hypothesis for the excess of dyslexia in boys. *Bulletin of the Orton Society, 29*, 74-83.

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

Ho, C. S-H., Chan, D. W., Lee, S., Tsang, S., & Luan, V. H. (2004). Cognitive profiling and preliminary subtyping in Chinese developmental dyslexia. *Cognition, 91,* 43-75.

Ho, C. S-H., Chan, D. W., Tsang, S., & Lee, S. (2000). *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., & Lee, S. (2002). The cognitive profile and multiple-deficit hypothesis in Chinese developmental dyslexia. *Developmental Psychology, 38,* 543-553.

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,* 173-186.

Hong Kong Education Department. (1986). *Hong Kong supplement to guide to the Standard Progressive Matrices.* Hong Kong: Hong Kong Government.

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, 4,* 145-150.

Lee, S. (2004). Dyslexia in Hong Kong. In I. Smythe, J. Everatt, & R. Salter (Eds.), *International Book of Dyslexia: A guide to practice and resources* (pp. 109-115). Chichester, UK: John Wiley & Sons.

Lundberg, I. (1999). Towards a sharper definition of dyslexia. In I. Lundberg, F. E. Tonnessen, & I. Austad (Eds.), *Dyslexia: Advances in theory and practice* (pp. 9-29). Dordrecht, The Netherlands: Kluwer Academic Publishers.

Lyon, G. R., Shaywitz, S. E., & Shaywitz, B. A. (2003). A definition of dyslexia. *Annals of Dyslexia, 53,* 1-14.

Mercer, C. D., Jordan, L., Allsop, D. H., & Mercer, A. R. (1996). Learning disabilities definitions and criteria used by state education departments. *Learning Disability Quarterly, 19,* 217-232.

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, UK: Open University Press.

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.

Peer, L. (1994). *Dyslexia: The training and awareness of teachers*. Reading, UK: British Dyslexia Association.

Psychological Corporation. (1981). *Hong Kong Wechsler Intelligence Scale for Children Manual*. New York: Author.

Pumfrey, P. D. (1995). The management of specific learning difficulties (dyslexia): Challenges and responses. In I. Lunt, B. Norwich, & V. Varma (Eds.), *Psychology and education for special needs: Recent developments and future directions* (pp. 45-70). London: Ashgate.

Raven, J., Raven, J. C., & Court, J. H. (1998). *Manual for Raven's Progressive Matrices and Vocabulary Scales.* Oxford, England: Oxford University Press.

Reason, R. (2002). From assessment to intervention: The educational psychology perspective. In G. Reid & J. Wearmouth (Eds.), *Dyslexia and literacy: Theory and practice* (pp. 187-200). Chichester, UK: John Wiley & Sons.

Rimm, A. A., Hartz, A. J., Kalbfleisch, J. H., Anderson, A. J., & Hoffmann, R. G. (1980). *Basic biostatistics in medicine and epidemiology*. New York: Appleton-Century-Crofts.

Rutter, M., Caspi, A., Fergusson, D., Horwood, L. J., Goodman, R., Maughan, B., Moffitt, T. E., Meltzer, H., & Carroll, J. (2004). Sex differences in developmental reading disability: New findings from 4 epidemiological studies. *Journal of American Medical Association, 291,* 2007-2012.

Salter, R., & Smythe, I. (1997). *The International Book of Dyslexia.* London: World Dyslexia Network Foundation and European Dyslexia Association.

Shaywitz, B. A., Holford, T. R., Holahan, J. M., Fletcher, J. M., Steubing, K. K., Francis, D. J., et al. (1995). A Matthew effect for IQ but not for reading. Results from a longitudinal study. *Reading Research Quarterly, 30,* 894-906.

Shaywitz, S. E., Shaywitz, B. A., Fletcher, J. M., & Escobar, M. D. (1990). Prevalence of reading disability in boys and girls. *Journal of American Medical Association, 264,* 998-1002.

Siegal, L. S. (1989). IQ is irrelevant to the definition of learning disabilities. *Journal of Learning Disabilities, 22,* 469-478, 486.

Siegel, L. S. (1992). An evaluation of the discrepancy definition of dyslexia. *Journal of Learning Disabilities, 25,* 618-629.

Siegel, L. S., & Smythe, I. S. (2005). Reflections on research on reading disability with special attention to gender issues. *Journal of Learning Disabilities, 38,* 473-477.

Smythe, I., Everatt, J., & Salter, R. (Eds.) (2004). *International Book of Dyslexia: A guide to practice and resources.* Chichester, UK: John Wiley & Sons.

Snowling, M. J. (2000). *Dyslexia* (2nd ed.) Oxford, UK: Blackwell.

Stanovich, K. E. (1996). Towards a more inclusive definition of dyslexia. *Dyslexia, 2,* 154-166.

Stanovich, K. E. (2005). The future of a mistake: Will discrepancy measurement continue to make the learning disabilities field a pseudoscience? *Learning Disability Quarterly, 28,* 103-106.

Stanovich, K. E., & Siegal, L. S. (1994). Phenotypic performance profiles of children with reading disabilities: A regression-based test of the phonological-core variable difference model. *Journal of Educational Psychology, 86,* 24-53.

Wadsworth, S. J., DeFries, J. C., Stevenson, J., Gilger, J. W., & Pennington, B. F. (1992). Gender ratios among reading-disabled children and their siblings as a function of parental impairment. *Journal of Child Psychology and Psychiatry, 33,* 1229-1239.

Table 1

Incidence Rate, Gender Ratio, and Reading-Related Cognitive Deficits in Children with Dyslexia (Education and Manpower Bureau Sample)

		Diagnostic Criteria		
		Hong Kong Cognitive Markers	Simple Discrepancy	Regression-Based Discrepancy
Discrepancy set at 1 or more SD units		(*n* = 1334)	(*n* = 1216)	(*n* = 1313)
		%	%	%
Cognitive Deficits (score 5.5 or less)				
Naming Speed		50.1	51.6	50.4
Phonological Awareness		8.4	8.1	8.5
Phonological Memory		14.0	12.8	13.7
Orthographic Knowledge		27.6	27.6	27.7
Gender Ratio (M: F; lower/upper bound)		3.04/3.29: 1	3.25/3.41: 1	3.10/3.33: 1
Incidence Rate (lower/upper bound)		0.32%/0.66%	0.29%/0.63%	0.31%/0.65%
IQ (80 to 139)	*M*	101.99	103.24	102.17
	SD	10.77	10.37	10.74

Discrepancy set at 1.5 or more SD units		(*n* = 1334)	(*n* = 991)	(*n* = 1018)
		%	%	%
Cognitive Deficits (score 5.5 or less)				
Naming Speed		50.1	54.0	54.8
Phonological Awareness		8.4	8.0	8.3
Phonological Memory		14.0	11.5	14.2
Orthographic Knowledge		27.6	27.5	30.6
Gender Ratio (M: F; lower/upper bound)		3.04/3.29: 1	3.46/3.52: 1	3.39/3.48: 1
Incidence Rate (lower/upper bound)		0.32%/0.66%	0.24%/0.58%	0.24%/0.58%
IQ (80 to 139)	*M*	101.99	105.27	102.28
	SD	10.77	10.09	10.81

Note. A child meets the Hong Kong criterion of dyslexia if he or she scores low in literacy skills despite an IQ within broadly normal limits and has weaknesses suggestive of possible deficits in any one of the cognitive skills assessed in the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD). The child meets the simple discrepancy criteria if his or her IQ and literacy scores differ by the specified standard deviation units. The child meets the regression-based discrepancy criteria if regression is involved in estimating the IQ-literacy difference. Incidence rate was estimated based on an estimate of 418,345 schoolchildren in primary schools (excluding international schools) in that period in Hong Kong. Lower bound estimates on incidence and gender ratio were computed based on the number of children out of the sample of 1334 children meeting the respective criterion, and upper bound estimates were computed by including the 1418 children with no available HKT-SpLD data, assuming that they all 2752 children met the respective criteria.

Table 2

Prevalence Rate, Gender Ratio, and Reading-Related Cognitive Deficits in Children with Dyslexia (Normative Sample)

		Diagnostic Criteria		
		Hong Kong Cognitive Markers	Simple Discrepancy	Regression-Based Discrepancy
Discrepancy set at 1 or more SD units		(*n* = 67)	(*n* = 51)	(*n* = 62)
		%	%	%
Cognitive Deficits (score 5.5 or less)				
Naming Speed		31.3	31.4	32.3
Phonological Awareness		7.5	7.8	8.1
Phonological Memory		13.4	13.7	12.9
Orthographic Knowledge		11.9	11.8	12.9
Gender Ratio (M: F)		2.05: 1	2.19: 1	2.26: 1
Prevalence Rate		9.71%	7.39%	8.99%
IQ (85 to 131)	*M*	101.39	104.55	102.29
	SD	10.44	9.77	10.28

Discrepancy set at 1.5 or more SD units		(*n* = 67)	(*n* = 33)	(*n* = 27)
		%	%	%
Cognitive Deficits (score 5.5 or less)				
Naming Speed		31.3	24.2	40.7
Phonological Awareness		7.5	12.1	7.4
Phonological Memory		13.4	15.2	14.8
Orthographic Knowledge		11.9	18.2	22.2
Gender Ratio (M: F)		2.05: 1	2.30: 1	2.00: 1
Prevalence Rate		9.71%	4.78%	3.91%
IQ (85 to 131)	*M*	101.39	108.15	101.63
	SD	10.44	9.92	8.62

Note. A child meets the Hong Kong criterion of dyslexia if he or she scores low in literacy skills despite an IQ within broadly normal limits and has weaknesses suggestive of possible deficits in any one of the cognitive skills assessed in the Hong Kong Test of Specific Learning Difficulties in Reading and Writing. The child meets the simple discrepancy criteria if his or her IQ and literacy scores differ by the specified standard deviation units. The child meets the regression-based discrepancy criteria if regression is involved in estimating the IQ-literacy difference. Prevalence rate was estimated based on the size of the normative sample of 690 children.

Table 3

Reading-Related Cognitive Abilities in Children with Dyslexia Based on the Hong Kong Criteria

Education and Manpower Bureau Sample (n = 1334)

Reading-related abilities	*M*	*SD*	Correlation LT	NS	PA	PM
Literacy (LT)	4.23	1.66				
Naming Speed (NS)	5.39	3.23	.26**			
Phonological Awareness (PA)	8.44	2.09	.10**	-.08**		
Phonological Memory (PM)	9.08	3.24	.08**	-.11**	.09**	
Orthographic Knowledge (OK)	7.10	2.53	.35**	-.00	.23**	.01

Normative Sample (n = 67)

Reading-related abilities	*M*	*SD*	Correlation LT	NS	PA	PM
Literacy (LT)	5.61	1.26				
Naming Speed (NS)	7.00	2.90	.29*			
Phonological Awareness (PA)	8.33	1.90	.24	.10		
Phonological Memory (PM)	8.37	2.62	.03	.04	.28*	
Orthographic Knowledge (OK)	7.84	2.20	.35**	-.08	.18	-.11

Note. The scores were composite scale scores from the Hong Kong Test of Specific Learning Difficulties in Reading and Writing, (Normative standard *M* = 10 and *SD* = 3).

*$p < .05$; **$p < .01$ (2-tailed).