Educational Psychology
Vol. 24, No. 6, December 2004

Carfax Publishing
Taylor & Francis Group

Screening for Chinese Children with Dyslexia in Hong Kong: The use of the Teachers' Behaviour Checklist

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Primary school teachers rated the frequency of occurrence of 65 reading-related behavioural characteristics in a sample of 251 Grade 1 to Grade 6 Chinese school children in Hong Kong. These behavioural characteristics were in the areas of general performance, reading, dictation, writing, mathematics, language, memory, concentration, sequential ability, motor co-ordination, spatial orientation, and social/emotional adjustment. Of these 12 areas, 10 yielded scale scores that could distinguish children with dyslexia from those without dyslexia, identified on the basis of their performance in five domains of literacy and cognitive skills. Using a summary score derived from the 10 relevant scales, an optimal cut-off score was suggested to arrive at a balance between high sensitivity and an acceptable rate of false positives in screening for children with dyslexia. The need for cross-replication in screening children with dyslexia using the behaviour checklist with different samples of school students is emphasised.

For decades, educators and researchers have found it puzzling that some children who appear normal, intelligent, healthy, and well-nurtured have marked difficulties in reading and learning to read. These difficulties, generally recognised as encompassing spelling and writing problems, are now studied under the concept of dyslexia. In general, dyslexia can be defined as

> a specific language-based disorder of constitutional origin characterised by difficulties in single word decoding, usually reflecting insufficient phonological processing. These difficulties ... are often unexpected in relation to age and other cognitive and academic abilities; they are not the result of generalised developmental disability or sensory impairment. (Orton Dyslexia Society, 1994, p. 5)

While recent research into developmental dyslexia has led to a greater understanding of its neurological and cognitive basis (see Miles & Miles, 1999; Snowling, 2000),

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ISSN 0144–3410(print)/ISSN 1469–046X (online)/04/060811-14

DOI: 10.1080/0144341042000271769

practitioners consider it desirable to have a more comprehensive description of dyslexia at the behavioural level (Frith, 1997). For one thing, neurological explanations are unlikely to influence strategies for helping children with dyslexia to improve their performance in school. In addition, it is at the behavioural level that literacy and specific cognitive deficits could be observed as signs or symptoms, or as patterns of reading-related behavioural characteristics. These observed behavioural characteristics might in turn be important indicators that a child is at risk. Thus, information about children's patterns of behavioural characteristics is potentially useful for improving methods for screening or early identification and subsequent treatment, for raising new questions to be pursued in future research, and for arriving at a more comprehensive explanation of dyslexia.

Over the years, researchers and practitioners have accumulated considerable experience in the use of behaviour checklists to assess children suffering from diverse disorders (see Mash & Wolfe, 2002; Wagner, 2003). Most of these behaviour checklists are global or broad-spectrum rating scales that ask parents and teachers to rate the presence of a wide variety of child behaviours, or the frequency and intensity of these behaviours. Other behaviour checklists are problem-focused rating scales that focus on children's specific disorders or particular areas of functioning (for example, Mash & Terdal, 1997). Exemplary global comprehensive systems are the Achenbach System of Empirically Based Assessment, which includes the Child Behaviour Checklist and the Teacher's Report Form (see Achenbach & Rescorla, 2001a, 2001b), and the Behaviour Assessment System for Children, which includes Parent Rating Scales and Teacher Rating Scales (see Reynolds & Kamphaus, 1992). Both global assessment systems have demonstrated that valuable information can be provided about parents' and teachers' perceptions of children's behaviours as well as children's strengths and weaknesses, as parents and teachers interact with children in different surroundings and circumstances.

Apart from the global behaviour checklists, there is also a variety of more specific behaviour checklists, but those that focus specifically on dyslexia are few in number. For example, the Myklebust Pupil Rating Scale (see Margolis, Sheridan, & Lemanowicz, 1981) and the Windward Rating Scale (see Hamada & Tomikawa, 1986) are rather broadband instruments that aim to screen for students with learning difficulties. On the other hand, the Dyslexia Screening Instrument (Coon, Waguespack, & Polk, 1994), which consists of 33 statements, is more specific with respect to screening for children who exhibit behaviours related to reading, spelling, writing, or language processing difficulties.

The development of a behaviour checklist to screen for children with dyslexia has been particularly appealing in Hong Kong, where parents and teachers have become increasingly aware and concerned in recent years that Chinese children with dyslexia might be under-identified and therefore unserved in schools in the local education system. This concern arises from an increased conceptual understanding of dyslexia, which is contradicted by an unexpected low incidence rate of dyslexia each year, the rate of less than 1% being much lower than would be expected from figures reported around the world (see Ho, Chan, Tsang, & Lee, 2000b; Salter & Smythe, 1997).

There are obviously many reasons that might account for the misleadingly low incidence of dyslexia and the associated problem of under-identification in Hong Kong. Perhaps one major reason is the lack of appropriate instruments and assessment procedures for the identification of children with dyslexia. Until recently, suspected cases of dyslexia were referred to government educational psychologists for special services provision. The assessment process typically involved a full IQ assessment using the Hong Kong Wechsler Intelligence Scale for Children (HK-WISC; Psychological Corporation, 1981), and informal tests assembled to assess word copying, word matching, and word reading, and the Bender-Gestalt Test (Bender, 1946). On the basis of these test results, and perhaps additional information from educational history, sample scripts of homework, dictation, and free writing, the educational psychologist would exercise his or her clinical judgement to decide whether the child being assessed could be classified as dyslexic. However, prior to the referral for assessment by educational psychologists, schoolteachers and parents also had to exercise their subjective judgement by relying on observation of behavioural manifestations of cognitive deficits and performance in reading and dictation. Increasingly, this process of observation, referral, and identification was deemed to be somewhat unsatisfactory, as case definition and the criteria for identification were based more on clinical experience than on empirical support, and there were no specific guidelines for behaviour observation.

With the development of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (HKT-SpLD; Ho et al., 2000b), which assesses multiple cognitive deficits in Cantonese-speaking Chinese children with dyslexia in Hong Kong (Ho, Chan, Tsang, & Lee, 2002a), the procedures and criteria of identification have undergone important changes. Although IQ assessment is still desirable to rule out mental retardation, the focus is on assessing students' literacy skills and cognitive deficits in phonological awareness, phonological memory, rapid naming, and orthographic knowledge using a battery of tests which yield scores to determine whether the respondent meets the criteria of dyslexia.

While psychologists' assessment of children with dyslexia using the HKT-SpLD yields profiles of literacy and cognitive skills or deficits for more accurate case identification that will in turn lead to more appropriate interventions based on these specific cognitive deficits, the full diagnostic assessment is typically a costly and time-consuming process. Thus, it is believed that prior to a full assessment, brief and efficient screening should help streamline the identification procedure. Since teachers in daily interaction with children are well placed to notice students' reading-related behavioural characteristics, it is further believed that teachers' ratings based on a checklist of students' behaviours related to reading and writing will allow teachers to determine whether to refer students for a full assessment by psychologists. With this view, the Hong Kong Specific Learning Difficulties Behaviour Checklist (HKSLDBC) was developed to cover 12 areas of student reading-related behavioural characteristics for dyslexia screening (Ho et al., 2000a; Ho, Chan, Tsang, & Lee, 2002b). The initial item pool consisted of more than 70 items written after a review of available behaviour checklists (for example, the Dyslexia Screening Instrument) and

consultation with experienced frontline teachers teaching children with dyslexia in Hong Kong. The final checklist consists of 65 items grouped in 12 areas representing 65 reading-related behavioural characteristics. Each of these items was found to be able to distinguish statistically a sample of 177 children with dyslexia from a sample of 176 children without dyslexia, the diagnostic decision being made using judgement based on clinical experience and results of informal tests assembled for the purpose of dyslexia case identification (see Ho et al., 2000a). While teachers' ratings using HKSLDBC yield a profile of scores on reading-related behavioural characteristics, the decision rule suggested for selecting children as probable cases for further assessment was based on counting the number of behavioural characteristics defined as salient. This procedure might be convenient for teachers, but might bias against underrepresented areas of behavioural characteristics, that is, areas with comparatively smaller number of items in the checklist. Thus, further studies need to be conducted to generate more rigorous decision rules based on scores of behavioural characteristics on the HKSLDBC, and to integrate the sequential administration of the two instruments (for example, the HKSLDBC for screening and the HKT-SpLD for case identification) into a more efficient identification procedure.

Based on the above, the present study aimed to provide data to test the use of the HKSLDBC as a teacher screening tool for Chinese children with dyslexia. Specifically, this study was concerned with: providing evidence to support the construct validity of the 12 areas of reading-related behavioural characteristics assessed in the HKSLDBC; contrasting the profiles of reading-related behavioural characteristics between children with dyslexia and children without dyslexia defined on the basis of scores on the HKT-SpLD; and generating and suggesting an optimal cut-off score for probable dyslexia case-noncase classification based on teachers' ratings on the HKSLDBC.

Method

Participants and Procedures

In this study, data were collected from teachers and students in primary schools in Hong Kong. First, primary school teachers were asked to participate voluntarily in a project of which this study formed a small component. These teachers were then asked to nominate students whom they judged to be poor readers, and complete their ratings on these students using the 65-item HKSLDBC (see Table 1 for the behavioural characteristics being rated). The only exclusionary criterion was not to nominate Chinese children who immigrated to Hong Kong in the previous year from mainland China because of their possibly different educational opportunities and dialects. All nominated students were then referred to government psychologists for IQ assessment using either the HK-WISC (Psychological Corporation, 1981) or Raven's Standard Progressive Matrices (SPM; Hong Kong Education Department, 1986; Raven, Raven, & Court, 1998). Students who scored below average for intelligence (HK-WISC score below 80 or SPM score below 85) were excluded on the

assumption that their reading problems might arise mainly from their generally low intellectual functioning. To obtain teachers' ratings on average readers, a second group of primary school teachers whose students had served as participants in another research project that studied average readers with average intelligence were also recruited. These teachers were also asked to complete ratings on the reading-related behavioural characteristics of these average readers using the HKSLDBC.

Second, these two groups of students who had been rated by teachers using the HKSLDBC were invited for individual assessment using the HKT-SpLD to determine whether they met the criteria of dyslexia as specified in the HKT-SpLD. Thus, teachers' rating data on the HKSLDBC and students' performance data on the HKT-SpLD were obtained for 251 primary students (187 boys and 63 girls, with one student having missing data on gender) aged between $6\frac{1}{2}$ and $12\frac{1}{2}$ years (M=99.92 months, SD=14.59). Of these students, 64% were from Grades 1 and 2, with the remaining 36% from Grades 3 to 6.

Measures

The HKSLDBC is a 65-item checklist of student reading-related behavioural characteristics that can be observed in the classroom by teachers. These behavioural characteristics fall into 12 areas that include general performance, reading, dictation, writing, mathematics, language, memory, concentration, sequencing ability, motor co-ordination, spatial orientation, and social/emotional adjustment. In completing the checklist, teachers indicate their observation of the frequency of occurrence of each of the behaviours using a five-point scale ranging from 1 (never observed) to 5 (often observed).

The HKT-SpLD is a battery of 12 tests to be administered individually to students. Specifically, the battery includes three literacy tests (Chinese word reading, one minute reading, Chinese word dictation), one rapid naming test (digit rapid naming), two phonological awareness tests (rhyme detection, onset detection), three phonological memory tests (word repetition I, nonword repetition, word repetition II), and three orthographic knowledge tests (light-left reversal, lexical decision, radical position). The 12 tests yield 12 separate initial scores, which were combined to yield five composite scores on the domains of literacy, phonological awareness, phonological memory, rapid naming, and orthographic knowledge. Cut-off scores of 7 were used on these composite scores (normative standard M=10, SD=3). Students scoring 7 or below on the literacy domain and on one or more of the cognitive skill domains can be classified as meeting the criteria of dyslexia.

Results

The 12 Areas of Reading-Related Behavioural Characteristics

Since teachers' ratings on the 65 items of the HKSLDBC could be scored into 12 scales, it was of interest to test whether student reading-related behavioural

Table 1. Completely standardised 12-factor solution of reading-related behavioural characteristics (N=251)

Reading-related behavioural characteristics	Factor											
	1	2	3	4	5	6	7	8	9	10	11	12
Leaves erasure marks (GP1)	35	–	–	–	–	–	–	–	–	–	–	–
Inconsistent performance and conduct (GP2)	33	–	–	–	–	–	–	–	–	–	–	–
Good class performance, poor exam results (GP3)	47	–	–	–	–	–	–	–	–	–	–	–
Poor exam results despite revision (GP4)	88	–	–	–	–	–	–	–	–	–	–	–
Poor dictation despite learning by heart (GP5)	90	–	–	–	–	–	–	–	–	–	–	–
Comprehends words worse than speech (R1)	–	75	–	–	–	–	–	–	–	–	–	–
Does not recognise common words (R2)	–	88	–	–	–	–	–	–	–	–	–	–
Does not comprehend sentences (R3)	–	88	–	–	–	–	–	–	–	–	–	–
Difficulty in finding main points of essay (R4)	–	89	–	–	–	–	–	–	–	–	–	–
Reads words wrongly (R5)	–	86	–	–	–	–	–	–	–	–	–	–
Frequent stops in reading (words unrecognised) (R6)	–	89	–	–	–	–	–	–	–	–	–	–
Ignores punctuation in reading (R7)	–	74	–	–	–	–	–	–	–	–	–	–
Confuses words close in pronunciation (R8)	–	69	–	–	–	–	–	–	–	–	–	–
Reads worse than age peers (R9)	–	90	–	–	–	–	–	–	–	–	–	–
Fails to find homework mistakes despite checking (R10)	–	80	–	–	–	–	–	–	–	–	–	–
Fails in dictation (wrong words/no attempt) (D1)	–	–	85	–	–	–	–	–	–	–	–	–
Mistakes in spelling/copying (D2)	–	–	85	–	–	–	–	–	–	–	–	–
Spends more time in copying (D3)	–	–	85	–	–	–	–	–	–	–	–	–
Misses words in copying from board (D4)	–	–	85	–	–	–	–	–	–	–	–	–
Different spellings for same words (D5)	–	–	66	–	–	–	–	–	–	–	–	–
Speaking but not writing vocabulary (W1)	–	–	–	85	–	–	–	–	–	–	–	–
Writing worse than verbal expression (W2)	–	–	–	88	–	–	–	–	–	–	–	–
Misses or misuses punctuation (W3)	–	–	–	86	–	–	–	–	–	–	–	–
Difficulty in rearranging parts of sentences (W4)	–	–	–	85	–	–	–	–	–	–	–	–
Unclear thoughts in composing (W5)	–	–	–	86	–	–	–	–	–	–	–	–
Poor written expression (grammatical errors) (W6)	–	–	–	88	–	–	–	–	–	–	–	–
Words missed, added, or in wrong orders (W7)	–	–	–	77	–	–	–	–	–	–	–	–
Computes aided by fingers or symbols (M1)	–	–	–	–	74	–	–	–	–	–	–	–
Does not comprehend math problem (M2)	–	–	–	–	66	–	–	–	–	–	–	–
Does not understand numbers/their values (M3)	–	–	–	–	65	–	–	–	–	–	–	–
Confuses symbols (plus/minus/multiply/divide) (M4)	–	–	–	–	82	–	–	–	–	–	–	–
Difficulty in memorising multiplication table (M5)	–	–	–	–	76	–	–	–	–	–	–	–
Slow to respond verbally (L1)	–	–	–	–	–	81	–	–	–	–	–	–
Nonfluent or inappropriate verbal expression (L2)	–	–	–	–	–	94	–	–	–	–	–	–
Wrong verbal expression (L3)	–	–	–	–	–	86	–	–	–	–	–	–
Wrong pronunciation (L4)	–	–	–	–	–	70	–	–	–	–	–	–
Forgetful (MM1)	–	–	–	–	–	–	75	–	–	–	–	–
Cannot follow series of instructions (MM2)	–	–	–	–	–	–	86	–	–	–	–	–
Needs message continuously repeated (MM3)	–	–	–	–	–	–	83	–	–	–	–	–
Difficulty in remembering names (MM4)	–	–	–	–	–	–	68	–	–	–	–	–
Difficulty in remembering nursery rhymes (MM5)	–	–	–	–	–	–	63	–	–	–	–	–
Cannot remember complex timetable (MM6)	–	–	–	–	–	–	64	–	–	–	–	–
Cannot remember personal information (MM7)	–	–	–	–	–	–	48	–	–	–	–	–
Easily distracted (CN1)	–	–	–	–	–	–	–	88	–	–	–	–
Cannot stay on task for long (CN2)	–	–	–	–	–	–	–	89	–	–	–	–
Cannot repeat information just heard (CN3)	–	–	–	–	–	–	–	52	–	–	–	–

Table 1. *Continued*

Reading-related behavioural characteristics	Factor											
	1	2	3	4	5	6	7	8	9	10	11	12
Wrong character stroke sequence (SQ1)	–	–	–	–	–	–	–	–	59	–	–	–
Difficulty writing down dates (SQ2)	–	–	–	–	–	–	–	–	71	–	–	–
Confuses time (yesterday/today/tomorrow) (SQ3)	–	–	–	–	–	–	–	–	76	–	–	–
Wrong sequence for information in serial order (SQ4)	–	–	–	–	–	–	–	–	70	–	–	–
Spends great efforts to learn to tell time (SQ5)	–	–	–	–	–	–	–	–	72	–	–	–
Colours out of bounds (MC1)	–	–	–	–	–	–	–	–	–	76	–	–
Clumsy in running/jumping (MC2)	–	–	–	–	–	–	–	–	–	75	–	–
Easily tired in very active games (MC3)	–	–	–	–	–	–	–	–	–	92	–	–
Poor performance in physical education (MC4)	–	–	–	–	–	–	–	–	–	87	–	–
Difficulty in rope skipping, throwing/catching (MC5)	–	–	–	–	–	–	–	–	–	53	–	–
Cannot follow beats in music lessons (MC6)	–	–	–	–	–	–	–	–	–	39	–	–
Difficulty in tying shoe laces or buttoning (MC7)	–	–	–	–	–	–	–	–	–	54	–	–
Confuses top/bottom, left/right orientations (SP1)	–	–	–	–	–	–	–	–	–	–	77	–
Poor orientation, needs extra time to get around (SP2)	–	–	–	–	–	–	–	–	–	–	75	–
Avoids learning (SA1)	–	–	–	–	–	–	–	–	–	–	–	51
Difficulty getting along with others (SA2)	–	–	–	–	–	–	–	–	–	–	–	85
Poor self-image (SA3)	–	–	–	–	–	–	–	–	–	–	–	88
Easily feels frustrated and gives up (SA4)	–	–	–	–	–	–	–	–	–	–	–	67
Somatic complaints when feels stressed (SA5)	–	–	–	–	–	–	–	–	–	–	–	54

Note. Decimals on loadings are omitted. Original item numbers in each of the 12 areas in the HKSLDBC (Ho et al., 2000a, 2002b) are in parentheses. The 12 areas are: R=Reading, W=Writing, D=Dictation, M=Mathematics, L=Language, MM=Memory, CN=Concentration, SQ=Sequencing Ability, MC=Motor Co-ordination, SP=Spatial Orientation, SA=Social/Emotional Adjustment, GP=General Performance.

characteristics did co-occur in correspondence with these 12 areas as specified in the HKSLDBC. Consequently, a maximum likelihood confirmatory factor analysis (LISREL 8; Joreskog & Sorbom, 1993) was first performed on the rating data of the 251 target students. Since the model would be rejected by the chi-square statistic at a conventional alpha level if a large enough sample was used, and accepted if a small enough sample was used (Browne & Cudeck, 1993), a number of goodness of fit or lack of fit indices were employed to help evaluate the 12-dimensional model (Bentler, 1989; Joreskog & Sorbom, 1993). Thus, apart from the chi-square statistic, a number of indices were used. These indices were the root mean squared error of approximation (RMSEA), the root mean square residual (RMSR), the goodness of fit and the adjusted goodness of fit indices (GFI and AGFI), the non-normed fit index (NNFI), and the comparative fit index (CFI). In general, an adequate to good fit is suggested by RMSEA and RMSR values approaching .05, and by fit index (GFI, AGFI, NNFI, CFI) values between .80 and 1.00. The results of fitting the 12-factor model to the data suggested moderately adequate fit as indicated by the chi-square statistic [χ^2 (1949)=4413.19, $p < .001$], and goodness of fit or lack of fit indices [RMSEA=.077,

Table 2. Means, standard deviations, and internal consistency of the 12 scales of reading-related behavioural characteristics (N=251)

Reading-related behavioural characteristics	Number of items	*M*	*SD*	Cronbach's α
General performance	5	2.93	1.07	.75
Reading	10	3.44	1.09	.96
Dictation	5	3.39	1.20	.90
Writing	7	3.73	1.12	.95
Mathematics	5	2.57	1.22	.84
Language	4	3.04	1.10	.89
Memory	7	2.85	1.02	.87
Concentration	3	3.66	1.12	.78
Sequential ability	5	2.60	1.05	.82
Motor co-ordination	7	2.42	0.94	.86
Spatial orientation	2	2.00	1.18	.73
Social/emotional adjustment	5	2.67	1.08	.82

RMR=.184, GFI=.627, AGFI=.590, NNFI=.800, and CFI=.813]. The correlation between pairs of these factors was substantial, ranging from r=.20 to r=.91, the most highly correlated dimensions (r=.86 to r=.91) being those defined by behavioural characteristics in reading, dictation, and writing. Table 1 summarises the completely standardised 12-factor solution by confirmatory factor analysis.

Table 2 summarises the means of teachers' ratings of students' reading-related behavioural characteristics scored into the 12 scales, and the internal consistencies of the 12 scales. It can be seen that the internal consistencies (Cronbach's alphas) of the 12 scales were reasonably high, ranging from .73 to .96, despite the small number of items in each scale, lending support to the construct validity of these 12 scales. The 12 scales correlated substantially and significantly with each other (r=.22 to r=.86, p < .001), the highest correlations being those associated with reading, writing, and dictation. The mean scale scores indicated that students were observed to have more problems with writing, concentration, reading, and dictation, and fewer problems with spatial orientation and motor co-ordination. Support for students having different manifestations of reading-related behavioural characteristics in specific areas could be gleaned from one-way within-subjects analysis of variance (ANOVA), treating the 12 scale scores as dependent measures. The results indicated that the overall differences among the 12 scores were significant [Wilks' Λ=0.28, $F(11, 240)$=57.55, p < .001, η^2=.73]. Follow-up paired t-tests on all 66 possible pairs of scores indicated that all except 13 pairs were significantly different after controlling for family-wise error rate across the 66 tests using the Bonferroni procedure, with t-values evaluated at .05/66 or .0007 level of significance. In general, the nonsignificant differences were among scores on reading, writing, dictation, and concentration, among scores on language, memory, and general performance, and among scores on mathematics, sequential ability, and social/emotional adjustment.

Classification of Students as Dyslexic/Nondyslexic

The 251 students also completed the HKT-SpLD. Based on their scores, their deficits in literacy skills, phonological awareness, phonological memory, rapid naming, and orthographic knowledge could be identified using the cut-off scores of 7 or less as specified in the HKT-SpLD (Ho et al., 2000b). Accordingly, for this sample of 251 students, 64% might have deficits in literacy skills, 48% in rapid naming, 43% in orthographic knowledge, 36% in phonological awareness, and 28% in phonological memory. Since students might have multiple deficits, a distinction was made between deficits in literacy skills and deficits in cognitive skills encompassing phonological awareness, phonological memory, rapid naming, and orthographic knowledge. The results indicated that 22% of the students were free from both literacy and cognitive deficits, 4% had literacy deficits only, 14% had cognitive deficits only, and 64% had literacy and one or more cognitive deficits. Thus, based on the case–noncase classification criterion specified in the HKT-SpLD, for children with deficits in literacy skills and in one or more cognitive skills, 64% of the 251 students could be classified as dyslexic.

To explore whether teachers observed different profiles of reading-related behavioural characteristics for children with and without dyslexia as defined by HKT-SpLD scores, the two groups of children were compared on their 12 HKSLDBC scores. Since teacher ratings might be affected by the target students' gender and age, gender and age group were included as grouping variables in addition to the case–noncase dichotomy. Specifically, a $2 \times 2 \times 2$ MANOVA was conducted, using caseness, gender (187 boys and 63 girls), and age group (median split 8 years; 8 years or less, n=133; above 8 years, n=117) as grouping variables, and the 12 HKSLDBC scores as dependent variables. The results indicated that the overall main effect of caseness was significant [Wilks' Λ=0.73, $F(12, 231)=7.09$, $p < .001$, $\eta^2=.27$], the overall main effect of age group was also significant [Wilks' Λ=0.88, $F(12, 231)=2.60$, $p < .005$, $\eta^2=.12$], and the overall effect of the gender–caseness interaction was also significant [Wilks' Λ=0.91, $F(12, 231)=1.82$, $p < .05$, $\eta^2=.09$].

Subsequent univariate ANOVAs were conducted separately on the 12 scores as follow-up analyses of the significant overall main effects of caseness and age group, and the significant overall gender–caseness interaction effect. Using the Bonferroni procedure, each ANOVA was tested at the significance level of .05/12 or .004 for the three sets of ANOVAs. For the main effect of caseness, scores for children with and without dyslexia were significantly different on 10 of the 12 areas, the two exception areas being motor co-ordination and social/emotional adjustment, indicating that teachers observed significantly more reading-related behavioural characteristics in those 10 areas for children with dyslexia. For the main effect of age group, the only significant ANOVA was the age group difference on difficulties in writing [$F(1, 242)=13.24$, $p < .001$], with a relatively small effect size of $\eta^2=.05$, indicating that teachers observed that older children (M=4.16, SD=0.91) tended to have significantly more writing difficulties than did younger children (M=3.36, SD=1.16). For

Table 3. Differences in scores on reading-related behavioural characteristics for children with and without dyslexia (n=250)

Scales of reading-related behavioural characteristics	Dyslexia					
	Noncase (n=102)		Case (n=148)			
	M	*SD*	*M*	*SD*	*F* (1,242)	η^2
General performance	2.56	0.98	3.18	1.06	9.60*	.04
Reading	2.67	1.02	3.97	0.79	59.42*	.20
Dictation	2.57	1.16	3.95	0.85	60.20*	.20
Writing	2.92	1.03	4.29	0.81	55.45*	.19
Mathematics	1.82	0.99	3.10	1.08	44.03*	.15
Language	2.54	1.06	3.39	0.99	30.13*	.11
Memory	2.42	1.03	3.16	0.91	24.49*	.09
Concentration	3.04	1.16	4.08	0.87	38.42*	.14
Sequential ability	2.11	0.88	2.94	1.03	23.71*	.09
Motor co-ordination	2.16	0.87	2.61	0.95	7.16	.03
Spatial orientation	1.68	0.98	2.22	1.26	11.11*	.04
Social/emotional adjustment	2.29	1.08	2.93	1.00	7.82	.03

Note. Case-noncase classification is based on the criteria using scores of the Hong Kong Test of Specific Learning Difficulties in Reading and Writing (Ho et al., 2000b). *F*-tests are follow-up analyses of variance tests after the overall test in multivariate analysis of variance, and are evaluated at .05/12 or .004 level of significance.
* $p < .001$.

the gender–caseness interaction effect, none of the ANOVAs was significant. Table 3 summarises the results of the analysis contrasting scores of children with and without dyslexia.

Since 10 of the 12 scores (excluding motor co-ordination and social/emotional adjustment) were found to be discriminating, a discriminant function analysis was conducted using these 10 scores to predict membership in the dyslexic group. The overall results were significant [Wilks' Λ=0.57, $\chi^2(10, n=251)=136.18$, $p < .001$], indicating that the 10 scores differentiated children with dyslexia from those without dyslexia. Specifically, based on the correlation coefficients of the scores with the discriminant function as well as the standardised weights, reading, writing, dictation, mathematics, and concentration demonstrated a stronger relationship with the discriminant function while spatial orientation and general performance showed a weaker relationship. The means of the two groups on the discriminant function were consistent with this interpretation. The dyslexic group had the higher mean score (M=.71) than that of the nondyslexic group (M=-1.04). With prior probabilities based on group sizes for classification, the discriminant function correctly classified 82% of the 251 students. Assessing how well the classification procedure would predict in a new sample, a correct classification rate of 80% was achieved using the leave-one-out technique (classifying each case by the function derived from all cases

Table 4. Sensitivity and specificity in screening for dyslexia using different cut-off scores on reading-related behavioural characteristics (N= 251)

Reading-related behavioural characteristics summary score (Positive if greater than)	Percentage			
	Sensitivity	Specificity	False negative	False positive
23	95	50	5	50
24	95	54	5	46
25	93	58	7	42
26	90	64	10	36
27	88	67	12	33
28	85	67	15	33
29	77	72	23	28
30	75	74	25	26
31	71	76	24	29

Note. Sensitivity is a measure of the ability to call positive (a case) those who are children with dyslexia. Specificity is a measure of the ability to call negative (a noncase) those who are children without dyslexia. False negative is a child with dyslexia but is declared to be one without dyslexia. False positive is a child without dyslexia but is declared to be one with dyslexia.

other than that case). To take into account chance agreement, a kappa coefficient was computed and the value of .61 ($p < .001$) indicated moderately accurate prediction.

Screening for Dyslexia

Given that 10 of the 12 scales of the HKSLDBC could predict with moderate accuracy schoolchildren's membership in the dyslexic group in the sample of this study, it appeared appropriate to consider aggregating the 10 scores by unit weighting to yield a summary measure or index that could be applied by teachers to screen for children with dyslexia in the school setting. This summary score was found to be significantly different for the dyslexic group (M=34.24, SD=6.29) and the nondyslexic group [M=24.33, SD=7.97; t (182)=-10.52, $p < .001$], the t-value being computed without assuming equal variances of the two groups.

To effect a simple decision rule for probable dyslexia case–noncase classification for further follow-up assessment, a cut-off score was sought using ROC curve analysis, plotting sensitivity (correct identification of children with dyslexia as cases) against false positives (incorrect identification of children without dyslexia as cases), both variables being in percentages. Table 4 summarises the relevant results of the analysis. It can be seen that using a cut-off score of 26, that is, regarding a child with ratings above 26 as positive or a probable case, a reasonably good sensitivity of 90% could be achieved with false positives maintained at 36%. This cut-off would result in somewhat lower specificity in correctly identifying children without dyslexia as noncases. Based on this sample of 251 students, this cut-off score yielded a correct

classification rate of 79% and the kappa coefficient achieved a value of .56 ($p < .001$), indicating moderately accurate prediction.

Discussion

For those teaching students with dyslexia, the general concern is how best to devise effective learning programs to address these children's specific needs, with a realisation that failure to identify these children and to recognise their needs may lead to severe problems for them in school and in later life (see, for example, Reid, 1998). In this regard, treating children with dyslexia within the framework of mainstream schooling appears necessary. Consequently, the use of classroom-based behaviour checklists like the HKSLDBC could assume a major role in the screening for dyslexia by teachers in Hong Kong.

This study provided data to demonstrate the viability of describing children with dyslexia using the 12 areas of reading-related behavioural characteristics in the HKSLDBC. The results of both the confirmatory factor analysis and the internal consistency analysis on teachers' ratings lent support to the construct validity of the 12 areas of reading-related behavioural characteristics. In general, children with dyslexia had significantly elevated scores on at least 10 of the 12 areas, in writing, reading, dictation, concentration, language, memory, mathematics, sequential ability, spatial orientation, and general performance, as compared with children without dyslexia. Thus, these findings provided support for the use of these 10 areas of reading-related behavioural characteristics in differentiating children with dyslexia from those without dyslexia, and for the use of the HKSLDBC as a brief first-stage screening measure for dyslexia that teachers could employ in their classrooms.

Specifically, based on the 10 relevant scores of the HKSLDBC, a summary score could be computed for each child. Comparing this summary score to a suggested cut-off score would provide information for teachers making the decision to refer children for more comprehensive assessment by educational psychologists who are already over-committed in practice in Hong Kong.

In summary, the present findings provide some initial evidence to substantiate the use of the HKSLDBC by teachers as a first-stage instrument to screen for children with probable cases of dyslexia, who can be referred for further assessment. In addition, based on the findings, suggestions have been made as to how such information may be organised in terms of a suggested cut-off score for teachers to effect a simple decision for second-stage assessment on literacy and cognitive deficits using the HKT-SpLD by educational psychologists. However, a cautionary note is also in order. The present suggested cut-off score was based on the assumption that one would like to achieve a high sensitivity, that is, missing very few true positives or probable cases, at the expense of allowing more false positives to be further assessed. If cost-effectiveness becomes an issue, especially when screening a large population of children, one could minimise the number of false positives while maintaining reasonably high sensitivity using a higher cut-off score.

The need for replication of this study with a larger population of students should be

emphasised, in order to research whether the suggested cut-off is an optimal cut-off for different populations of students.

Acknowledgements

This study was supported in part by the Quality Education Fund (#1998/2298) and a Research Initiation Grant from the University of Hong Kong. We thank Dr. Agnes Au for her contribution to the study.

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