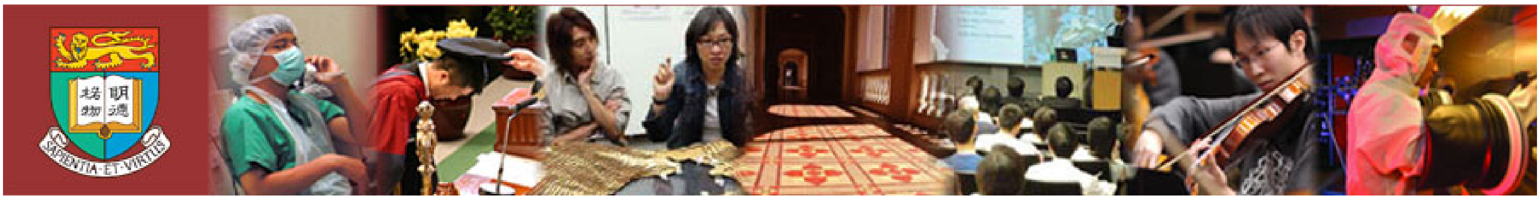

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Characterizing the Overlap between SLI and Dyslexia in Chinese: The Role of Phonology and Beyond

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Abstract

This study examined the overlap of dyslexia and specific language impairment (SLI) in Cantonese-Chinese speaking children. Thirty children with a prior diagnosis of SLI and nine normal controls, aged between 6;0 and 11;3, participated. The children with SLI were tested for language impairment and dyslexia. Seven retained a diagnosis of SLI but were dyslexia-free (SLI-only), 13 received a co-morbid diagnosis of dyslexia (SLI-D), and SLI had become history (SLI-H) in the other 10 children with no co-morbid diagnoses of dyslexia. The SLI-only group did worse on textual comprehension, but better on left-right reversal (an orthographic skill), than the SLI-D group. The SLI-only and the SLI-D group shared the same range of cognitive deficits relative to age norms, and showed no difference in phonological processing. The SLI-D group did worse than the Normal group on phonological representation, and both the SLI-only and the SLI-D group had difficulties with morphological awareness.

Specific Language Impairment (SLI) and dyslexia are two common developmental disorders. They are typically diagnosed and treated by different professionals (speech therapists and school psychologists, respectively), and children with SLI are not routinely tested for dyslexia, and vice versa. These disorders are traditionally considered as belonging to two separate clinical populations that frequently share a set of characteristic cognitive difficulties, but to date, relatively little is known about their possible overlap (see Bishop & Snowling, 2004). Moreover, what is known has largely been limited to English-speaking populations; an important oversight given that oral language and reading tend to draw on language- and orthography-specific cognitive functions. This study set out to examine the nature of the overlap of dyslexia and SLI among (as yet unstudied) Cantonese Chinese-speaking children.

SLI, dyslexia and co-morbidity

SLI is a developmental disorder of oral language. Children with SLI speak and/or understand language below age-expected levels despite the absence of clinically-significant cognitive, peripheral hearing, psychosocial or neurological impairments. SLI affects about 7% of 5-year-old children in the United States (Tomblin et al., 1997). For many children, kindergarten diagnosis of SLI persists into the school years (See Tomblin et al. 2003 for review). While Chinese prevalence data are not yet available, Cantonese Chinese-speaking children with SLI have been identified using international diagnostic criteria (Leonard, 1998). Importantly, a standardized test, the Hong Kong Cantonese Oral Language Assessment Scale (HKCOLAS, T'sou et al., 2006), has recently been developed for diagnosing language impairment in school-aged children, making research questions about SLI in Cantonese-Chinese more empirically tractable.

Developmental dyslexia is a ‘specific’ reading disability that affects about 5 to 17.5% of school-age children (Interagency Committee on Learning Disabilities, 1987; Shaywitz, 1998). Children with dyslexia show persistent difficulties in word reading and spelling in alphabetic languages (Lyon, Shaywitz, & Shaywitz, 2003), despite the absence of clinically significant visual, general cognitive or experiential deficits (See Shaywitz, Gruen, Mody, & Shaywitz, 2009, for a review). A prevalence rate between 9.7% and 12.6% was reported for dyslexia among Cantonese-Chinese speaking children in Hong Kong (Chan, Ho, Tsang, Lee, & Chung, 2007).

Oral language, including vocabulary, grammar, and narrative knowledge, is fundamental to word recognition (NICHD, 2005). Reading typically involves mapping printed symbols with pre-existing and meaningful units of spoken language. Difficulties with oral language and reading should therefore perhaps not be conceived of as separate and ‘specific’ disorders. Co-morbidity estimates of SLI and dyslexia in English-speaking samples vary considerably. In their review, McArthur, Hogben, Edwards, Heath and Mengler (2000) reported concurrent co-morbidity rates between 25% and 75%. In a longitudinal study, Catts et al. (2005) reported that 15% of children with SLI in kindergarten also met the criteria for dyslexia in Grades 2, 4 and 8, while 29% diagnosed with dyslexia in these grades had met the criteria for SLI in kindergarten. Much less is known about such co-morbidity in languages other than English.

Underlying deficits of SLI and Dyslexia in Cantonese-Chinese

Children with SLI have deficits not only in linguistic knowledge, but also speech perception, processing speed, working memory, attention and executive functions (See Schwartz, 2009 for a review). These observed cognitive deficits gave rise to several competing explanatory accounts of SLI. The linguistic deficits of Cantonese-Chinese speaking children with SLI have been documented and evaluated (Fletcher, Leonard, Stokes, & Wong, 2005; Klee, Stokes, Wong, Fletcher & Gavin, 2004; Leonard, Deevy, & Wong, Stokes, & Fletcher, 2003; Wong, Leonard, Fletcher, & Stokes, 2004). The pattern of cognitive deficits for children with SLI seems to vary across languages to some extent. For example, unlike their English-speaking counterparts, Cantonese-Chinese speaking preschool children with SLI perform as well as their age peers on non-word repetition, a task for measuring phonological working memory (Stokes, Wong, Fletcher, & Leonard, 2006). They have more difficulties in the identification and discrimination of lexical tones than their age peers, suggesting a deficit in fundamental frequency processing (Wong, Ciocca and Yung, in press).

Research on dyslexia in alphabetic languages has converged to suggest deficient phonological processing—encompassing phonological awareness, phonological memory and phonological retrieval—as a defining characteristic of the disorder (e.g., Snowling, 2000; Wagner & Torgesen, 1987). Despite questions on its causal link with reading (Castles & Coltheart, 2004), phonological awareness is by far the more commonly reported deficit for dyslexia in alphabetic languages. Phonological awareness enables the child to map phonemes on to graphemes, breaking the alphabetic code and establishing a working basis for automatic word identification; a deficit in this awareness prevents the child from accurate application of the alphabetic code, leading to subsequent word identification problems. In years past, there was every reason to suspect that this would not be the case for dyslexia in readers of Chinese orthographies, for which grapheme-to-phoneme conversion does not occur.

Chinese script is non-alphabetic, and is not dialect-specific. All Chinese dialects share the same script, although Mandarin-Chinese speakers in Mainland China use simplified characters and Cantonese-Chinese speakers in Hong Kong use the traditional form. Most Chinese characters are ideophonetic compounds made up of a semantic and a phonetic component (Kang, 1993). Phonological information is represented in the phonetic component of Chinese characters (e.g., the pronunciation of the character [ma5] _ 'yard' can be derived from its component [ma5 _ 'horse'). The importance of phonological awareness for acquiring these 'orthography-phonology correspondence rules' is well documented, and it has been identified as a characteristic deficit of Chinese dyslexia (Chung et al., 2008; Ho, Chan, Chung, Lee, & Tsang, 2007; Ho, Chan, Lee, Tsang, Luan, 2004; Ho, Chan, Tsang, & Lee, 2002; Ho, Law & Ng, 2000; Huang & Hanley, 1994; Huang & Zhang, 1997). Given that the phonetic component directly informs the pronunciation of characters only about 40% of the time (Zhou, 1978, cited in Huang & Hanley, 1995), and that this figure drops to around 23% to 26% if the radical and the character share the same tone as well (Shu, Chen, Andersen, Wu, & Xuan, 2003), other core skills are probably required for reading Chinese.

Indeed, in profiling Cantonese-Chinese dyslexia, Ho, Chang, Tsang, and Lee (2002) reported difficulties in phonological memory, and in orthographic and visual processing. Given that Chinese characters are visually complex and the orthographic rules are complicated, the ability to identify visual-spatial relationships and associate them with units of language, to remember visual details, and to identify orthographic orientation of characters should be important for accurate word reading. Ho et al. (2002) also concluded that rapid automatized naming (RAN) is the most dominant cognitive deficit in dyslexia in Cantonese-Chinese speaking children. RAN is thought to index the ability to retrieve accurately and efficiently phonological information from the lexical store (Denckla & Rudel, 1976). Ho et al. (2002) also observed that deficits in phonological awareness were relatively less common in Cantonese-Chinese compared to English (a finding replicated by Ho, Chan, Lee, Tsang, & Luan, 2004). In other words, phonological processing problems are also typical of Cantonese-Chinese dyslexia, as is the case in alphabetic languages, but the predominant *type* of phonological processing problem is quite different.

What could be the root cause of phonological processing problems? They could be a result of indistinct, poorly specified, or inadequately segmented, phonological representations of words in the mental lexicon (Elbro, 1998; Goswami, 2000; Metsala, 1997; Snowling, 2000). Such sub-par phonological representations may lead to inaccurate or inefficient storage and/or retrieval of phonological information, which in turn may prevent accurate and fluent conversion of orthography to phonology during reading (Snowling, 2000). Results in English-speaking dyslexia samples have offered some support (e.g., Bruno et al., 2007; Elbro, Børstrom, & Petersen, 1998; Elbro & Jensen, 2005; Swan & Goswami, 1997a, b) but also some challenges to this hypothesis (e.g., Griffiths & Snowling, 2002; Metsala, 1997). This same hypothesis has also been considered a possible explanation for SLI, although, again, empirical evidence has been mixed (Claessen, Heath, Fletcher, Hogben & Laitao, 2008; Dollaghan, 1998; Maillart, Schelstraete, & Hupet, 2004; Mainela-Arnold, Evans, & Coady, 2008; Marshall & van der Lely, 2008; Montgomery, 1999).

Morphological awareness, or the sensitivity to the morphological structure of words (Carlisle, 1995), has emerged as another reading-related cognitive deficit at least as important as phonological awareness for English-speaking children with dyslexia (Siegel, 2008). Unlike English words that are often multi-syllabic, Chinese characters are monosyllabic (e.g., _ [ma5] for horse). A majority of Chinese words are, however, multi-syllabic compounds (e.g., __ [ban1 ma5] in Cantonese-Chinese refers to striped horse, zebra) (Taylor & Taylor, 1995). Importantly, the awareness of morphological structure of word compounds predicts Chinese character recognition (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003) and vocabulary knowledge (McBride-Chang, Tardif, et al., 2008) in normal Chinese children. Morphological awareness has also been found to be the skill best distinguished Chinese children with dyslexia from their normal reading peers (Shu, McBride-Chang, Wu and Liu, 2006) and identified Cantonese-Chinese speaking children at risk for dyslexia (McBride-Chang, Lam, et al, 2008). Will morphological awareness turn out to be an area of difficulty for Chinese children with SLI as well? This question deserves investigation given the report of a bidirectional relationship between vocabulary knowledge and morphological awareness in normal Chinese children (McBride-Chang, Tardif, et al., 2008). It is likely that children with poor vocabulary knowledge, including those with SLI, will have problems in morphological awareness.

The nature of the co-morbidity of SLI and Dyslexia

There are three working hypotheses about the basis of the co-morbidity of SLI and dyslexia (Catts et al., 2005). First, the ‘Severity’ hypothesis posits that SLI and dyslexia share a common phonological processing deficit, with the former being more severely affected (Kamhi & Catts, 1986; Tallal, Allard, Miller, & Curtiss, 1997;

Snowling, Bishop, & Stothard, 2000). Second, the ‘Dyslexia-plus’ hypothesis posits that SLI and dyslexia are the manifestation of a similar level of phonological processing deficit, but children with SLI suffer from additional cognitive deficit(s) that results in difficulties in learning oral language (Snowling & Bishop, 2004). Third, the ‘Distinct’ hypothesis suggests that dyslexia and SLI are distinct disorders with entirely different underlying cognitive deficits (Catts et al., 2005).

To evaluate these three hypotheses, Catts et al., (2005) examined the prevalence of dyslexia among school-aged children who had an SLI diagnosis in kindergarten. They also compared the phonological awareness and phonological memory of four groups of children: children with SLI only, children with dyslexia, children with SLI and dyslexia, and normal children. Catts et al. found relatively low prevalence of dyslexia in children with SLI (between 15% to 29%) and that children with SLI showed only a mild deficit in phonological processing (a core deficit of dyslexia), and so concluded that SLI and dyslexia are two distinct disorders.

We are intrigued by the elevated prevalence of dyslexia in children with SLI—the 25 to 75% concurrent co-morbidity rate summarized in McArthur et al. (2000) is about four to five times the population prevalence of dyslexia. Because the nature of the spoken language and/or orthography could affect the relationship between SLI and dyslexia, we set out to examine the nature of the overlap in children learning to speak Cantonese-Chinese and read Chinese. As a first step, we reported whether dyslexia could be identified in a group of Cantonese-Chinese speaking school-aged children with SLI. Second, we compared children with a singular diagnosis of SLI (SLI-only group) with those diagnosed as having both SLI and dyslexia (SLI-D group) on a range of language or literacy-related cognitive skills thought to impact these disorders (e.g., phonological processing, orthographic skills and morphological awareness). Third, to explore whether poor phonological representation could be a candidate cause of SLI-dyslexia co-morbidity, we also assessed phonological representations. SLI in kindergarten persists in the early school years in some but not all cases. Little is known how persistence of SLI may predict dyslexia in elementary school. Our fourth objective was to compare children with only a history of SLI (SLI-H) and those with persistent SLI. More specifically, our research questions were as follows:

1. How well do the SLI-only, the SLI-D, and the SLI-H groups perform on oral language, literacy, and related cognitive skills with reference to age norms?
2. Do the SLI-only, the SLI-D, the SLI-H and the Normal control groups differ from one another on phonological processing, phonological representation, orthographic skills, and morphological awareness?

Method

Participants

Thirty-nine children between 6;0 (year;month) and 11;3 with mean age of 8;8 (SD = 1;2) participated in this study. Among them, 30 children with a prior diagnosis of SLI were (re)-tested for language impairment, if it had not been done within the last eight months before this study, and for dyslexia, if it had not been, or only been partially, done within the year. A diagnosis of SLI requires the child to score more than 1.25 SD below the mean for age on at least two of the six subtests on the HKCOLAS, which has good diagnostic accuracy, with sensitivity equaled to 94.6% (53/56) and specificity 98.2% (55/56; T’sou et al., 2006).

In Hong Kong, a diagnosis of dyslexia requires the child to score 1 SD or more below the mean (i.e., a scaled score at or below 7 out of a mean of 10) on the literacy composite and on at least one of the four cognitive composite scores on the Hong Kong Test of Specific Learning Difficulties in Reading and Writing for Primary School Students-Second Edition (HKT-P [II]; Ho et al., 2007; Chan, Ho, Tsang, Lee, & Chung, 2007). These scores measure rapid digit naming, phonological awareness, working memory and orthographic skills. The inclusion of a cognitive component protects us from inappropriate diagnosis of poor word reading in children merely due to poor learning motivation or limited exposure to print or reading instructions. These 30 children also received tests of general intelligence to confirm their SLI and/or dyslexia diagnosis. The 13 children recruited from the child assessment centre had been given the Hong Kong Wechsler Intelligence Scale for Children (HK-WISC, 1981), and according to clinical records, they all scored within the normal limits for age on the full scale. The remaining 17 children were given the Raven's Standard Progressive Matrices (Hong Kong Education Department, 1986), and 15 of these 17 children scored no lower than 1 SD below mean. The other two scored only 2 or 3 points below 1 SD (85 points) and were included in the study nevertheless. All 30 children passed a hearing screening of pure tones of 0.5, 1, 2, 4 kHz presented at 30 dB HL, and they showed no signs of psychosocial problems.

Results of this battery of testing confirmed that among the 30 children with SLI, seven continued to show SLI in the absence of dyslexia (SLI-only group), 13 children showed not only persistent SLI but also dyslexia (SLI-D group), and ten no longer met the criterion for SLI and were also dyslexia-free (i.e., the History of SLI, or the SLI-H group). According to clinical records available, four children in the SLI-D group and three children in the SLI-only group were noted as having either poor attention, showing features of attention deficits, or having a diagnosis of attention deficit disorders.

There were nine other children in this study and they constituted the Normal group. They received a scaled score above seven in the Chinese word reading and one-minute word reading subtests in the HKT-P [II] no more than a year prior to this study, suggesting normal literacy skills. They also received a score that was no lower than –1.25 SD on the narrative re-tell subtest of the HKCOLAS, and a score that was no lower than –1 SD on the Ravens. They all passed the pure tone hearing screening as mentioned earlier. None of these children presented oral language or academic concerns to their teachers.

Procedures

Except for the nine children in the Normal group who only received the story-retell subtest as a screening of their oral language status, the other 30 children in the study completed the entire HKCOLAS. All 39 children completed the entire HKT-P [II], except one child in the SLI-only group and one child in the Normal group who were over-age for some of the subtests at the time of the study. In addition to the battery of standardized oral language (HKCOLAS) and literacy (HKT-P [II]) tests, the children also completed a set of experimental tasks for assessing phonological representation and a task of morphological awareness. Below we include a brief description of these assessments.

Oral language assessment

The children's oral language status and skills were examined using the HKCOLAS (T'sou et al., 2006). The six subtests examined the children's comprehension and production of vocabulary, syntax, as well as narrative discourse. In the Cantonese grammar subtest, the child identifies a picture that matches the sentence heard, answers questions that target specific grammatical morphemes, produces and makes judgments about complex sentences. In the textual comprehension subtest, the child listens to two short stories and answers questions about them. In the word definition subtest, the child defines several common object nouns. In the lexical semantic relations subtest, the child produces synonyms, antonyms, hyponyms, superordinate and literary terms, and constructs new four-character words by analogy and explains them**.** In the narrative-retell subtest, the child listens to a story and tells it back to a naïve listener. The child is scored on story content, their use of referring expressions, connectives and complex sentences. In the expressive vocabulary subtest, the child uses nouns or noun compounds to name pictures.

Assessment of word reading, phonological processing and orthographic skills

Word reading and reading-related cognitive skills were examined using the HKT-P [II] (Ho et al., 2007). The five domains examined the children's literacy, phonological processing and orthographic skills. There are three subtests in the literacy domain: (1) in the Chinese word reading subtest, the child reads 150 Chinese two-character words graded in levels of difficulty; (2) in the one-minute word reading subtest, the child reads aloud as quickly and as accurately as possible from the list of 90 simple Chinese two-character word in one minute; (3) in the Chinese word dictation subtest, the child writes as best s/he can the 48 two-character words presented orally.

Phonological processing is examined in three domains: (1) rapid digit naming, (2) phonological awareness, and (3) phonological memory. In the rapid digit naming domain, the child names five digits randomly arranged in eight rows as fast and as accurately as possible twice. In the phonological awareness domain, the child indicates which two of the three syllables sound similar. There are two subtests: (1) in the rhyme detection subtest, the child has to pick out the two that share the same vowels or diphthongs; (2) in the onset detection subtest, the child identifies the two that share the same initial phoneme. In the phonological memory domain, the child repeats orally three to six or seven syllables, in the order presented. There are three subtests: (1) word repetition I, (2) non-word repetition and (3) word repetition II. All syllables in the non-word repetition subtest are designed to meet the phonotactic rules of Cantonese, but none of them refers to any morphemes of the language. The non-words that are formed from these syllables are sometimes known as pseudo-syllable combinations. An example is *bei5 tan5 daai5*[1]. Each syllable in the two "word" repetition subtests refers to a Cantonese morpheme, but the syllables do not combine to form a meaningful word. Instead, they combine to form non-words that are sometimes known as pseudo-morpheme combinations. An example is *baa1 mong1 hung1*. The Word repetition I and the non-word repetition subtest test the child's phonological short-term memory, where the syllables are presented at a rate of two syllables per second. In word repetition II, the syllables are presented at a rate of one syllable per second. This slower presentation rate can allow the child to rehearse the pseudo-morpheme combinations and hence test the child's phonological working

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[1] Cantonese morphemes are presented in romanized forms following the scheme adopted by the Linguistic Society of Hong Kong, 1994. Numerals following the syllables represent one of the six lexical tones in the language.

memory. As in many serial recall tasks, the child's responses are scored for the ordering of the syllables, as well as for the accuracy in their repetition and the presence of any syllables that are added to the target.

The orthographic domain contains three subtests: (1) left-right reversal, (2) lexical decision, and (3) radical position. On left-right reversal, the child identifies characters and numbers that are incorrectly organized in terms of their left right orientation. On lexical decision, the child identifies the non-characters, characters whose radicals are misplaced, among the rare characters. On radical position, the child indicates among the four options, the proper position of some Chinese radicals.

Phonological representation assessment

Two experimental tasks, speech gating and lexical judgment, were designed to examine the children's phonological representations, and they were administered using custom-written Matlab (version R2006A) programs on a laptop computer. Auditory stimuli were presented to participants via headphones (fitted with a microphone attachment) at a comfortable sound level.

The speech-gating task was modeled on Grosjean (1980) and adapted for Cantonese. The rationale for this task is that a well specified or well segmented phonological representation ought to allow the language user access to all phonological components (e.g., Goswami, 2000; Walley & Mesala, 1998). The task presents spoken words in successive increments ('gates'), and assesses the proportion of a spoken word (i.e., the number of 'gates' or increment length) that the child needs to hear in order to identify the word correctly. A total of sixteen known Cantonese monosyllabic concrete nouns were used as stimuli, half high frequency, and half low frequency (over 200 times and under 10 times per 180,000 respectively). The 16 words were also categorized as either belonging to dense or sparse word neighbourhoods, estimated according to the number of words overlapping with the target word by substituting the onset, nucleus, final phoneme, or lexical tone. The words ranged in length from 400msec to 900msec. There was no significant difference in length between high and low frequency words (t [14] = 0.28, $p > 0.05$), nor between dense and sparse neighborhood density words (t [14] = 0.25, $p > 0.05$).

A forward gating, duration-blocked procedure was used for the speech-gating task (Grosjean, 1980; Griffiths & Snowling, 2001 for details). Over successive blocks, the child listened to accumulating increments of each word, and tried to identify the word after each presentation. To make the task more child-friendly, the child was asked to say aloud the word said ‘by an alien who was trying to learn our language’. The initial gate duration was set to 250 msec with successive gate durations set to 50 msec. The index of the degree of segmentation of the phonological representation (i.e., the amount of the word the child requires to hear to facilitate correct identification) for this task is known as the ‘isolation point’ (e.g., Metsala, 1997). It is possible to estimate this in two ways. The 'first isolation point' is the gate, or increment of speech, at which the first correct guess is made, and does not take into account any change in response from subsequent exposures to the word. The 'last isolation point' is the first correct guess at the word where all subsequent guesses are correct. In our analyses, both will be estimated. Because words differ in length, in each case the isolation point will be reported as the proportion of the whole word length required for correct identification.

The second task was lexical judgment. Modeled on Cleassen, Laitao, Heath, Fletcher, & Hogben (2008) and adapted for Cantonese, this task randomly presents a series of correct and incorrect pronunciations of twelve words (monosyllabic nouns) commonly known to preschool children. It assesses the quality of phonological representations by assessing the ability to correctly accept accurate productions, and correctly reject mispronunciations of the objects in the accompanying picture, as well as the time taken to do so. For each of 12 real words, we created five mispronunciations by substituting an alternative onset, nucleus, final consonant or lexical tone, such that the mispronunciation of the target word corresponded to the correct pronunciation of an alternative legal word, or by substituting the tone for one which converts the spoken word into one which was not a legal word. For example, where the picture is of a leaf, on a single trial the child might have heard either 'jip6', which would be the correct pronunciation, or 'jit6', meaning 'hot'.

The task comprised a total of 120 trials: each of the 12 stimuli had five corresponding mispronunciations and five presentations of the correct pronunciation. The stimuli were randomized across the 120 trials both within and between subjects. Each trial began with the presentation of the picture corresponding to a target word. After a 500 msec delay, the child heard the target word (either correctly or incorrectly pronounced) embedded in a sentence in Cantonese, which is equivalent to "Is this a ___" or "Is this____". Once the child had responded with a button-press and was ready, the experimenter initiated the next trial. Responses were recorded on the computer along with reaction time, measured from the offset of the stimulus. Children were instructed to respond as accurately as possible and were not told that reaction time was to be measured. The number of correct identifications of correct pronunciations (hits) and correct identifications of mispronunciations (correct rejections), as well as response latency and *d*', will be the variables of interest.

Morphological awareness assessment

To measure morphological awareness, we used the morphological construction task that was reported in Chung et al. (2008). The child was asked to construct a novel word compound that mirrors an existing one in structure. A word compound that is familiar to children at that age was presented in a scenario that illustrates its meaning, and then another scenario analogous to the first one was described to the child, who was then invited to make up a new compound. An example will be "Here is a traffic light. It has red and green, and we call it red-green-light (hung4luk6dang1___). Now this traffic light has blue and green, and what do we call it?", and the answer is blue-green-light (laam4luk6dang1___). The child received one point for a correct answer and the maximum was 27 points. This task was developed for children from K3 to P4 with five items for each grade except for K3, which has seven items. Each child started the task at his/her grade level, and basal performance was established if the child missed no more than one item at this level (or a lower level if needed), and all items in the previous level(s) were considered correct. The discontinuation rule was reached when the child failed four or more items within a level.

Results

Here we will present findings on the groups' oral language, literacy, and cognitive skills. First we describe the groups' performance with reference to the HKCOLAS or HKT-P [II] age norms. We use the term 'below average' for scores between the mean and 1 SD below the mean (scaled score of 10 and 7), 'very weak' for scores between 1 and 2

SD below the mean (4 and 7), and ‘extremely weak’ for scores more than 2 SD below the mean (< 4). We compare the groups’ performance using ANOVA, MANOVA or ANCOVA procedures, and the *p*-level for these analyses is set at .05. Before we use these procedures, we first run the univariate Levene’s test or the multivariate Box’s test on the variables. For the purpose of brevity, we generally point out only those instances where the homogeneity of variances is violated. Post-hoc analyses are conducted using the Tukey test for unequal sample sizes, and Bonferroni corrections on the *p*-level are made to control for the occurrence of Type I errors. Recall that one child in the Normal group and one in the SLI-D group were above the upper age limits for completion of all subtests in HKT-P [II], the total number of children involved in the related analyses was reduced to 37.

Oral language

No one was at, or close to, ceiling (scaled score of 17 or above out of 19) on any of the HKCOLAS subtests. The scaled scores on each subtest for the four groups of children are presented in Table 1. The age row reports the mean age of each group of children at the time of their participation in the experimental tasks. The Normal group had the highest mean age (9;5) and the SLI-H group the lowest (8;1), but group differences were not statistically significant F (3.35) = 1.56, *p* = .22. The Levene’s test was not significant (*p* = .24) despite the fact that the SLI-only group had a lower within-group variability in age than the other groups.

Insert Table 1 about here

To be included in the Normal group, all the children had to score at least 8 on the narrative retell subtest, and therefore they had the highest group mean and the lowest within-group variability. The SLI-only group was very weak and the SLI-D group was extremely weak on narrative retell. A one-way ANOVA revealed significant group effects, F (3, 35) = 26.70, $p < .01$. Post-hoc tests revealed that, with the exception of SLI-only and SLI-D, the groups differed significantly from each other. Although the SLI-only group scored higher than the SLI-D group, the difference was not statistically significant ($p = .42$).

The SLI-only, SLI-H and SLI-D groups completed all six subtests in the HKCOLAS. The SLI-only group was below average on word definition, very weak in four of the six subtests, including Cantonese grammar, lexical semantics, narrative retell and expressive vocabulary, and extremely weak on textual comprehension. The SLI-H group, although no longer meeting the criteria for language impairment, did well only on word definition but remained below average in the other five subtests. The SLI-D group was below average on textual comprehension and word definition, very weak on Cantonese grammar and expressive vocabulary, and extremely weak on lexical semantics and story retell. The groups' performance was compared using MANOVA, and results indicated that there were significant group differences in the six subtests (Wilk's Lambda (12, 44) = .12, $p < .01$). We should note however that the result of the Box's test was significant ($p < .005$), indicating the possibility that the multivariate assumption of normality was not met. Subsequent analysis with the Levene's test suggested that this was due to the Cantonese grammar subtest ($p = .05$)

Univariate analyses revealed that group differences were found in all ($p < .05$) but the expressive vocabulary subtests ($p = .07$), and these differences were further tested with p-value set at .01. The SLI-H group seemed to do the best among the three groups. It scored higher than the SLI-only group on textual comprehension, lexical semantics and perhaps word definition also ($p = .013$), and outperformed the SLI-D group on lexical semantics, narrative retell and word definition. There were no significant differences between the SLI-only and the SLI-D group, except on textual comprehension. In this subtest, the SLI-only group received a mean scaled score of 2.07 (SD = 1.84). Six children's scaled score fell between .5 and 2, and the remaining child's score was 6. The SLI-only group scored significantly lower than the SLI-D group (mean = 7.08, SD = 2.99) and this difference was confirmed in a Chi-square test (Chi-sq = 8.81, $p < .05$), where there was a relatively higher number of children in the SLI-only group (100%, 7/7) who failed the textual comprehension subtest than the SLI-D group (61.5%, 8/13). No such differences were reported for Chi-square analyses of other subtests. A one-way ANOVA was conducted to see if the SLI-only and the SLI-D group differed in the number of subtests the children failed on the HKCOLAS. The SLI-only group failed on average 4.14 subtests (SD = 1.35), and the SLI-D failed 3.85 subtests (1.46) and the difference was clearly not significant (F (1,18) = .02, $p = .66$). This finding suggested that that the SLI-only and the SLI-D group did not differ in the severity of oral language impairment.

Literacy, phonological processing and orthographic skills

On the HKT-P [II], except for the one child in the Normal group who received a scale score of 17 on rapid naming, no one scored 17 or above in any other domains. The scaled literacy and cognitive composite scores for all groups are presented in Table 2. Recall a diagnosis of dyslexia requires the child to score 7 or less on the literacy composite, and on at least one of the four cognitive composites. Although they did not meet the criteria for dyslexia, the SLI-only group was below average on literacy. This finding could have been due to the presence of a child who received an extremely low score on literacy (i.e., 3.33) and a score above 7 in all cognitive domains. This child could not be diagnosed as dyslexic accordingly to the criteria we adopted (Chan et al., 2007). If this child's score were taken out, the mean for the group of six increased to nine (SD = 1.55), still indicating below-average literacy skills. The SLI-only group was also below average on rapid digit naming, phonological awareness, and very weak on phonological memory. By contrast, the Normal group did well, scoring above the mean in all domains. The SLI-H group did well in almost all domains, but was below average on phonological memory. The SLI-D group was extremely weak on literacy, and in the cognitive domains the group was very weak on rapid digit naming, below average on phonological awareness, phonological memory and orthographic skills.

Insert Table 2 about here

Results from MANOVA suggested that the groups' performance differed significantly in the HKT-P [II] domains (Wilk's Lambda (15, 80) = .15; $p < .001$). Univariate tests indicated that the groups differed significantly on literacy (F (3, 33) = 22.17, $p < .05$), rapid digit naming (F (3, 33) = 3.87, $p < .05$), phonological awareness (F (3, 33) = 6.49; $p < .05$), orthographic skills (F (3, 33) = 2.37; $p < .05$) and perhaps marginally on phonological memory (F (3, 33) = 4.05, p = .06). Results from post-hoc analyses indicated that on literacy, as expected, the SLI-D group, performed significantly worse than the other three groups ($p < .01$). To examine whether the groups showed differences in the three subtests, MANOVA was run. Results were affirmative (Wilk's Lambda (9, 80) = .16, $p < .01$), and the groups differed on all three of them ($p < .05$). Post-hoc analyses were conducted at $p = .02$. The SLI-D group performed worse than the other three groups on word reading, but only worse than the Normal and the SLI-H group on one-minute word reading. On word dictation, the SLI-D group also performed worse than the Normal and the SLI-H group, and the SLI-H group scored significantly better than the SLI-only group. Post-hoc analyses of the other the HKT-P [II] composites again revealed specific group differences with p-level set at .01. On rapid digit naming, the SLI-D group scored lower than the SLI-H group and this difference was approaching significance ($p = .018$). On phonological awareness, the SLI-D group performed worse than the SLI-H group ($p < .01$). Further testing revealed that this group difference was specific to rhyme detection ($p < .03$). On the orthographic skills composite scores, none of the group differences turned out to be statistically significant ($p > .01$). To investigate whether there were significant differences between the groups in the three subtests for the orthographic composite, MANOVA was run. Results were positive (Wilk's Lambda (9,75) = .45, $p < .01$), and univariate analyses suggested that the groups differed on the left-right reversal measure. Post-hoc analyses conducted at $p = .02$ confirmed that the SLI-D group performed significantly worse than the Normal, the H-SLI, as well as the SLI-only group.

Phonological representation

Table 3 shows the groups' performance on the experimental tasks assessing the quality and distinctness of phonological representations. On speech gating, separate analyses were conducted for words that differed along the frequency and neighborhood density dimensions. For each word, the children's performance was measured in two points, first isolation and last isolation. The dependent variable was the proportion of the whole word length required for correct identification.

Insert Table 3 about here

Pearson correlation coefficients between 0 and -.16 indicated no significant relationship between age and each of the variables. A three-way ANOVA with group (4) X isolation point (2) X frequency (2) was conducted. There was no significant main effect of group (F (3, 35) = .62, *p* = .61), no interaction effect of group and isolation point (F (3, 35) = .44, *p* = .72), and no interaction effect of group, isolation point and frequency (F (3, 35) = .78, *p* = .51). However, there was a significant effect in isolation point (F (1, 35) = 70.15, $p < .01$) and frequency (F (1, 35) = 135.26, $p < .01$). As expected, given a more stringent criterion for success, a higher proportion of the word length was required for identification at the last than the first isolation point. The children also required a larger proportion of the low than high frequency word length to succeed. The isolation point and frequency interaction effect was statistically significant (F (1, 35) = 7.65, $p < .05$). At both isolation points, the children needed a higher proportion of low than high frequency words. As expected, the children also required a higher proportion of both high and low frequency words at the last than the first isolation point. These findings, although not directly relevant to our hypotheses, nonetheless suggest that this speech-gating task is tapping into the children's lexical access for Cantonese-Chinese words.

The most interesting findings came from the statistically significant group and frequency interaction effect (F (3, 35) = 6.02, $p < .01$). For high frequency words, the SLI-D group required a significantly larger proportion of word length than the Normal group for accurate identification. Such a difference was likely not due to effects of potential confounds such as vocabulary size and language exposure, since significant group differences were found only for high-frequency but not low-frequency words.

To examine the effect of word density, a three-way ANOVA group (4) X isolation point (2) X density (2) was conducted. The main effect of group (F (3, 35) = .62, $p = .61$) and density (F (1, 35) = 1.11, $p = .30$) were not statistically significant. The interaction effect of group and isolation (F (3, 35) = .44, $p = .72$), isolation and density (F (1, 35) = 2.33, $p = .14$), and group isolation and density (F (3, 35) = .91, $p = .44$) were also not significant. As expected, there was a significant effect of isolation point (F (1, 35) = 70.15), where the children needed a higher proportion of word length at the last than first isolation point. The interesting finding came from the group and density interaction (F (3, 35) = 3.22, $p = .03$). For dense words, the SLI-D group required a significantly larger proportion of word length than both the Normal and the SLI-H group ($p < .05$) for successful recognition.

Phonological representation was also measured by the lexical judgment task. A signal detection paradigm (see MacMillan & Creelman, 2004) was applied to analysis of responses on this task. Accordingly, there were four dependent variables of interest:

proportion of hits (proportion of matched items correctly identified as correct answers), proportion of correct rejections (proportion of unmatched items that were correctly rejected as incorrect answers), *d*' (the z-score of the hit rate minus the z-score of the false alarm rate), and the latency of correct rejection of mismatched items. All but one child in the SLI-only group received a positive *d*'. The other child received a negative score, suggesting that the child had a higher false alarm than hit rate, and he was given a zero score for the purpose of data analysis.

Among the four variables, only the latency of correct rejection variable was significantly correlated with age (r = -.04, $p < .05$). The correlation of the other three variables with age ranged from -.1 to .01. The four variables were included in three analyses. MANOVA results indicated that the groups did not differ in the two measures of proportion (F (6, 68) = .74, $p = .10$). In fact the groups were almost at ceiling in these measures. On the latency of correct rejection, a one-way ANOVA with age as a covariate also indicated no significant difference between the groups (F (3, 34) = .89, $p = .46$). There were differences, however, between the groups on *d*-prime (F (3, 35) = 4.32, $p < .05$). Both the SLI-D ($p < .05$) and the SLI-H ($p = .05$) group performed worse than the Normal group. Although the SLI group received a lower *d*-prime score than the Normal group as well, the difference did not turn out to be statistically significant ($p > .05$).

Morphological Awareness

Given the variability in the children's age, we first tested and confirmed that the children's performance on this task strongly relates to their age (r = .51, $p < .01$). Age was used as a covariate in the one-way ANOVA, which reported significant group differences (F (3, 34) = 7.18, *p* = .001). Both the SLI-D and the SLI-only groups performed worse than the Normal group (*p* < .05).

Summary

This study addresses two research questions. One relates to the groups' performance with reference to HKCOLAS or HKT-P [II] age norms. Although the SLI-H group did not meet the clinical criteria for SLI or dyslexia, they continued to show sub-clinical deficits in some areas of oral language and problems in phonological memory. In addition to a persistent impairment in oral language, the SLI-only demonstrated sub-clinical deficits in word reading and different degrees of problems with a range of cognitive skills, including rapid digit naming, phonological memory and awareness. The SLI-D group showed problems in the same broad range of cognitive skills as the SLI group, albeit at different levels of severity. Unlike the SLI group, however, the SLI-D group showed an additional deficit in orthographic skills.

The other set of analyses relates to the comparison of the groups' performance with one another. The one area the SLI-only group did worse than the SLI-D group was textual comprehension. The SLI-D group, as expected, had significantly more difficulty in word reading than the SLI-only group. The two groups did not differ significantly in the three phonological processing measures, including RAN, phonological memory and phonological awareness, but the SLI-D group scored significantly worse than the SLI-only group in left-right reversal, one of the measures of orthographic skills. While only the SLI-D group did worse than the Normal group on phonological representation, both the SLI-only and the SLI-D group had difficulties with morphological awareness relative to the Normal group.

Discussion

In this study, we reported on the co-morbidity of dyslexia in a small convenience sample of school-aged Cantonese-Chinese speaking children with SLI in Hong Kong. Dyslexia is defined as performance below a scaled score of 7 or below on the literacy composite, and on at least one of the four cognitive composites, on the HKP-T [II] and performance at or above –1 SD on a test of nonverbal intelligence. We examined the profile of language or literacy-related cognitive deficits in children with SLI-only and children with SLI-D. The lack of a dyslexia-only group does not give us all the evidence we need to evaluate hypotheses on the basis of the relationship between SLI and dyslexia. In this section, however, we will interpret our findings for some early insights on the nature of this relationship in Cantonese-Chinese speaking children.

The SLI-only and the SLI-D group generally showed a similar degree of oral language deficit, and they both demonstrated very weak skills in many areas. The SLI-only group however performed much worse than the SLI-D group on textual comprehension. They provided inappropriate or inadequate responses to the story questions. In the HKCOLAS textual comprehension task, about three quarters of the questions required inference making. To succeed in inference making, the child needs to construct an integrated representation of the story, and infer new information that has not been explicitly and literally given. Children with SLI have been reported to have problems in inferential comprehension (Bishop & Adams, 1992; Ellis-Weismer, 1985), but it is unclear why children with the SLI-only children have more problems than their peers who have an additional diagnosis of dyslexia. Future research using a larger sample size is needed to confirm this finding and to find out why.

Recent evidence has shown that oral language skills contribute to word reading (NICHD, 2005). In typical readers, vocabulary knowledge and listening comprehension of short stories predicted current and future word identification above and beyond phonological and word decoding skills (Nation & Snowling, 2004). In children with dyslexia, expressive vocabulary was also found to be related to word recognition and phonological awareness (Wise, Sevcik, Morris, Lovett, & Wolf, 2007). Given their shared oral language impairment, children in the SLI-only and the SLI-D group also experienced significant difficulties in vocabulary knowledge, as revealed in their performance in word definition, lexical semantics and expressive vocabulary subtests in the HKCOLAS. Although not statistically significant, the SLI-D group performed even worse than the SLI-only group in the latter two of these subtests. While poor vocabulary knowledge could be a consequence of dyslexia, the evidence is scarce and inconsistent (Scarborough, 2005).

Although none of the children in the SLI-only group met the criteria for dyslexia, the group was below average on word reading. In addition to the child who was extremely weak, four children of the entire group of seven scored between the mean and –1 SD on the literacy composite on the HKT-P [II]. This is consistent with previous reports of difficulties in word reading in some school-aged children with SLI (e.g., Bishop & Adams, 1990; Silva, Williams, & McGee, 1987), suggesting overlaps in the cognitive skills required for oral language and word reading.

At the cognitive level, both the SLI and SLI-D group showed a deficit in rapid digit naming, phonological memory and awareness and morphological awareness. These common deficits could be due to the persistent SLI that the two groups shared, or due to dyslexia, since a number of children in the SLI-only group actually had sub-clinical deficits in word reading. Evidence from prior work on SLI and dyslexia, however, seems to support a third possibility. Namely, these deficits characterize both SLI and dyslexia to some extent. Rapid automatic naming was the most dominant type of cognitive deficit and the most predictive of word reading in Chinese children with dyslexia (Ho et al., 2002, 2004). In these tasks, the child has to name randomized highly-familiar items such as digits, colors, pictures as quickly as s/he could, and it measures his/her speed of processing of different automatic tasks involving language, including phonological retrieval and speech production. Slow processing speed for linguistic tasks such as picture naming has also been reported in English-speaking children with SLI (Miller, Kail, Leonard, & Tomblin, 2001; Leonard, Ellis Weismer, Miller, Francis, Tomblin, & Kail, 2007; Windsor & Huang, 1999). These studies suggest that slow processing of phonological information can underlie both SLI and dyslexia.

Percentage of phonemes correct in non-word repetition, a common measure of phonological working memory, consistently discriminates school-aged English-speaking children with and without SLI (e.g., Dollaghan & Campbell, 1998; Conti-Ramsden, 2003). In an earlier study on Cantonese-Chinese speaking preschool children (Stokes et al., 2006), no significant differences in non-word repetition were reported between the children with SLI and their normal age peers. In this study, the word repetition II subtest from HKT-P [II] was used to measure phonological working memory, although the non-word repetition subtest was the one that was more like the task reported in Stokes et al. (2006), as both used syllables that are not morphemes in the language. The two non-word repetition tasks were however different in several other aspects. In Stokes et al. (2006), the multi-syllabic non-words were presented in tonal patterns that are typical of Cantonese-Chinese word compounds (e.g., taau3feu1map6), and the children's responses were scored in terms of percentage phonemes correct. In this study, the non-word repetition task was more akin to serial recall, because the syllables for each non-word carried the same lexical tone and they were presented in a steady rate. The children's responses were scored in terms of the ordering of the syllables as well as the accuracy of their repetition. This study reports a different finding from Stokes et al. (2006). The SLI-only group's scores demonstrated very weak performance in both the word repetition II and the non-word repetition subtests and in the phonological memory domain in general when compared with age norms. When compared with the other three groups, the SLI-only group earned the lowest score on these two subtests and the domain composite, although group differences were not statistically significant. In fact, not only did the SLI-only group have difficulties with phonological memory, the SLI-H group in this study was also below average on all subtests in the phonological memory domain relative to age norms. These findings were consistent with an earlier report of non-word repetition deficits in English-speaking children with persistent and resolved language impairments (Bishop, North, & Donlan, 1996). Recall that children in the SLI-H group had a history of SLI who were now both SLI- and dyslexia-free. Despite the fact that these children no longer met the diagnostic criteria for SLI, they demonstrated below average performance in all but one subtest in the HKCOLAS. Poor phonological memory might be a potential reason for the SLI-H group's sub-clinical deficits as well as the SLI group's persistent impairment in oral language. The discrepancies in findings between this study and Stokes et al. (2006) could be a result of stimuli, scoring, and/or task differences. Future studies examining phonological working memory problems in Cantonese-Chinese speaking children with SLI can directly compare their performance in the repetition and the serial recall of the same matched sequences of syllables with their age peers. Results from a recent study (Archibald & Gathercole, 2007) suggested that these comparisons could lead not only to a better understanding of phonological memory problems, but also potentially provide insights on other processes that might account for language learning difficulties in children with SLI.

Problems in non-word repetition have been reported in several studies on English-speaking children with dyslexia (e.g., Brady, Poggie, & Rapala, 1989). On Cantonese-Chinese-speaking children with dyslexia, results were mixed. Problems in these children were reported in Ho, Law, and Ng's (2000), but in Ho et al.'s (2002) study, there were no statistically significant differences in non-word repetition between children with dyslexia and their normal reading peers. One interpretation of these mixed findings is that phonological working memory problems might affect only some Cantonese-Chinese speaking children with SLI and/or dyslexia. This is plausible since the relatively simple phonotactic and syllabic structure of Chinese might not have put much strain on the children's phonological working memory for any deficit to be noticeable in many children. Regarding phonological awareness, while this was the first study examining Chinese children with SLI, several studies have reported deficits in English-speaking children with SLI (e.g. Briscoe, Bishop, & Norbury, 2001). These same deficits had been reported in English (e.g., Bradley & Bryant, 1983) as well as Chinese children with dyslexia (Ho et al. 2002). It is therefore plausible that problems in phonological awareness can lead to SLI and/or dyslexia.

Preliminary evidence from this study however suggests that there might be different causes of phonological processing difficulties for children with SLI and children with dyslexia. Note that only the SLI-D, but not the SLI-only group, performed significantly worse than the Normal group in the speech gating and the lexical judgment task—both are putative measures of phonological representation. These findings lend support to earlier works which report inadequate phonological representations in English-speaking children with dyslexia (e.g., Bruno et al., 2007; Elbro, Børstrom, & Petersen, 1998; Elbro & Jensen, 2005; Swan & Goswami, 1997a, b), and suggest that Cantonese-Chinese speaking children with dyslexia can be characterized by poorly segmented or poorly-specified phonological representations, which might contribute to their difficulties in phonological awareness and phonological memory. Future research, however, is needed to confirm this suggestion with a group of children with a singular diagnosis of dyslexia, and to rule out the possibility that children with SLI-only's phonological representations are also poorly segmented or under-specified with a larger sample of children. In this study, the SLI-only group did in fact score lower than the Normal group on the lexical judgment task, although the difference was not statistically significant.

Morphological awareness has been shown to be a core construct for distinguishing Chinese children with and without dyslexia (Shu et al., 2006), and the strongest predictor for reading in normal children (McBride-Chang et al., 2003) and in children with dyslexia in Chinese (Shu et al., 2006). It is also a useful tool for identifying children at risk for dyslexia in Chinese (McBride-Chang et al., 2008). Work on English-speaking children with SLI has also reported problems in constructing new compound words (Grela, Sydner, & Hiramatsu, 2005). Morphological construction taps the child's ability to construct new words from individual morphemes that are presented orally. It is plausible that children with better word knowledge are better able to decompose words into their component morphemes and use them to construct new words. This was confirmed in McBride-Chang et al. (2008), which reported a significant correlation between vocabulary definition and morphological construction in Cantonese and Mandarin-speaking children. In fact, in our present study, the Spearman R (.79) indicated a very strong and significant correlation between morphological awareness and lexical semantics in the SLI-only group ($p < .05$). The correlation (.26) was however not significant in the SLI-D group ($p > .05$). Although these results suggest a different strength of relationship between lexical semantics and morphological awareness in children with SLI and in children with SLI-D, replication is needed in light of the small group sizes in this study. There is a trend, although not statistically significant, that the SLI-D group performed worse than the SLI-only group on morphological awareness. Future research should also investigate the possibility that SLI and dyslexia are characterized by different levels of morphological awareness deficits and should compare the relationship among morphological awareness, expressive vocabulary skills and word reading in the two groups of children.

Among all the cognitive skills that were examined, left-right reversal, a measure of orthographic skills, was the one that the SLI-D group did worse than the SLI group, suggesting that this was a deficit unique to children with dyslexia. Although the SLI-only group was somewhat below average in lexical decision (given their sub-clinical problems in word reading), a deficit in orthographic skills may nonetheless uniquely characterize dyslexia but not SLI. Note that the SLI-H group did well in literacy and also performed adequately in orthographic skills, further supporting this interpretation. These findings are consistent with previous studies reporting that orthographic skills were difficult for Chinese children with dyslexia (Ho et al., 2002; Ho et al., 2004; Ho, Chan, Chung, Lee, & Tsang, 2007).

Conclusion

Earlier reports argued that SLI is a multi-casual disorder (Bishop, 2006) and that dyslexia in Chinese involves multiple-deficits (Ho et al., 2002). Despite a very small SLI group, variable ages of the children, and the lack of a group of children with a singular diagnosis of dyslexia, evidence from this study offers promising support for these arguments. On the relationship between SLI and dyslexia, this study provides some tentative ideas. In Chinese children, SLI and dyslexia do not seem to be distinct disorders, as they are likely to share the same broad range of deficits in language and literacy-related cognitive deficits, including phonological retrieval, phonological memory and awareness and morphological awareness. It remains to be seen whether the two groups of children differ in the degree of severity in these cognitive skills. While Chinese children with SLI may show additional underlying cognitive deficits in grammar when compared with children with dyslexia, Chinese children with dyslexia are likely to show at least one additional cognitive deficit that is not observed in children with SLI. As Bishop (2008) pointed out, “the difference between SLI and dyslexia cannot be captured by a single dimension of severity” (page 74) and this might be even more so for children learning a writing system like Chinese. In Chinese children with dyslexia, orthographic skills have been found to be a key cognitive deficit. Future research with Chinese children should examine the relationship of SLI and dyslexia as one that includes shared as well as unique deficits. An additional shared deficit that needs to be examined is auditory and speech processing. Latest research has shown that Chinese children with dyslexia struggled with temporal auditory processing (Chung et al., 2008) and perception of lexical tones and aspiration (Cheung et al., 2009), and that Cantonese-Chinese speaking children with SLI also experience problems with the identification and discrimination of lexical tones (Wong, Ciocca, & Yung, in press).

This study reports that a good percentage of children with SLI were also clinically diagnosed as dyslexic, and that a good percentage of children with SLI showed sub-clinical skills in word reading. These suggest that children with SLI should be screened for dyslexia as soon as they have some systematic exposure to print at Primary school. Early identification can lead to early reading support or professional intervention for those children in need. Future research should explore whether testing word reading or orthographic skills would result in a higher screening accuracy for dyslexia in Chinese children with SLI.

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Table 1. Mean (and standard deviation) of each group’s age and scaled scores on each of the subtests in the HKCOLAS

	Normal	SLI-H	SLI-only	SLI-D	Significant group differences
Group size	9	10	7	13	
Age in months	112.11	97.8	106.29	106.54	
	(13.72)	(17.08)	(5.65)	(16.26)	
Cantonese grammar		8.4	5	5.27	
		(1.26)	(2.71)	(2.96)	
Textual comprehension		8.8	2.07	7.08	SLI-H> SLI;
		(2.2)	(1.84)	(2.99)	SLI only < SLI-D
Word definition		11.9	7.43	7.92	SLI-H> SLI-D
		(2.51)	(3.31)	(2.56)	
Lexical semantics		9	4.57	3.65	SLI-H> SLI-only;
		(1.56)	(2.23)	(1.82)	SLI-H> SLI-D
Narrative retell	12.11	9	5.57	3.65	SLI-only< SLI-H, Normal;
	(1.76)	(2.58)	(2.57)	(2.3)	Normal > SLI-H, SLI-D;
					SLI-D <SLI-H[1]
Expressive vocabulary		8.5	6.43	5.04	
		(2.68)	(2.82)	(4.05)	

1: significant also in the analysis involving three groups, SLI-only, SLI-D and SLI-H

Table 2. Mean (and standard deviation) of each group's age and scaled scores on each of the subtests in the HKT-P [II]

	Normal	SLI-H	SLI-only	SLI-D	Significant group differences
Group size	8	10	7	12	
Literacy	10.5 (1.58)	11.57 (1.98)	8.19 (2.64)	3.83 (2.09)	SLI-D < SLI-only, SLI-H, Normal
Word reading	11.89 (1.54)	11.3 (2.75)	8.86 (4.53)	3.23 (2.35)	SLI-D < SLI-only, SLI-H, Normal
One minute word reading	10.56 (2.46)	11.6 (2.67)	9.43 (2.07)	5.31 (2.98)	SLI-D < SLI-H, Normal
Word dictation	8.67 (2.29)	11.8 (2.25)	6.29 (3.3)	2.77 (2.28)	SLI-D < SLI-H, Normal; SLI-H> SLI-only
Rapid Digit Naming	10.5 (3.07)	11.2 (3.49)	7.86 (2.41)	5.75 (5.12)	
Phonological Awareness	10.88 (2.28)	11.9 (2.74)	8.14 (2.93)	7.71 (2.29)	SLI-D < SLI-H
Rhyme detection	10.25 (2.25)	11.9 (2.73)	8.86 (3.8)	7.58 (2.91)	SLI-D < SLI-H

Onset detection	11.5	11.9	7.43	7.83	
	(2.56)	(3.84)	(2.82)	(3.3)	
Phonological Memory	10.54	8.4	6.57	8	
	(2.26)	(2.13)	(3.48)	(2.79)	
Word repetition	10.75	8.4	7	7.83	
	(2.55)	(3.13)	(3.65)	(3.16)	
Nonword repetition	10.25	8.1	6.43	8.08	
	(2.31)	(1.79)	(3.78)	(3.26)	
Word repetition II	10.63	8.7	6.57	8.19	
	(3.58)	(2.16)	(3.91)	(2.97)	
Orthographic Awareness	11.25	10.9	10	8.45	
	(1.34)	(1.53)	(1.14)	(2.82)	
Left right reversal	11.13	11.2	10.86	6.5	SLI-D < SLI-only,
	(1.81)	(2.15)	(1.07)	(3.58)	SLI-H, Normal
Lexical decision	10.88	9.4	9	8.83	
	(1.96)	(3.1)	(2.65)	(3.83)	
Radical position	11.75	12.1	10.14	10	
	(1.04)	(1.73)	(2.54)	(2.41)	

Table 3. The mean (and standard deviation) of each group's performance in the two tasks measuring phonological representation and in the task of morphological awareness.

	Normal	SLI-H	SLI-only	SLI-D	Significant group differences
Group size	9	10	7	13	
Speech gating					
Frequency					LIP > FIP; LF > HF; At FIP and LIP: LF > HF; For HF and LF: LIP > HIP; For HF: SLI-D > Normal
FIPHF	0.61	0.61	0.66	0.69	
	(0.09)	(0.06)	(0.05)	(0.07)	
FIPLF	0.8	0.78	0.77	0.77	
	(0.07)	(0.04)	(0.02)	(0.06)	
LIPHF	0.73	0.74	0.81	0.81	
	(0.18)	(0.12)	(0.12)	(0.1)	
LIPLF	0.87	0.9	0.88	0.86	
	(0.1)	(0.07)	(0.08)	(0.06)	
Density					LIP > FIP; For dense words: SLI-D > Normal, SLI-H
FIPDEN	0.69	0.69	0.72	0.75	
	(0.06)	(0.04)	(0.04)	(0.06)	

FIPSPA	0.73	0.7	0.71	0.72	
	(0.09)	(0.07)	(0.05)	(0.07)	
LIPDEN	0.78	0.79	0.85	0.84	
	(0.14)	(0.09)	(0.09)	(0.07)	
LIPSPA	0.81	0.84	0.85	0.83	
	(0.12)	(0.1)	(0.11)	(0.09)	
Lexical judgment					
Proportion of Hit	0.99	0.95	0.95	0.9	
	(0.02)	(0.04)	(0.06)	(0.13)	
Proportion of	0.9	0.8	0.86	0.79	
Correct Rejection	(0.03)	(0.13)	(0.04)	(0.15)	
d-prime	3.88	2.74	3.04	2.52	Normal > SLI-D, SLI-H;
	(0.65)	(0.71)	(0.84)	(1.18)	
Latency of Correct	1.68	1.5	1.47	1.37	
Rejection (in sec)	(0.39)	(0.51)	(0.48)	(0.29)	
Morphological awareness					
Morphological	22.56	18.5	17.43	14.77	Normal > SLI-D, SLI-only
construction	(3.36)	(5.38)	(3.15)	(5.43)	
(max = 27)					

FIP and LIP stand for first isolation and last isolation point respectively; HF and LF for high frequency and low frequency respectively; HD and LD for high and low density respectively.