HK J Paediatr (new series) 2008;**13**:184-195

Theory-based Assessment of Reading and Its Difficulties in The Chinese Language System

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Abstract This paper has three aims. First, we discuss the critical role of segmental phoneme manipulation and suprasegmental tone perception in predicting early reading of Chinese characters and words. Second, we offer a tentative framework for assessing reading and its difficulties in Chinese primary school children. Third, we propose a theory-based adaptation of Perfetti's Blueprint of the Reader as a viable basis for the Chinese Language Abilities Assessment for Secondary School Students, an instrument specially designed and recently standardised on 1,164 students for the assessment of reading and its difficulties in Chinese in Hong Kong secondary students. Based on our cumulative research findings we emphasize the importance of lexical knowledge and also the broader aspects of text comprehension and essay writing as important in remediation and instruction.

Key words Assessment of Chinese; Componential approach; Primary and secondary Chinese students; Suggestions for remediation and instruction

In their generally accepted working definition of developmental dyslexia as a language-based disorder Lyon et al.[1] discuss advances in epidemiology, developmental trajectory, neurobiology, and cognitive and linguistic characteristics of the disorder. Two of these components are of particular interest for the purpose of this paper. They are: (a) "difficulties with accurate and/or fluent word recognition and by poor spelling and decoding abilities", and (b) "these difficulties typically result[ing] from a deficit in the phonological component of language" as characteristic of children with developmental dyslexia.

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In an extension of the Lyon et al.[1] definition, Berninger et al. propose a triple word form theory emphasizing the coordination and teaching of phonological, orthographic and morphological word forms in predicting word reading and spelling in children and adults with developmental dyslexia.[2] These researchers have shown the addition of morphological training to the phonological and orthographic treatment enhanced phonological decoding. While accepting the critical role of phonological processing in learning to read and its difficulties, Bishop and Snowling propose the reconceptualisation of developmental dyslexia in a two-dimensional model of language impairment to incorporate studies of syntactic and reading comprehension skills.[3]

These researchers all base their critical reviews on their own and related research studies dealing with alphabetic language systems, especially the "deep" English orthography. While reading and spelling disorders constitute the main difficulties of children with dyslexia in English, are similar characteristics found in children with developmental dyslexia using other language systems?[4] In particular, what about Chinese students using the morpho-syllabic Chinese orthography? What are the Chinese linguistic profiles of those at risk for reading difficulties?

There are three aims in this paper. First, we will argue that segmental phoneme manipulation and suprasegmental tone perception are also predictive of reading Chinese pseudowords, difficulties with which are considered to be the hallmark of developmental dyslexia in English. Second, we will suggest a tentative framework, based on current cross-linguistic research findings and clinical practices, as useful in assessing developmental dyslexia in Chinese primary school children. Third, we will present a theory-based blueprint together with the summary of a recent, specially constructed instrument for the assessment of Hong Kong secondary school Chinese students in their Chinese reading performance and reading difficulties.[5] We will conclude with suggestions for remediation and instruction based on the components and tasks of our assessment tool and cumulative research.

Phonological Processing in Reading Chinese Characters and Words

It is often assumed that learning to read Chinese characters and words relies primarily on "visual" skills and orthographic analysis and that the processing route is directly from symbols to meaning or at best "mediated" by phonology. While the square-shaped Chinese characters occupying the same geometric space for each symbol is visually complex as compared with alphabetic English, there is little support for the assertion that the identification of characters is mainly from form directly to meaning. Phonology is a constituent part in identifying Chinese characters, as is with any language system; and phonology is activated early and rapidly in recognising Chinese characters.[6-8] Outlined below are several lines of evidence to suggest that phonology is involved as a constituent in learning to read Chinese characters.

Evidence from Language Games, "Slips of the Tongue" and Experimental Studies

The language game of tongue twisters or rao[tone 4] kou [tone 3] ling[tone 4] is a favorite game played by children and adults alike. This word game uses sets of segmental phonemes such as alveolar stops (/t/ & /d/), alveolar fricatives (/s/ & /z/), bilabial and velar stops (/b/ & /p/, /g/ & /k/) and players are asked to repeat the speech sound in the correct sequence. Tones in Chinese are primarily the pitch contours of the voiced part of the character and convey meaning. The term pitch refers to the placement of speech sound on a scale going from low to high and the primary acoustic correlate is fundamental frequency. The four classical tones of the Chinese language in Putonghua are: high level or even tone (Tone 1), low rising or Tone 2, low falling or going tone (Tone 3) and high rising or entering tone (Tone 4). It should be noted that tongue twisters make use of the principle of alliteration and the principle of rhyming. Alliteration and rhyming have been shown to be linguistic activities presaging learning to read and spell in alphabetic language systems.

Another source of evidence of phonological involvement in Chinese word reading is from Chen's detailed analyses of "slips of the tongue" of Mandarin or Putonghua Chinese from the perspective of tones.[9] Chen collected over 1,300 natural spontaneous speech errors from radio call-in programs in Taiwan and carefully analysed 987 useable naturalistic slips of the tongue. The small sample of Mandarin speech errors was found to be attributable to character blending, haplology (telescopic errors), malaproprism, rhythmic perseveration, and misapplication of the tone sandhi rule (Tone 3 becoming Tone 2 when the latter occurring before Tone 3). Based on these careful analyses, Chen emphasized that Mandarin or Putonghua Chinese tones are suprasegmental in their underlying forms, and the representation and processing of tones in Mandarin are akin to those of stresses in English.[9]

The third line of evidence of phonological involvement in reading Chinese words is from experimental psychology. Using different experimental techniques such as backward and forward masking, tongue twisters, Perfetti and his colleagues have shown that phonological processing is robust, is activated rapidly and early in both single and two-character Chinese word identification.[10-12] Phonological activation is a constituent in the visual identification of Chinese characters and has some unique features relative to English and other alphabetic writing systems. Furthermore, the orthography to phonology activation is stronger and faster acting than the orthography to meaning activation. This is shown from Perfetti et al.'s converging behavioural, event-related potentials (ERP) and functional magnetic resonance imaging (fMRI) data.[12] The convergence supports the general framework of their multi-level representations and interactions amongst the levels as mapped out in their Lexical Constituency Model. These researchers are cautious to state that in Chinese character and word identification "phonology is rapid, probably automatic, and perhaps universal".

The three lines of evidence summarised in the preceding

paragraphs in this Section show that phonology is involved "at lexicality" in processing Chinese characters and words. To understand learning to read Chinese and its disorders it seems important to begin, though not to end, with the investigation of phonological processing.

Some Relevant Recent Studies

There is a growing body of literature showing the effect of phonological awareness or analysis on early reading in Chinese children.[13-15] In a study of Taiwanese first graders, phonological retrieval (rapid automatised naming of pictures of coloured animals) was found to make unique contributions to reading familiar Chinese characters and phonological awareness (phonetic contrasts of initial consonants and rime with tones crossed orthogonally) and phonological memory (repetition of bisyllabic pseudowords) were shown to contribute to variations in reading less familiar words.[13] In a study of three- and four-year-old Hong Kong Chinese children, syllable deletion and letter naming of the English alphabet were found to contribute unique variance to character recognition and to explain some 50% of the variance.[14] In another study, onset-rime awareness and not so much phoneme segmentation was shown to be a better predictor of Chinese reading, even after partialling out the effect of IQ.[15] Knowledge of Pinyin and homophone discrimination (two-choice task in selecting the correct heterographic homophonic character to form a legal two-character word) was found to explain considerable variation in character and word reading in grades 2 to 5.[15]

From the above fairly representative studies it is reasonable to suggest that speech-sound perception and repetition of Chinese characters with the same or varying tones and retrieval in working memory are amongst important parameters to explore in the phonological analysis of Chinese character and word reading. Such an exploration should provide some answers to the research question of the nature of phonological analysis of speech segmentation by Chinese children learning to read, and also some basis for the assessment of those with developmental dyslexia in Chinese.

Studies of Putonghua Speaking Chinese Children

We summarise here the results of two studies of Putonghua-speaking Beijing children carried out by Leong and Tan.[16] For the first study with 70 grades 4 and 5 children (mean age of 10.34 years) stepwise multiple regression analyses were carried out separately with Chinese and English pseudoword reading tasks as criteria and onset and rime deletion tasks and speech-sound repetition as predictors. The criterion Chinese pseudoword reading task consisted of 72 anomalous two-character items formed from individually legal single characters. The corresponding English pseudoword reading task consisted of 67 three-, four-, five-, and six-letter pronounceable nonwords. For Chinese, the speech-sound repetition task was found to be predictive with an R of 0.369 and R^2 of 0.136 ($F(1, 68) = 10.69$, $p=0.002$). The speech-sound repetition task consisted of 20 sets of items with 3 conditions and 4 sound segments each: same onset, same rime and no segment with the same or different tones (one of the 4 sounds being a filler item to minimise ceiling effect). For English pseudoword reading, it was onset deletion that was significant with an R of 0.507 and an R^2 of 0.257 ($F(1, 68)=23.51$, $p=0.000$). These modest results point to the role of tone discrimination and retrieval and also the differential prediction of reading Chinese and English words. Sample items of these tasks are given in the Appendix.

Similar patterns were found in the second study with a much larger sample size of 180 grades 3, 4 and 5 children (mean ages from 9.43 years to 12.11 years) with Chinese pseudoword reading as the criterion and the 120 grades 4 and 5 children with English pseudoword reading as the criterion (English being taught only from grade 4 onward). The speech-sound repetition task was the most predictive of Chinese pseudoword reading with an R of 0.427 and an R^2 of 0.182 ($F(1, 178) = 39.69$, $p=0.000$). This contribution was followed by verbal working memory with an R change of 0.06, onset deletion with another R change of 0.028 and chronological age with a further R change of 0.029. The working memory task consisted of 13 sets of 2-, 3-, 4- and 5-sentences, all unrelated in meaning. The child listened to each set of sentences spoken at an even pace by the experimenter and after the presentation of each set of sentences answered one comprehension question and said the very last word of each of the sentence in the set (see Appendix for sample sentence set). The total contribution to the variance of Chinese pseudoword reading from speech-sound repetition (18%), verbal working memory (6%), onset deletion (3%) and age (3%) was 30%. In comparison, English pseudoword reading for the 120 grades 4 and 5 children with the same predictor variables was predicted by onset deletion with an R of 0.472 and an R^2

of 0.223 (F (1,118)=33.82, p=0.000). Rime deletion added another 0.064 to the variation with a total R of 0.536 and an R^2 of 0.287 for a total R^2 of 0.287. Parenthetically, for the English pseudoword reading it was onset deletion that was significant in both studies.

To examine the results of the predictive efficacy for Chinese pseudoword reading further, the best predictors from the multiple regression in the second study were used in a discriminant function analysis with a subgroup of 18 good readers and 21 poor readers defined as those students in the second study scoring one standard deviation above or below the mean on the performance of the Chinese pseudoword task. On this criterion, the predictor variables of speech-sound repetition, working memory, onset deletion and chronological age correctly classified 15 of the 18 good readers (83.3%) and 20 of the 21 poor readers (95.2%). This discriminant function analysis further confirmed the efficacy of the tasks and pointed to their useability in an assessment framework.

Role of Speech-Sound Repetition and Lexical Tones

The two studies provide some suggestive evidence that the correct perception of Putonghua speech sounds with tone variations, holding these sounds in working memory, and retrieving them seem to be important in reading Chinese characters and words.[13-15] In the detailed analysis of the speech-sound repetition task by different conditions, the Beijing children found it easier to delete rimes than onsets. This pattern of better performance in rime deletion than onset deletion and better repetition of speech-sound items involving same rimes can be explained by the Sonority Principle.[17-19] The Sonority Principle states that sonority tends to increase from stops through fricatives, nasals, liquids, glides and vowels with the latter segment as the most sonorous. On this account, the rime segment is more salient and generally more preferred than the onset segment. Both the main vowels and the suprasegmental tonal elements are critical in providing meaning in the context of very extensive homophony of Chinese characters.

The suggestive evidence from both Beijing studies[16] is that these phonetic segments are at the level of onsets and rimes with rimes being perceived more easily than onsets because the vowels are more sonorous. Furthermore, the perception and retrieval of different lexical tones from working memory predict moderately the reading of Chinese pseudowords. While no explicit instruction in the alphabetic code may be needed as the Beijing children tested did not start learning English until grade 4 there is systematic instruction in the early grades in using the phonetic Pinyin system as an adjunct in character reading. This adjunct phonetic system and the use of Putonghua may have an effect on the results.

Phonological Sensitivity Affected by the Phonologically Salient Putonghua

To verify these suggestions, Leong et al.[20] investigated the effect of phonological sensitivity of two comparable groups of grades 4 and 5 children, one a Putonghua speaking group (n=77) from Beijing and the other a Cantonese speaking group (n=80) from Hong Kong on both Chinese and English pseudoword word reading as markers of efficiency in processing words and indicators of reading disorders. It was hypothesised that the Putonghau speaking Beijing group using the phonetic Pinyin system as an adjunct to reading would process more accurately suprasegmental lexical tones and phonological sensitivity tasks (rhyme detection and discrimination, two phoneme segmentation tasks deleting initial, medial and final phonemes) than their Cantonese speaking Hong Kong counterparts not using such a phonetic system in Chinese word reading. Multivariate analyses of variance of the five tasks considered conjointly as dependent variables and spoken language groups and grades as independent variables confirmed the hypothesis.

The more accurate performance of the Putonghua group might be explained by their use of the phonologically more salient spoken Putonghua with its four lexical tones and the phonetic Pinyin system as an adjunct in early character and word reading, as compared with the Hong Kong children using the spoken Cantonese with its traditional six tones and without the benefit of the phonetic Pinyin system as an adjunct to reading. This is the general notion of phonological saliency, which is related to the frequency and quantity of input.[21] This principle states that the less options there are in the phonological features, the higher is the saliency and the more accessible and noticeable would these features be to children. According to this principle, Putonghua is more accessible to and more noticeable by children, as compared with Cantonese. This principle is the basis for the argument that Chinese children brought up in the Putonghua speaking environment would perfom better in phonological sensitivity tasks than their counterparts raised in the Cantonese speaking environment.

The results with the two spoken language groups also suggest the need to map out different strategies for the different spoken Chinese language groups in assessment and remediation.[22]

An Assessment Framework of Primary School Chinese

Even though phonological processing is a necessary prerequisite for learning to read Chinese characters at the emergent literacy stage, it is not sufficient to explain the process of reading acquisition and reading difficulties in Chinese. Other linguistic components would also need to be considered. Studies of Hong Kong Chinese children diagnosed with developmental dyslexia points to deficits in orthographic processing (e.g., understanding of radical positions) and rapid naming in addition to phonological difficulties.[23, 24] These components need to be taken into account in the assessment and actual work with these students.

Another important linguistic characteristic of developmental dyslexia in Chinese, that of spelling difficulties, is an under-studied area. This is mainly because of the lack of a sound psycholinguistic theoretical framework and a dearth of sufficiently large corpus of data for analysis to show patterns of errors in written Chinese. There is some encouraging development in this area in a recent study by Shen and Bear.[25] These authors collected 7,000 invented spellings from writing samples of 1,200 elementary school children in China, who used 318,277 running characters and made 7,486 writing errors (including repeated errors); and also 3,995 invented spelling patterns from spelling tests of 300 children writing 36 characters. The multiple regression analyses of the data showed a linear trend. What is more important is that at the lower end of the elementary level phonological strategies predominated, then the use of graphemic and semantic strategies increased with older children as they gained graphemic or orthographic knowledge. From the error analyses these authors suggested some thirteen types of errors. This study is of interest because it confirms the contribution of the phonological strategy to the early phase of reading and spelling and also the increasing role played by orthographic processing and other cognitive components.

From the various recent behavioural studies[13-15, 20, 22-25] a very tentative framework for assessing developmental dyslexia in Chinese might be offered. In general, this framework should consist of reading of real and pseudo two-character words, spelling of both real and pseudo two-character words, rapid automatised naming of Chinese syllables akin to the tongue twister task and of numerics, speech-sound repetition with control for tones, onset and rime similar to the tasked used by Leong and Tan,[16] and working memory task.[26] The assessment of orthographic sensitivity should include lexical decision tasks to test the rapid and correct decision of lexicality of individual characters and the correct compositionality of phonetic and semantic radicals inherent in the characters. Morphological sensitivity should examine the relational and productive aspects of words such as the rapid and accurate generation of new words from a constituent component character. The analysis of spelling errors should concentrate on: phonologically based spelling errors such as the use of heterographic homophones; graphemic spelling errors related to the substitution of graphemically similar characters, radical substitutions, addition and deletion of strokes and partial radicals; semantic errors related to synonyms and irrelevant substitutions.

The above sketch covering both reading and spelling should provide a workable and effective framework to assess children with developmental dyslexia in Chinese. The components involving different levels of phonological awareness (syllable detection, rime detection, onset detection and tone detection) and morphological awareness support the recent findings with young Putonghua speaking children[27] and also Chinese children with familial risk for dyslexia.[28] This scheme should add to the existing instrument devised and updated by the Hong Kong Specific Learning Difficulties Research Team for assessing Hong Kong primary students with reading disorders.[29]

Support from Imaging Studies

There is recent evidence from a series of fMRI studies by Siok et al.[30] that the coordination of phonological processing of Chinese characters at lexicality and the visual-orthographic analyses of the strokes inherent in the square configuration of characters show strong activation in the left middle frontal cortex, which is interpreted as mediating the syllable level of phonological processing of Chinese characters. These neuroimaging findings offer evidence of cortical areas relevant to the processing of syllables and phonemes and converge on the behavioural data summarised here. In a recent fMRI study of 16 eleven-year-old Chinese dyslexics compared with 16 controls, Siok and her team found reduced activation in the same left middle

frontal gyrus (LMFG) regions in the dyslexics and significant correlation between gray matter volume and activation in the language task in the same area.[31] This recent finding of atypical development of gray matter in the LMFG is in some contrast to the findings in dyslexics of alphabetic languages. Siok et al. suggest that the LMFG might be involved in the coordination and allocation of resources in working memory.[31] Verbal working memory has also been shown from a structural equation modeling and a hierarichical multiple regression analysis to play a critical role in reading comprehension in 31 less competent Chinese language and reading comprehenders compared with 37 reading comprehension and 23 chronological age controls.[32]

An Assessment Framework of Secondary Chinese

The framework for assessing primary Chinese reading and its difficulties incorporates linguistic marker tasks which examine the accurate and rapid integration of constituents of phonology, orthography, and morphology of Chinese characters and words. The emphasis at the lexical or word level with particular reference to Chinese is in keeping with current research literature on reading disorder in children using alphabetic language systems.[1-4] As children with reading disorders progress to secondary schools there is a need for an expanded theory-based assessment instrument to examine the wider components of Chinese language and reading comprehension such as text comprehension and essay writing.

This need is acknowledged by theorists, clinicians and school personnel. In 2006 the Hong Kong Education Bureau (EDB) commissioned one of the authors (MKH) to design such an instrument for the assessment of secondary school Chinese in Hong Kong students. This work was completed in April, 2008 with the production of a teacher-friendly instrument known as the Hong Kong Chinese Language Abilities Assessment for Secondary School Students (CLAAS). In the following sections we discuss the theoretical framework, and the language and reading components consisting of nine language tasks based on the framework. CLAAS was first tested on 361 secondary forms 1, 3 and 4 Cantonese-speaking Chinese students (mean age of 15 years) from three schools in Hong Kong considered to be average, above-average and below-average in Chinese language performance. CLAAS was subsequently standardised on 1,164 secondary students from eleven carefully selected representative secondary schools. Details of the theory and CLAAS are given in a 2008 paper by Leong and Ho[5] and are outlined below.

Theoretical Framework

Of the various models on reading and its difficulties, Perfetti's "Blueprint of the Reader" in comprehending language (2000, summarised in variant schematic blueprints in Figure 6.1 and Figure 6.2), Perfetti, Liu & Tan (2002) and Perfetti, Landi & Oakhill (2005) is particularly suited for adaptation as a framework for the study of Chinese language and reading comprehension for several reasons.[33-38] First, the Blueprint has been tested in part in different writing systems including English, Chinese and Korean. Second, the Blueprint emphasizes all writing systems encode language according to the Universal Writing System Constraint; and the activation of word pronunciation occurs across all writing systems according to the Universal Phonological Principle with robust effect of phonology as empirically tested with Event Related Potentials (ERPs) and functional MRI.[35, 37, 38] Third, the psycholinguistic processes schematised in the Blueprint are compatible with modern grammar of both spoken and written Chinese.[39,40] Fourth, and this is central to our thinking, word identification and word knowledge involving orthographic, phonological, morphological and semantic units, has an important role to play in language and text comprehension.

The centrality of lexical knowledge is particularly suited towards building a framework of language and reading comprehension in Chinese. Lexical knowledge problems as a whole may lead to reading disorders and also reading comprehension problems, as tested in our sub-samples of poor language and reading comprehenders and their controls.[5] Based on the Perfetti Blueprint adapted for Chinese our main hypothesis was that lexical knowledge consisting of derivational morphology; correction of characters, words and sentences; segmentation of text into phrases and sentences; and writing to dictation should explain considerable individual variations, as shown in the English literature. This was tested with promax oblique structure factor analyses and hierarchical multiple regression analyses. The total CLAAS battery accounted for 66.80% of individual variations while lexical knowledge alone explained 33.51% of the individual variation in the overall school performance in Chinese language and reading comprehension. The other contributions were: essay writing (9.90%), text comprehension (7.54%), fluency of text reading (6.05%), copying of words and texts (5.27%)

and reading aloud (4.54%). A succinct description of these tasks is given below.

Construct of Lexical Knowledge

For our central notion of lexical knowledge in Chinese we posit as important morphological processing, correct usage of lexical items in Chinese characters and two-character words, segmentation of text passages and to some extent writing to dictation.

Morphological processing in two sub-parts examines the productive aspect of derivational morphology with prefixing and suffixing of a constituent form to a base form.[39-41] The correct usage of characters and words in three sub-parts is important in that Chinese students may use vernacular versions, may miss inter-sentential connectives in their usage of lexical items in short contexts and may make syntactical and other grammatical errors.[39,40] The segmentation of short passages into sentences and phrases in the way they should be read with ease promotes text comprehension. The writing to dictation of two-character words with two sub-parts goes beyond the motoric programming of writing in the form of copying of characters, words and short texts. Writing to dictation is important for the visual-orthographic processing in Chinese reading to form an orthography-phonology-meaning circuit. The practice of writing and writing to dictation is an essential component in instruction, especially in elementary schools. There is recent evidence that the reading ability of Chinese students is strongly related to their writing skills and phonological awareness is much weaker than found in English.[42]

Of these tasks we place particular importance on morphological processing as shown in English and Chinese. [42-44] But there are marked differences between the productive aspect of morphological derivation in English and Chinese. In English morphologically related words look alike and have similar meaning (e.g., satisfy, satisfactory, dissatisfy and the like). In Chinese there is not the same form-meaning association in morphological relatedness. An example of prefixation to the character of 樂 is 快、音、國、西 (meaning happiness, music, Chinese music and western music respectively). An example of suffixation to the same character 樂 is 事、天、土、園 (meaning happy event, optimism, paradise and happy place respectively). Unlike English, morphological affixation in Chinese involves full characters (full morphemes with meaning) and empty characters (empty morphemes devoid of meaning but serving to mark grammatical functions of the full morphemes) even though fullness and emptiness of morphemes may differ in degree because meaningfulness is a matter of degree.[39] Compared with English, suffixes in Chinese are more numerous than prefixes and are usually empty morphemes with neutral tones. These versatile end morphemes generate a considerable number of new words and frequently these newly formed suffixed words differ in meaning from that of the base form and the grammatical category of the suffix. This succinct discussion suggests that what may appear to be similar concepts of morphology in fact involve different psycholinguistic and cognitive considerations and different structures.[39-41] This is an area rich for further exploration.

The correction of errors of characters and words is also of significance in language and reading comprehension in Chinese.[39,41] The threefold aims of this task are: 1) identification of errors, 2) correction of errors by grammatical categories, and 3) understanding of the psycholinguistic principles of the errors and provision of reasons to help students. The students were assessed according to the first two aims and the third should be required of teachers when they were correcting their students' exercises.

Construct of Essay Writing

Four black-and-white cartoon line drawings are used to elicit the writing of short essays varying from 150 to 500 words for the different secondary forms. Students are asked to supply appropriate short titles for the integrated cartoons and to write short essays from visual imagery, personal experiences and emotional aspects along the lines of the situation model.[45] The emphasis is on active meaning construction by concentrating on significant ideas generated from the visual imagery and neglecting unimportant points.

Construct of Text Comprehension

Chinese text comprehension is defined operationally as encoding and activating relevant information during reading which may not be stated explicitly in the text.[36,45] Text comprehension in English has been shown to be influenced by "lower" levels of cognitive and linguistic skills such as word reading, rapid naming, segmentation at the onset-rime level (all three tasks with some variations used in the present study) and verbal working memory.[46]

Construct of Fluency in Text Reading

The "visual-verbal" responses instantiated by the rapid automatised naming (RAN) originally proposed by Denckla and Rudel[47] has been shown to be a correlate of reading and its difficulties in alphabetic orthographies.[48] However,

RAN and its variants are not reading tasks in themselves but are correlates of reading and almost all RAN and RAN-related studies deal with single word reading in elementary school children. In the CLAAS project we extended previous studies by testing directly the fluency in text reading and not its RAN correlates or general speed.

Construct of Copying

The efficiency in copying exemplar characters, words and short passages correctly and fairly effortlessly is integral to writing to dictation and important for the orthographic processing of Chinese. Chinese characters obey the *Pragnanz* ("good form") psycho-geometric principles of linearity, parallelism, connectivity, closure, and symmetry. Stroke sequence, combination of radicals and topographic shape of a character are essential to locating and retrieving lexical items from both the literal and mental dictionary.

Construct of Reading Aloud

Reading aloud by individual students of words, then short passages with clear enunciation of characters, words, phrasing and rise and fall of prosodic patterns is another important component in Chinese language processing. It has been shown there is a more general association between sentence-final pitch change especially large pitch rises following yes-no questions and reading comprehension; and prosody may provide the link between syntactic and semantic boundaries in reading comprehension.[49]

Summary of This Section

To summarise, CLAAS provides several levels of psycholinguistic analyses: at the lexical level with the morphological, syntactic and semantic sub-components; at the essay-writing level; at the reading comprehension level; at the fluency level while reading actual texts; at the copying and writing to dictation levels and through individuals' reading text passages aloud. The test battery as a whole with its different constructs subserved by 9 tasks with their sub-parts shows reasonably high psychometric characteristics with reliability coefficients (Cronbach's alphas) ranging from the moderate of 0.462 (Fluency in text reading) to the high of 0.928 for essay writing and 0.915 for writing to dictation.[5] The moderate inter-correlations of the tasks after partialling out chronological age minimise the possible confound of multi-collinearity which might mitigate against the promax oblique structure analysis and hierarachical multiple regression analysis.[5] It would thus appear CLAAS is reliable for the assessment of Chinese language and reading performance in secondary school Hong Kong Chinese students. The discriminability of CLAAS among the different secondary forms is clearly evident from the box-plots shown in Figure 1 which summarises the multivariate analyses of covariance (MANCOVA with chronological age partialed out) results of the standardised scores (Z scores with M = 100 and SD = 15) of the 9 tasks and their aggregate scores shown individually by grade or secondary form.

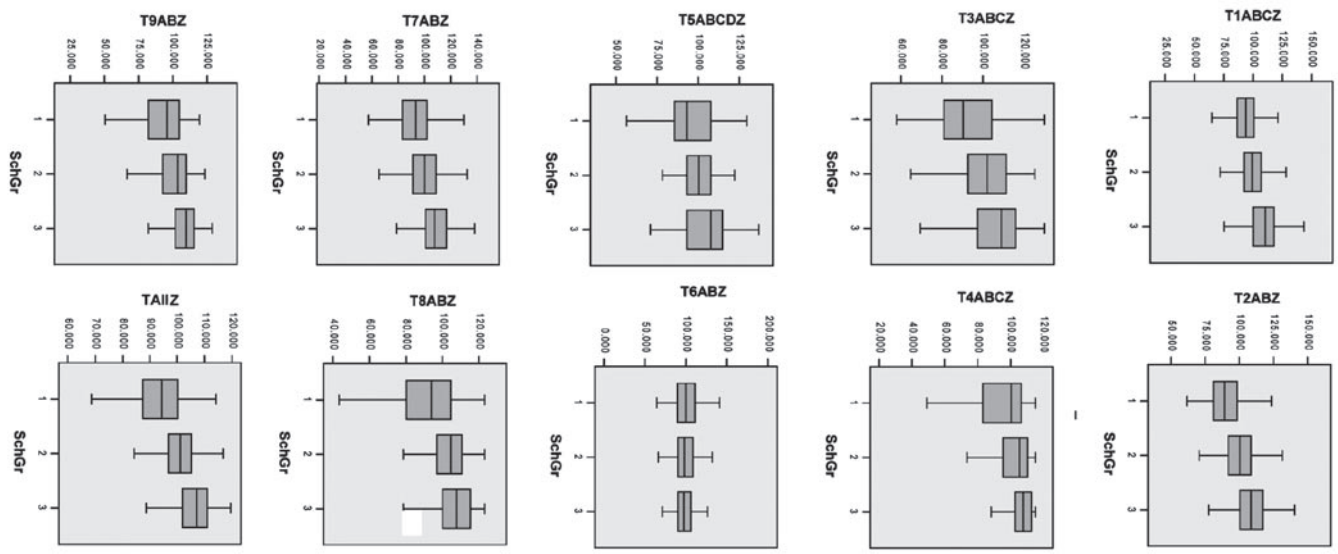


Figure 1 Performance of 361 Hong Kong Secondary Students (SchGr 1 = Secondary 1, SchGr 2 = Secondary 3, SchGr3 = Secondary 4) in 9 tasks and their total of the Hong Kong Chinese Language Abilities Assessment for Secondary School Students (CLAAS). All scores are standardized with mean of Z = 100 and standard deviation = 15. The letters A, B, and C denote the different sub-parts of each task. T1ABCZ = Task 1 Essay Writing Z scores, T2ABZ = Task 2 Morphological Processing Z scores, T3ABCZ = Task 3 Correction of Characters and Words Z scores, T4ABCZ = Task 4 Segmentation of Text Z scores, T5ABCDZ = Task 5 Text Comprehension Z scores, T6ABZ = Task 6 Fluency in Text Reading Z scores, T7ABZ = Task 7 Copying of Words and Passages Z scores, T8ABZ = Task 8 Writing to Dictation Z scores, T9ABZ = Task 9 Reading Aloud of Words and Texts Z scores, and TAllZ = Total 9 Tasks Z scores.

To the best of our knowledge CLAAS consisting of the constructs of lexical knowledge comprising morphological processing, correct usage of Chinese characters and two-character words, segmentation of text passages and to some extent writing to dictation; essay writing; text comprehension; fluency in text reading; copying; and reading aloud might be the first comprehensive theory-based battery to assess Chinese language and reading performance in Hong Kong secondary students. We would also like to acknowledge some shortcomings. We would need to incorporate some cognitive tasks such as verbal working memory, which have been shown from behavioural data to explain individual differences in inferential text comprehension[26,32] and from fMRI analysis of the performance of dyslexics in Chinese.[31] We would further emphasize that CLAAS should be used in combination with such other data as internal school marks in Chinese, teachers' estimates, parents' observations and other relevant reports as data to gain more in-depth knowledge of possible difficulties in Chinese in secondary Hong Kong students. We would also like to point out that we are in the process of analysing the scores of the 9 tasks with their sub-parts from the much larger standardisation sample of 1,164 secondary students from 11 representative schools to gain greater insight into both the CLAAS battery and the process of understanding Chinese language and reading performance.

Summary Suggestions for Remediation and Instruction

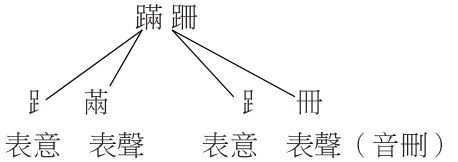
In this section we offer briefly some suggestions for helping students in both primary and secondary schools to enhance their proficiency in Chinese language and reading performance. Our CLAAS results and careful scrutiny of the spoken and written performance of the 361 students show that their difficulties can be attributed mainly to the word or lexical knowledge level.[33] Our data are based on and adapted from Perfetti's Blueprint of the Reader.[33-38] We have provided results to support his central notion of high-quality lexical knowledge.[5,34] This relates to the proficiency and precision with which lexical items are used actively. Much of this lexical knowledge derives from intensive and extensive reading and this reading experience is also enhanced with analytic and synthetic Chinese language instruction.

Integration of Orthography, Semantics and Phonology

Stable and precise knowledge of word form (orthography), meaning (semantics) and speech sound (phonology) and their integration as constituent parts of Chinese characters and words is central to lexical knowledge, reading comprehension and writing and should be instilled in students. Take the one-character morpheme of "染" ("to dye") as an example. Many students erroneously add a dot to the top right-hand constituent of "九" (the number nine) to turn it into "丸" (a pellet) without realising that etymologically the three constituents of the character refers to "water" (semantic radical in the top left-hand corner), "wood" (radical in the lower half), which in olden days was a dye stuff and the morpheme nine to denote nine rinsing cycles in using dye stuff in water in the dyeing process. When this logic is pointed out to students it is unlikely they would make errors in this and similarly constructed lexical items.

Other examples come from heterographic homophonic characters which are sources of difficulties and persistent written errors. Take the two-character pairs of 刻苦 and 克服 the first characters of each of the two character-words sound the same (homophonic) but their orthographic shapes differ (heterographic). It needs to be explained that the first character in 刻苦 refers to using a knife to make marks on a piece of wood, whereas the first character in the homophonic 克服 refers to overcoming [an obstacle]. Hence the first two-character word refers to working hard and persistently because wood carving is hard work and the second two-character word means to overcome some difficulties.

A further example of the role of morpho-semantics and morpho-syntax of words is given by the following two-character word meaning walking unsteadily and not in control of one's legs or body. Teachers and clinicians should help students understand the integrative constituent parts of the semantic radical which is usually on the left-hand side and the phonetic radical which is usually on the right-hand side of a character in the left-right compostionality. In the example shown below the semantic radical on the left-hand side of each character means "foot" and hence the connection to walking and the phonetic radical on the right gives a clue to speech sound or pronunciation.



After such an explanation students should be asked to construct sentences to show their understanding of this two-character word. A possible sentence could be: 小強大病初癒，在學校長廊 _____ 地走著，十分吃力。[After the recovery from his severe illness, Siu Keung walked unsteadily along the long corridor in the school.] Students should be helped to understand why and why not the sentences are properly constructed. They should be further asked to construct morphological words using the semantic radical meaning "leg, foot" such as "run, jump" and so on. This associative process should help to increase the size and precision of their vocabulary.

The above principles and actual examples underscore the importance of building up students' stable knowledge and representation of words in their many form-meaning complexities. The theoretical framework and suggested tasks for assessing primary Chinese students' performance are attempts to bolster lexical knowledge. The Blueprint of the Reader based on Perfetti's cumulative experimental studies[33-38] has been shown to fit well the data of the 361 secondary students from promax oblique structure analyses and hierarchical multiple regression analyses for the whole sample and subsamples of 54 poor comprehenders and 56 good comprehenders.[5] The resulting instrument CLAAS with its emphasis on lexical knowledge especially on morphological processing, correction of characters and words, text segmentation and writing to dictation extends the suggestions for primary Chinese students. These tasks subserving the construct of lexical knowledge should provide indications of students' mental representation of form-meaning components which are critical to reading comprehension.[50]

In addition, CLAAS also covers reading comprehension, reading aloud, fluency in text processing and essay writing. These components are also integral to proficiency in Chinese language learning and reading at the secondary level. Each of these components can be further refined.[51] Assessment of text comprehension can be enhanced with different experimental and correlational approaches, text genre, structure and response format.[52] Furthermore, Leong et al. have successfully used the open-ended format coupled with constructive short written answers to test the reading comprehension of short text passages in a large sample of 518 grades 3 to 5 Chinese children in Hong Kong.[53] For the construct of essay writing, we would like to add that our use of interesting cartoons to elicit essay writing is both innovative and flexible. First, cartoons have universal appeals to both primary and secondary students, and also to adults. Second, they allow for the use of different genres: descriptive, narrative and expository forms. They provide an alternative to the usual way of just giving a title or even providing beginning or ending sentences for students to write and offer diagnostic and instructional possibilities as discussed in Leong and Ho.[5] The whole area of writing – its development, instruction and research – is under-developed as compared with reading and deserves further attention.[54]

Acknowledgments

The studies carried out in Beijing and Hong Kong by the first author (CKL) and summarised in the paper were assisted with research grants by the Social Sciences and Humanities Research Council of Canada (SSHRCC), for which CKL was grateful. The construction, standardisation and study of the Hong Kong Chinese Language Abilities Assessment for Secondary School Students (CLAAS) were assisted with a grant to the second author (MKH) from the Hong Kong Education Bureau (HKEDB). We thank HKEDB, Suk-Han Lee and Suk-Man Tsang of the Bureau for their assistance. We also thank the principals, teachers, students and their parents in the fourteen secondary schools in Hong Kong for their participation and cooperation in the CLAAS project. We appreciate the advice from Pui-Kuen Au of Ho Man Tin Secondary School of HKEDB in the design of the tasks and the permission from Zhang Shi-rong for the use of his cartoons in the essay task. We are grateful to our research assistants for their careful and hard work in the fourteen schools, their scoring and task analyses of the protocols.

Note: *The discussion of CLAAS is based in part on the invited papers presented by CKL and MKH at the Specific Learning Disabilities Summit conference organised by the Hong Kong Society of Child Neurology and Developmental Paediatrics (HKCNDP) at the Queen Elizabeth Hospital, Hong Kong, China on November 19, 2007, and also on the invited speech by the second author at a seminar for teachers organised by EDB in Kwai Ching on April 25, 2008. Inquiries of CLAAS should be directed to Suk Han Lee or Suk Man Tsang of HKEDB.*

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Appendix Sample Items from Different Tasks

Chinese Pseudoword Reading (72 two-character items)
喊健　藏躲　炮喻　寂奔　偎瀑　瞎狹

English Pseudoword Reading (67 items for Grades 4 & 5 only)
orp　lun　stib　klat　slonk　plisk　wumber　biquid

Rime Deletion (10 items in Chinese, 10 in English)
mi　dao　mian　wet　hide　shirt

Onset Deletion (10 items in Chinese, 10 in English)
wo　xia　tian　kit　best　will

Speech-Sound Repetition (3 main conditions: same onset, same rime, no segment, all with same or different tones for total of 30 items)

yan[3]	zhun[3]	ye[3]	you[3]
man[1]	die[4]	chan[2]	zhan[3]
jian[4]	zong[1]	xiu[3]	mu[2]

Tongue Twister (3 sets of 2/3 sentences & 5 sets of 4 sentences)

四是四	si[4]	shi[4]	si[4]		
十是十	shi[2]	shi[4]	shi[2]		
十四是十四	shi[2]	si[4]	shi[4]	shi[2]	si[4]
四十是四十	si[4]	shi[2]	shi[4]	si[4]	shi[2]

Working Memory (Total of 13 sets of 2-, 3-, 4- & 5-sentences)
太陽射出強烈的光芒　The sun gives out bright light.
幫媽媽做一件難事　I help mom do a hard job.
問題：太陽放出甚麼樣的光芒？　[強烈]
詞語：光芒，難事