Journal of ICSAR
ISSN (print): 2548-8619; ISSN (online): 2548-8600
Volume 7 Number 1; DOI: http://dx.doi.org/10.17977/um005v7i12023p144

Cognitive Abilities Related to Reading and Writing Skills in Chinese Third-grade Children

Jieping Ou[1], Ami Sambai[2,3], Hong Pei[2], Akira Uno[3], Hiroki Yoneda[2,*]

[1]Kansai Gaidai University, Osaka, Japan
[2]University of Tsukuba, Tsukuba, Japan
[3]LD/Dyslexia centre, Chiba, Japan

*Corresponding Author e-mail: hyoneda@human.tsukuba.ac.jp

Abstract: In this study, we analysed the cognitive abilities that predict reading and writing attainment in the Chinese language for Mandarin-speaking children. A total of 140 Chinese third-graders studying in Ningbo, Zhejiang were evaluated for their visual cognition including visual perception and memory, naming speed, vocabulary knowledge, phonological skills, nonverbal intelligence, and abilities to read and write. The results of multiple regression analyses revealed that word and nonword reading accuracy were predicted to a significant degree by visual memory and phonological awareness, respectively. Naming speed significantly contributed to the reading speeds regarding words, nonwords, and paragraphs. Our results also showed that the scores in word and nonword reading predicted the scores of writing as well. Visual memory and phonological awareness are essential for reading Chinese accurately, while naming speed is an important factor for Chinese reading fluency. The present results have implications regarding the design of useful tasks that screen poor readers of Chinese.

Keywords: Naming speed; Phonological awareness; Reading; Visual memory; Writing

INTRODUCTION

In the past decades, studies of children with developmental dyslexia, have generated lots of evidence which indicated that learning to read and spell involves cognitive skills in visual, orthographic, phonological and semantic processing in alphabetic languages (Snowling & Hulme, 1989; Snowling, 2000). Differed from the alphabetic orthography in which letters represent phonemes, each Chinese character represents a syllable and meantime a unit of meaning or morpheme. Chinese characters consist of many strokes, which makes them visually complex (Kao, 2000; Shu, McBride-Chang, Wu & Liu, 2006). Although the manifestation of difficulties in Chinese children with developmental dyslexia appears to be similar to which found in children learning alphabetic languages (Shu et al., 2006), McBride (2016) argued that reading development and its deficits in Chinese differ from those in alphabetical languages. Therefore, researches on Chinese literacy performance and cognitive abilities among Chinese children would help us understanding Chinese developmental dyslexia and shed light on which cognitive abilities should be tested for detecting cognitive origin of reading deficits in individual children.

Many studies focusing on the explorations of reading and writing development in relation to diverse cognitive constructs have been conducted on Hong Kong and Taiwan (Chan, Ho, Tsang, Lee & Chung, 2006; Chung, Lam, & Cheung, 2018; Ho, Chan, Tsang & Lee, 2002; Liu & Liu, 2020; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001; McBride-Chang, Lam, Lam, Doo, Wong & Chow, 2008; Mo, McBride & Yip, 2018). Prior researches on developmental dyslexia in Chinese (e.g., Ho, Chan, Lee, Tsang & Luan, 2004; Chung, Ho, Chan, Tsang & Lee, 2009; McBride-Change, Chung & Tong, 2011) suggest the involvement of visual skills, phonological awareness and naming speed with the reading development and its deficits.

Visual skills, including the ability to recognise, discriminate, and remember unfamiliar figures, are critical for learning Chinese characters. Given that Chinese characters are visually distinctive and complex, it is possible that those who have problems regarding their visual skills will encounter difficulties in learning to read and write Chinese. Woo and Hoosain's study (1984) found that Chinese children in Hong Kong with developmental dyslexia made more visual-distractor errors in a Chinese character recognition task compared to age-matched average readers. A study by Huang and Hanley (1995) found that visual skills were significantly correlated with the reading performances of children in Taiwan and Hong Kong, but not with the reading ability of children in Britain. These researches demonstrated that visual skills are more important than phonological skills in terms of Chinese reading development. Furthermore, recent research found that skills in copying visual forms are particularly important for Chinese writing development (Wang, McBride-Chang & Chan, 2014). Two aspects of copying, in terms of pure copying and delayed copying have been examined in Chinese children (Wang et al., 2014; Lo, Ye, Tong, McBride, Ho & Waye, 2018)). Pure copying refers to copying unfamiliar print without any time constrains, which requires visual-motor integration skills. On the other hand, delayed copying asks children to copy stimuli in a familiar script after brief exposure to them, so that delay copying likely requires children's visual-orthographic skills. Previous studies found that both visual-motor integration skills and visual-orthographic skills are important in Chinese word dictation (Wang et al., 2014; Wang, Yin, & McBride, 2015).

The association between phonological abilities and the development of reading skills in Chinese remains a source of controversy. On the one hand, previous studies have shown that phonological awareness is related to Chinese reading acquisition (e.g., Ho, 1997; Ho & Bryant, 1997b; Huang & Hanley, 1997; Hu & Catts, 1998; Ho, Law, & Ng, 2000). On the other hand, further research has also demonstrated that phonological awareness is not a universal predictor of Chinese reading attainment, and that the impact of phonological awareness on a child's English reading ability is more important than that of Chinese (Ho, Chan, Tsang, & Lee, 2002; McBride-Chang, Cho, Liu et al., 2005). A longitudinal study conducted among kindergarteners by Chow and colleagues (2005) reported that phonological awareness contributed to Chinese word-reading ability following controlled visual skills tests, suggesting that phonological awareness not only plays an important role in learning alphabetical orthographies, but is also important for reading development in Chinese.

Some studies conducted in alphabetic languages (Gathercole, Willis & Baddeley, 1991; Gathercole, Willis, Emslie, & Baddeley, 1992), meanwhile, have reported that phonological memory is also related to reading acquisition. The findings of studies regarding phonological memory's role in Chinese reading development have not been consistent. McBride-Chang and Ho (2005) conducted a study among kindergartners, finding that phonological memory was not an important predictor of performance in terms of being able to read Chinese characters. On the other hand, a study by Chan et al. (2006) reported that Chinese word reading and spelling were significantly predicted by phonological memory among students from Grades 1 to 4.

Additionally, Rapid Automatized Naming (RAN) has also been connected to reading variability among Chinese children. RAN is defined as the ability to name some familiar stimuli, such as digits, letters, characters, objects, or colours, as quickly as possible. RAN has been found to be an important predictor of reading performance in different orthographies (e.g., Ho & Lai, 2000; Landerl & Wimmer, 2008). In previous researches (Ho & Lai, 2000; Ho et al., 2002), RAN discriminated between good and poor readers in order to predict early Chinese character recognition. Ho et al. (2004) reported that rapid naming uniquely contributes to literacy performance, adding that the difficulty posed by this task resembles one of the most common cognitive deficits found in dyslexic Chinese children. Compared to Hong Kong and Taiwan, only limited research has been conducted in mainland China discussing the relationship between RAN and reading fluency/accuracy.

Furthermore, Shu and colleagues (2006) have found that Chinese readers with developmental dyslexia differed from age-matched controls regarding vocabulary skills. We also included children's vocabulary knowledge in the present study due to the fact that early vocabulary knowledge has also sometimes emerged in previous studies as an important factor in correlating Chinese reading performance (e.g., Liu, McBride-Chang, Wong, Tardif, Stokes, & Shu, 2010; Pan, McBride-Chang, Shu, Liu, Zhang & Li, 2011).

In summary, previous researches have demonstrated that phonological skills, visual skills, naming speed and vocabulary knowledge are important cognitive-linguistic skills for learning to read and write Chinese (e.g., Chan et.al., 2006; Ho, Ng, & Ng, 2003; Liu & McBride-Chang, 2010; McBride-Chang & Ho, 2005; Shu et al., 2006; Tong, McBride-Chang, Wong, Shu & Rispens, 2011). However, most previous experiments on the relationship between literacy development and different cognitive constructs have been conducted mainly on children from Hong Kong and Taiwan (Chung, et al., 2018; Ho et al., 2002; Ho et al., 2004; Liu & Liu, 2020; McBride-Chang & Kail, 2002; Siok & Fletcher, 2001; McBride-Chang et al., 2008; Mo et al., 2018), whereas researches regarding reading and writing development in mainland Chinese children has been relatively fewer. The differences in scripts and literacy instruction methods implies the possibility of different optimal learning strategies (McBride, 2016). These differences may occur the discrepancy of cognitive abilities related to literacy development across Chinese different writing systems. Thus, the researches focusing on mainland Chinese children's literacy development are very important. Furthermore, some of the previous studies did not evaluate all potentially important skills comprehensively. These issues make it difficult to draw conclusions in the predictive power of each cognitive-linguistic skill in Chinese word reading as well as writing. In the present study, we conducted a comprehensive set of cognitive ability tests to determine the reading and writing-related skills of Mandarin-speaking intermediate grade children. Since children in grade 3 have learned to read and write through formal school instructions for two years, they need to learn more and more Chinese characters and words without the assistance of Pinyin. As they enter into a relatively stable stage in the development of reading and writing skills, it is likely they are suitable to participant in our study. We conducted a number of the cognitive ability tests deployed in previous pieces of researches on Chinese character reading and writing development, including visual skills, phonological skills, RAN, and vocabulary knowledge, in order to determine the reading and writing-related skills of Mandarin-speaking children, as well as to make a comparison with studies that have conducted similar tests among children from Taiwan and Hong Kong.

METHOD

Participants

140 children (75 boys and 65 girls) from a primary school in Ningbo, Zhejiang participated in this study. They were all native Chinese speakers. The individual tests were conducted when they were third graders (June, 2017), and the group tests were conducted when they were fourth graders (October, 2017).

Tests and Materials

Nonverbal intelligence test

Raven Coloured Progressive Matrices (RCPM; Raven, Court, & Raven, 1995) were administered as a nonverbal intelligence test. The test consisted of 36 items and was divided into three sets. The items were ordered in terms of increasing difficulty. For each item, a coloured pattern with a missing part was presented to the children, and they were required to select the correct missing part from six choices. Each participant's score in this test was the number of correct answers for the three sets.

Reading tests

The reading tests comprised tests focusing on both reading accuracy and reading fluency. In the reading accuracy test, two sub-tests were included: word reading and nonword reading tasks. In the reading fluency test, three sub-tests were included: rapid word reading, rapid nonword reading, and rapid paragraph reading tasks.

(1) Reading accuracy tests

The word reading test consisted of 40 words, while the nonword reading test consisted of 40 nonword stimuli. Each test included 20 one-character and 20 two-character stimuli in Chinese. For both tests, 10 out of 20 one-character and 20 two-character words were contained in typical reading patterns, as well as 10 in atypical ones. The stimuli were printed on two A4 size sheets, with the participants required to read them aloud. All of the word stimuli were selected from textbooks that had already been studied by the participants.

The one-character nonword stimuli were the component characters of disyllabic words, which did not comprise meaningful words in and of themselves. The two-character nonword stimuli were created by replacing the characters used in the two-character word reading test. In the reading accuracy tests, each participant's score was the number of correctly pronounced stimuli.

(2) Reading fluency tests

The rapid word reading test consisted of 18 word stimuli and the rapid nonword reading test consisted of 18 nonword stimuli, with each consisting of 10 one-character and 8 two-character stimuli in Chinese. All of the word stimuli were selected from textbooks that had already been taught and were therefore familiar to the children. The one-character non-word stimuli were the component characters of disyllabic words, which did not comprise meaningful words in and of themselves. The two-character non-word stimuli were created by replacing the character in the two-character compound word. For the rapid paragraph reading test, we used an original story created by the lead author of this study. This paragraph consisted of 336 words.

In the fluency test, the participants were required to read the word, nonword, and paragraph as fast as possible. The duration of each task was estimated by the experimenter using a stopwatch, and this measure represented the participant’s score.

Word-writing test

12 two-character compound words that do not have homophones were selected as the stimuli and these were derived from textbooks widely used in Chinese primary schools. These words were printed out in Pinyin and the children were then required to write down the corresponding Chinese words. The score of each participant was determined by totalling the number of correctly spelled words. A point was only awarded when both of the characters in a stimulus were spelled correctly.

Cognitive abilities tests

(1) Phonological awareness tests

The phonological awareness tests included an onset deletion and a rime deletion task. In two practice runs and five trials each, the participants were required to delete the onset or rime from the syllables and answer orally. Each sub-task included five items, making a total of 10 real syllables. Each syllable was orally presented to the children, and they were then required to repeat the syllable. Following this, they were asked to repeat the syllable, but to omit a target sound which was either the onset or rime of the syllable. Each participant's score for both the onset and rime deletion tasks was the number of correct answers out of the 5 items.

(2) Phonological memory test
In two practice runs and ten trials, the participants were asked to complete non-word repetition tests in which the stimuli consisted of 3-9 syllables. The participants were first required to listen to each nonword and then to repeat them. The stimuli were ordered in terms of the increasing length of the syllables. For the nonword repetition test, however, the real syllables were combined in a random order. Each participant's score was the number of correctly pronounced nonwords out of the 10 items.

(3) Rey-Osterrieth Complex Figure Test (ROCFT)
The Rey-Osterrieth Complex Figure Test (ROCFT) (Osterrieth, 1993) includes copy drawing, immediate recall, and delayed recall tasks. The participants were required to copy a complicated figure (copy drawing), after which they were required to draw the figure again without the target stimulus for reference (immediate recall). After about 30 minutes, the children were then asked to draw the figure again (delayed recall). The maximum score for each task was 36, calculated according to the ROCFT scoring manual. In order to minimize the impact of motor skills on the visual memory task, the immediate recall and delayed recall scores were divided by the score of copy task and the ratios of short-term visual memory and long-term visual memory were calculated and used in the analysis.

(4) Rapid automatized naming (RAN)
RAN tests, which were developed by Kaneko and colleagues (2004), were also administered to the participants. The children were asked to name, as fast as possible, drawings of objects and digits that were printed in rows on A4 size paper. The RAN tests consisted of one practice and three trials. The time used to name all the stimuli was also accounted for in each trial and the average duration of the three trials was used as the participant's score in the analyses.

(5) Standardized Comprehension Test of Abstract Words (SCTAW)
The SCTAW, a standardised test developed in Japan (Uno, Haruhara, & Kaneko, 2002), was conducted in order to test the participants' vocabulary knowledge. The participants were given the target word orally and were then presented with six pictures of each item on a slide projector screen. The participants were required to repeat the word orally twice after the experimenter, and were then asked to select one picture and circle the corresponding number on the paper. As the test was originally conducted in Japanese, the Chinese target words were based on those used in a study by Lin and Uno (2015). Each participant's score was the number of correct answers.

Procedures
The individual tests were administered in quiet rooms in the participants' school, while the group tests were administered in their classrooms. The individual sessions lasted approximately 15-20 min, while the group sessions lasted 35-40 min. This study was approved by the Ethics Committee of the University of Tsukuba (Graduate School of Comprehensive Human Sciences).

Statistical Methods

The RCPM mean score was 29, while the standard deviation was 4. Data from participants who obtained RCPM score below -1.5 SD of the mean score, as well as from participants who did not participate in all the tests, were excluded. This resulted in the exclusion of seven children. As a result, 133 children in total were included in the analysis (71 boys and 62 girls). All analyses were conducted using IBM SPSS Statistics Version 25.

RESULT AND DISCUSSION

Result(S)

Table 1 shows the descriptive statistics for each test regarding the 133 children.

Table 1. Descriptive statistics on the nonverbal intelligence test, reading tests, writing test, and cognitive abilities tests

Measures	Maximum	Minimum	Mean	SD
Nonverbal intelligence test				
RCPM (36)	36.00	19.00	28.63	4.13
Reading tests				
Word reading test (40)	40.00	32.00	38.08	1.80
Nonword reading test (40)	40.00	25.00	33.85	3.19
Rapid word reading test (sec)	29.55	5.97	14.46	4.17
Rapid nonword reading test (sec)	59.50	8.54	18.70	6.05
Rapid paragraph reading test (sec)	166.60	42.77	85.38	20.12
Writing test				
Word-writing test (12)	12.00	0.00	7.96	3.02
Cognitive abilities tests				
Onset deletion (5)	5.00	0.00	4.44	0.93
Rime deletion (5)	5.00	0.00	4.17	1.23
Nonword repetition	10.00	3.00	7.18	1.56
ROCFT copy drawing (36)	36.00	9.50	32.34	4.25
Ratio of ROCFT immediate recall	1.68	0.01	0.62	0.23
Ratio of ROCFT delayed recall	1.58	0.15	0.65	0.22
RAN (sec)	23.30	8.91	13.43	2.65
SCTAW (16)	15.00	4.00	9.92	2.12

A correlation analysis of the literacy tests (Table 2) revealed that the performances on all the reading and writing tests were significantly correlated ($p<.01$). A correlation analysis of the variables indicated that word reading was significantly correlated with the ROCFT immediate recall ($r=.208$, $p<.05$), ROCFT delayed recall ($r=.183$, $p<.05$), RAN ($r=-.203$, $p<.05$), and nonword repetition ($r=.285$, $p<.01$) cognitive tests. On the other hand, nonword reading had correlations with the ROCFT immediate recall ($r=.177$, $p<.05$), onset ($r=.175$, $p<.05$), rime deletion ($r=.19$, $p<.05$), and nonword repetition ($r=.222$, $p<.05$) cognitive tests. Rapid word reading ($r=.445$, $p<.01$) and rapid nonword reading ($r=.401$, $p<.01$) were also significantly correlated with RAN, while rapid paragraph reading had low-to-moderate correlations with the ROCFT immediate recall ($r=-.205$, $p<.01$), ROCFT delayed recall ($r=-.175$, $p<.05$), RAN ($r=.498$, $p<.01$), and nonword repetition ($r=-.209$, $p<.05$) cognitive tests. The word-writing test was significantly correlated to RAN ($r=-.264$, $p<.01$), onset deletion ($r=.191$, $p<.05$), and nonword repetition ($r=.196$, $p<.05$).

Table 2. Pearson correlation analyses of all variables

Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. SCTAW	–													
2. ROCFT copy	.040	–												
3. ROCFT imm	**.190***	.014	–											
4. ROCFT del	**.244****	.003	**.920****	–										
5. RAN	-.095	-.099	**-.201***	-.147	–									
6. onset Del.	.021	.085	-.032	-.025	-.062	–								
7. rime Del.	.022	-.151	.026	.045	-.098	**.287****	–							
8. non-word rep	.084	.097	**.179***	.114	-.035	**.211***	.08	–						
9. W Reading	.137	.091	**.208***	**.183***	**-.203***	.082	-.013	**.285****	–					
10. NWReading	.030	-.014	**.177***	.142	-.146	**.175***	.190*	**.222***	**.612****	–				
11. Rap WReading	-.034	-.085	-.059	-.035	**.445****	-.065	-.06	-.019	**-.374****	**-.371****	–			
12. Rap NW Reading	-.006	.034	-.097	-.095	**.401****	-.071	-.068	-.007	**-.404****	**-.459****	**.732****	–		
13. Rap Par Reading	-.103	-.114	**-.205***	**-.175***	**.498****	-.131	-.139	**-.209***	**-.558****	**-.602****	**.663****	**.710****	–	
14. W Writing	.085	.14	.167	.164	**-.264****	**.191***	.126	**.196***	**.501****	**.498****	**-.325****	**-.343****	**-.515****	–

ROCFT immediate (r=.19, p<.05) and delayed recall (r=.244, p<.01) had low correlations with SCTAW. Moreover, ROCFT immediate recall was significantly correlated with ROCFT delayed recall with a high correlation (r=.92, p<.01), as well as RAN (r=-.201 p<.05). Nonword repetition was significantly correlated with onset deletion (r=.211, p<.05) and ROCFT immediate recall (r=.179, p<.05) with low correlations. Furthermore, onset deletion was significantly correlated with rime deletion (r=.287, p<.01). Table 2 shows the results of the correlation analyses.

In terms of the exploratory factor analysis, Factor 1 consisted of two variables: ROCFT immediate recall (.971) and ROCFT delayed recall (.945). This factor appeared to include variables measuring visual processing skills, such as visual short-term and long-term memory (Park & Uno, 2015), and, consequently, Factor 1 was labelled ‘Visual memory’. Factor 2 included two variables: onset deletion (.619) and rime deletion (.521). This factor appeared to consist of a variable correlated with phonological processing skills, such as skills in identifying, manipulating, and reproducing phoneme units (Park & Uno, 2015). As a result, Factor 2 was labelled ‘Phonological awareness’. Factor 3 included one variable: ROCFT copy drawing (.557). This factor appeared to consist of information regarding visual perceptual skill, and thus Factor 3 was labelled ‘Visual perception’. The results of the exploratory factor analysis are shown in Table 3.

Table 3. Factor analysis of the correlation structure of 8 variables

	Factor 1 Visual memory	Factor 2 Phonological awareness	Factor 3Visual perception	Communalities
ROCFT imm	**.971**	-.018	-.016	.944
ROCFT del	**.945**	-.026	-.064	.897
SCTAW	.234	.068	.052	.062
RAN	-.191	-.134	-.082	.061
onset Del.	-.014	**.619**	.109	.395
rime Del.	.040	**.521**	-.314	.372
nonword rep	.162	.281	.160	.131
ROCFT copy	.037	.045	**.557**	.314
Contribution of factor	1.957	.760	.461	
Contribution ratio	24.458	33.954	39.716	

Multiple regression analyses were administered in order to confirm how effectively ‘Visual memory’, ‘Phonological awareness’, and ‘Visual perception’ would predict reading and writing abilities. We used the performance in the ROCFT immediate recall, onset deletion, and ROCFT copy drawing as the representative values of each factor in the factor analysis for multiple regression analyses. This was because these factors had greater variable loading on each factor (Park & Uno, 2015). The SCTAW, RAN, and nonword repetition loading on each of the three factors were relatively low. In previous studies, Pan and colleagues (2011) reported that vocabulary knowledge was a unique developmental predictor of reading ability, reading fluency, and dictation regarding Chinese characters. Rapid naming significantly predicted word reading and spelling ability among Chinese students from Grades 1 to 4 in Chan and colleagues’ study (2006), as well as Chinese students from Grades 5 to 6 in research by Shu and colleagues (2006). It would also be interesting to understand the role of SCTAW and RAN performances on reading and writing acquisition. Therefore, we used the performances in these tests in the multiple regression analyses in order to determine the relationship between the dependent variables (reading and writing performances) and the independent variables, with SCTAW and RAN labelled as ‘Receptive vocabulary’ and ‘Naming speed’, respectively. Thus, participants' performances in ROCFT immediate recall, onset deletion, ROCFT copy drawing, SCTAW, and RAN were used as representative values for each variable ('Visual memory', 'Phonological awareness', 'Visual perception', 'Receptive vocabulary', and 'Naming speed') in multiple regression analyses.

The results of the multiple regression analyses revealed that 'Visual memory' (β=0.193, p<.05) significantly predicted two-character word reading (F (5, 126) =3.56), while 'Phonological awareness' (β=0.191, p<.05) was a unique predictor of two-character nonword reading (F (5, 126) =1.67). Furthermore, the results indicated that rapid word reading, rapid nonword reading, and rapid paragraph reading (F (5, 126) =6.38, 5.20, and 9.58, respectively) were all significantly predicted by 'Naming speed' (β=0.446, p<.001, β=0.405, p<.001, β=0.461, p<.001, respectively). Furthermore, word writing performance (F (5, 126) =3.69) was also significantly predicted by both 'Phonological awareness' (β=0.176, p<.05) and 'Naming speed' (β=-0.215, p<.05) when the cognitive ability measures were used as the independent variables. In our study, participants' performance in word writing (F (7, 124) =10.00) was significantly predicted by their performances in word reading (β=0.268, p<.01) and nonword reading (β=0.296, p<.01) when word reading and nonword reading measures were added as the independent variables. 'Visual perception' and 'Receptive vocabulary' did not predict Chinese reading or writing performance. The results of the multiple regression analyses are shown in Table 4 and Table 5.

Table 4. Multiple regression analysis between the scores on reading and each variable

Variables	β coefficient	t	p	Adjusted R^2
Two-character word reading				.089
Visual memory	.193	2.227*	.028	
Phonological awareness	.097	1.155	.250	
Visual perception	.139	1.653	.101	
Receptive vocabulary	.139	1.631	.105	
Naming speed	-.099	-1.155	.250	
Two-character nonword reading				.025
Visual memory	.114	1.277	.204	
Phonological awareness	.191	2.194*	.030	
Visual perception	-.029	-.338	.736	
Receptive vocabulary	.003	.034	.973	
Naming speed	-.090	-1.018	.311	
Rapid word reading				.170
Visual memory	.031	.374	.709	
Phonological awareness	-.049	-.537	.592	
Visual perception	-.039	-.487	.627	
Receptive vocabulary	-.002	-.029	.977	
Naming speed	.446	5.441***	.0	
Rapid nonword reading				.138
Visual memory	-.023	-.278	.781	
Phonological awareness	-.051	-.626	.533	
Visual perception	.078	.952	.343	
Receptive vocabulary	.026	.308	.758	
Naming speed	.405	4.849***	.0	
Rapid paragraph reading				.247
Visual memory	-.108	-1.367	.174	
Phonological awareness	-.099	-1.302	.195	
Visual perception	-.057	-.742	.460	
Receptive vocabulary	-.036	-.470	.639	
Naming speed	.461	5.913***	.0	

Table 5. Multiple regression analysis between the scores on writing and each variable

Variables	β coefficient	t	p	Adjusted R^2
Word writing				.093
Visual memory	.124	1.432	.155	
Phonological awareness	.176	2.102*	.038	
Visual perception	.101	1.202	.232	
Receptive vocabulary	.023	.275	.784	
Naming speed	-.215	-2.515*	.013	
Word writing				.325
Visual memory	.032	.425	.671	
Phonological awareness	.106	1.439	.153	
Visual perception	.096	1.316	.190	
Receptive vocabulary	.0	.005	.996	
Naming speed	-.143	-1.908	.059	
Word reading	.268	2.857**	.005	
Nonword reading	.296	3.184**	.002	

Discussion(s)

Cognitive Predictors for Reading and Writing Abilities of Mainland Chinese Children in Intermediate Grade

The results of present study showed that phonological awareness significantly predicts non-word reading. The results of our study are in line with previous studies on alphabetic languages (e.g., Castles & Coltheart, 1993; Manis, Seidenberg, Doi, McBride-Chang, & Petersen, 1996). For alphabetic languages, phonological decoding skills are often assessed by requiring participants to read non-words (Rack, Snowling, & Olson, 1992). Previous research has classified children who mainly have difficulties in phonological processing skills into a phonological dyslexia subtype (Ho et al., 2002). These children usually provide poor performances in pseudo-word reading tasks but adequate performances in exception-word (irregular word) reading (e.g., Castles & Coltheart, 1993; Manis et al., 1996). Furthermore, compared to younger children matched for reading levels, children with dyslexia were found to be particularly poor in terms of reading non-words (e.g., Snowling, 1981; Siegel & Ryan, 1988). Similar to the results of alphabetic language studies, Ho and Bryant (1997a) found that there were significant correlations among Chinese pseudo-character reading and rhyme detection in first grade children. Unlike Ho and Bryant's study (1997a), which used pseudo-characters as stimuli, our study administered a non-word reading task in which the stimuli were created by replacing the characters used in the two-character word reading task. Although the stimuli used in Ho and Bryant's study (1997a) are different from ours, a similar result was obtained. That is, phonological awareness affects a student's performance in Chinese non-word or pseudo-character reading.

It is interesting that in our study, phonological awareness predicted non-word reading, but not word reading. The findings of previous studies (e.g., Huang & Hanley, 1995; McBride-Chang et al., 2005; Lin & Uno, 2015) demonstrate that phonological awareness is not a universal predictor of children's Chinese word-reading acquisition, which is supported by our findings. However, in contrast to our results, many studies have reported that performance on phonological awareness tasks is significantly correlated to Chinese word reading skills (e.g., Ho & Bryant, 1997b; Huang & Hanley, 1997; Hu & Catts, 1998; Siok & Fletcher, 2001; McBride-Chang & Kail, 2002). In addition, the tasks to measure phonological awareness were different across the studies mentioned above. These different findings can be accounted for the following reasons: the participants varied in age and reading experience from pre-schoolers (Ho & Bryant, 1997b) to third graders (Huang & Hanley, 1995); moreover, the tasks to measure phonological awareness, reading and writing abilities differ across previous studies.

The results of the multiple regression analyses revealed that visual memory significantly predicted Chinese word reading accuracy of intermediate grade children. This finding is consistent with previous results suggesting that visual skill contributes to Chinese reading ability (Ho & Bryant, 1999; Siok & Fletcher, 2001; Lin & Uno, 2015). In the study of Huang and Hanley (1995), performance on the visual memory test (visual paired associates) was more powerfully correlated with reading performance than the visual perceptual test (visual form discrimination). In line with study conducted by Lin and Uno (2015), we found that the score on the visual memory test (measured by ROCFT immediate recall) was the most powerful predictor of word reading performance, rather than the visual perceptual test (measured by ROCFT copy drawing). Furthermore, McBride-Chang and colleagues (2008, 2011) found a relationship between visual skills and early Chinese word recognition, suggesting that visual skills may influence Chinese literacy acquisition among at-risk readers. It appears that visual memory is strongly correlated with the ability to learn new Chinese characters. Given that the Chinese education system requires that children should be able to identify about 4,000 different characters by the end of primary school education (Huang & Hanley, 1995), excellent visual memory skills may facilitate children's ability to learn to read Chinese characters. In contrast, according to Huang and Hanley’s (1995) study, visual skills were not a significant predictor of reading abilities in children who speak alphabetic language (i.e., English). Our finding that visual memory is an important predictor of Chinese word reading ability is in line with many previous studies, although we used comprehensive set of cognitive ability, indicating that visual memory is more important in terms of the acquisition of the visually complicated Chinese orthographies than alphabetic ones.

This study also found that naming speed, as measured by the RAN test strongly predicted the reading fluency of words, non-words, and paragraphs. The correlation analyses suggest that RAN shows a powerful association with rapid reading tasks rather than reading tasks in intermediate grade. RAN has been reported to be an important predictor of reading attainment in Chinese in many existing studies (e.g., Lei, Pan, Liu, McBride-Chang, Li, & Shu, 2011; Liao, Georgiou, & Parrila, 2008; McBride-Chang & Ho, 2005; Shu et al., 2006). Prior research into Chinese speaking subjects has found that RAN is significantly related to character reading among children ranging from kindergarten to third-grade in Hong Kong and Taiwan (Lin & Uno, 2015; Hu & Catts, 1998; Chow et al., 2005; Chen, Hao, Geva, & Zhu, 2009). The findings of present study support the observation in the study of Wolf and Bowers (1999) that RAN is correlated with reading fluency more strongly than with reading accuracy. Previous research involving Japanese students has shown that the ability of automatization, as measured by RAN, significantly predicts Japanese Kana reading performance (one of the Japanese writing systems, which represents the syllable, or mora, of the Japanese language) and paragraph reading speed (Haruhara, Uno, Asahi, Kaneko, & Awaya, 2011). Similar to the findings in both alphabetic languages and Japanese (e.g., Georgiou, Parrila, & Kirby, 2009; Haruhara et al., 2011), RAN was correlated more strongly with reading fluency than with reading accuracy in intermediate grade in Chinese. The RAN task in the present study was used in order to measure the ability to retrieve phonological information from symbols or semantic information. The process during performing the RAN task is same as the process involved in the rapid reading task, in which the children retrieve the phonological representation from characters or words as quickly as possible. Therefore, it is likely that we obtained the result showing a strong association of the RAN performance with reading speed.

In this study, none of the analysed cognitive abilities successfully predicted Chinese writing ability directly when the performance on the word and non-word reading tests were used as predictive variables in multiple regression models. This finding suggests that reading ability is the most important predictor for accurate Chinese writing, and the importance of reading attainment in terms of the development of writing accuracy is in line with previous studies (Chan et al., 2006; Tan, Spinks, Eden, Perfetti & Siok, 2005; Treiman, Tincoff, Rodriguez, Mouzaki, & Francis, 1998). The results of Cheng-Lai and colleagues' (2013) study reported that Chinese character naming was a unique predictor for word dictation. Tan and colleagues (2005) have also found that writing performance was strongly correlated with Chinese reading in beginning and intermediate level readers. In Chinese, there are lots of homophones, and this causes the phonology-to-orthography correspondence relatively inconsistent. In the present study, stimuli of the writing task were printed out in Pinyin, and the children were required to write down the corresponding Chinese words. Chinese children who are skilled readers are good at the use of mappings between characters and sounds. Proficient reading skills may facilitate their abilities to retrieve the orthographic forms of the words from the sounds and meanings of the target words in their mental lexicon during the writing task (Cheng-Lai et al., 2013).

Comparison of Our results with the Findings of Previous Studies in Hong Kong and Taiwan

Consistent with the previous researches conducted in Hong Kong and Taiwan which use traditional Chinese characters, visual skills are important predictors for Chinese reading ability in Mandarin speaking children of this study who use simplified Chinese characters. The results of the present study revealed that especially visual memory is important in Chinese word reading even for intermediate grade children. This finding indicates that visual skills are correlated with the acquisition of Chinese characters or words, including both traditional or simplified characters. On the other hand, in contrast to the reports that phonological awareness played an important role in the Chinese word reading ability of younger children in Taiwan and Hong Kong, we found that phonological awareness is significantly correlated with Chinese non-word reading but not word reading. The participants in this study were intermediate grade children who were not in early stage of learning to read and write. Therefore, in order to compare our findings with those relating to children from Taiwan and Hong Kong, the relationship between reading acquisition and the phonological skills of younger readers in Mainland China should be investigated in the future studies. The result that phonological awareness predicted Chinese non-word reading is in accordance with the findings of previous studies regarding alphabetic orthographies (Rack et al., 1992). This result revealed that phonological awareness may be a universal predictor of non-word reading across orthographies.

The results of the present study indicate that naming speed contributes to reading fluency, which is consistent with the findings of previous studies involving alphabetic languages (e.g., Georgiou et al., 2009; Wolf & Bowers, 1999) and replicated the findings regarding Chinese children in Taiwan and Hong Kong (e.g., Liao et al., 2008; McBride-Chang & Ho, 2005). Moreover, the results of this study have also revealed that performance in word and non-word reading tasks successfully predicts writing performance, which is also supported by the results of existing studies conducted in Hong Kong and Taiwan (e.g., Chan et al., 2006; Cheng-Lai, et al., 2013).

CONCLUSSION

In the present study, we conducted a series of reading and writing tests, as well as cognitive tasks, in order to determine which type of cognitive abilities are correlated with the Chinese reading and writing attainment of Mandarin-speaking children. The results of present studies indicate that visual memory plays an important role in Chinese word reading accuracy, while naming speed contributes to reading fluency. The present results have implications regarding the design of useful tasks that screen poor readers of Chinese. Moreover, our results have also revealed that performance in word and nonword reading tasks successfully predicts word writing performance. Our study provides evidence that both reading and writing ability are significantly correlated, implying that teachers can improve students' writing by instructing them in the skills of reading. In conclusion, our findings suggest that the role of visual cognition including visual perception and memory in Chinese is consistent, despite the complexity of the characters and the divergence in the literacy instruction regarding the Chinese writing system.

REFERENCES

Castles, A., & Coltheart, M. (1993). Varieties of developmental dyslexia. Cognition, 47, 149-180. http://psycnet.apa.org/doi/10.1016/0010-0277(93)90003-E

Chan, D. W., Ho, C. S. H., Tsang, S. M., Lee, S. H. & Chung, K. K. H. (2006). Exploring the reading-writing connection in Chinese children with dyslexia in Hong Kong. Reading and Writing, 19, 543-561.

Chen, X., Hao, M., Geva, E., & Zhu, H. (2009). The role of compound awareness in Chinese children's vocabulary acquisition and character reading. Reading and Writing, 22, 615-631. https://doi.org/10.1007/s11145-008-9127-9

Cheng-Lai, A., Li-Tsang, C. W., Chan, A. H., & Lo, A. G. (2013). Writing to dictation and handwriting performance among Chinese children with dyslexia: Relationships with orthographic knowledge and perceptual-motor skills. Research in Developmental Disabilities, 34(10), 3372-3383. https://doi.org/10.1016/j.ridd.2013.06.039

Chung, K. K. H., Ho, C. S-H., Chan, W. W., Tsang, S-M., & Lee, S-H. (2009). Cognitive profiles of Chinese adolescents with dyslexia. Dyslexia, 16, 2-23.

Chung, K. K. H., Lam, C. B., & Cheung, K. C. (2018) Visuomotor integration and executive functioning are uniquely linked to Chinese word reading and writing in kindergarten children. Reading and Writing, 31, 155-171.

Chow, B. W.-Y., McBride-Chang, C., & Burgess, S. (2005). Phonological processing skills and early reading abilities in Hong Kong Chinese kindergarteners learning to read English as a second language. Journal of Educational Psychology, 97, 81-87. http://psycnet.apa.org/doi/10.1037/0022-0663.97.1.81

Gathercole, S. E., Willis, C. & Baddeley, A. D. (1991). Differentiating phonological memory and. awareness of rhyme: Reading and vocabulary development in children. British Journal of Psychology, 82, 387-406.

Gathercole, S. E., Willis, C., Emslie, H. & Baddeley, A. (1992). Phonological memory and vocabulary development during the early school years: A longitudinal study. Development Psychology, 28, 887-898.

Georgiou, G. K., Parrila, R., & Kirby, J. R. (2009). RAN components and reading development from Grade 3 to Grade 5: What underlies their relationship? Scientific Studies of Reading, 13, 508-534. https://doi.org/10.1080/10888430903034796

Haruhara, N., Uno, A., Asahi, M., Kaneko, M., & Awaya, N. (2011). Development of reading fluency and cognitive abilities related to reading fluency for normal child development: Fundamental study to evaluate developmental dyslexia. The Japanese Journal of Logopedics and Phoniatrics, 52(3), 263-270. https://doi.org/10.5112/jjlp.52.263

Ho, C. S.-H. (1997). The importance of phonological awareness and verbal short-term memory to children's success in learning to read Chinese. Psychologia, 40(4), 211-219.

Ho, C. S.-H, & Bryant, P. (1997a). Learning to read Chinese beyond the logographic phase. Reading Research Quarterly, 32, 276-289. http://www.jstor.org/stable/748134

Ho, C. S.-H, & Bryant, P. (1997b). Phonological skills are important in learning to read Chinese. Developmental Psychology, 33(6), 946-951. http://psycnet.apa.org/doi/10.1037/0012-1649.33.6.946

Ho, C. S.-H, & Bryant, P. (1999). Different visual skills are important in learning to read English and. Chinese. Educational and Child Psychology, 16, 4-14.

Ho, C. S.-H., Chan, D. W.-O., Lee, S-H., Tsang, S.-M., & Luan, V. H. (2004). Cognitive profiling and preliminary subtyping in Chinese developmental dyslexia. Cognition, 91, 43-75. https://doi.org/10.1016/S0010-0277(03)00163-X

Ho, C. S.-H., Chan, D. W.-O., Tsang, S.-M., & Lee, S.-H. (2002). The cognitive profile and multiple-deficit hypothesis in Chinese developmental dyslexia. Developmental Psychology, 38, 543-553. http://psycnet.apa.org/doi/10.1037/0012-1649.38.4.543

Ho, C. S.-H., & Lai, D. N-C. (2000). Naming-speed deficits and phonological memory deficits in Chinese developmental dyslexia. Learning and Individual Differences, 11, 173-186. https://doi.org/10.1016/S1041-6080(00)80004-7

Ho, C. S.-H., Law, T. P.-S., & Ng, P. M. (2000), The phonological deficit hypothesis in Chinese developmental dyslexia. Reading and Writing, 13, 57-79.

Ho, C. S.-H., Ng, T. T., & Ng, W.-K. (2003). A 'radical' approach to reading development in Chinese: The role of semantic radicals and phonetic radicals. Journal of Literacy Research, 35, 849-878.

Hu, C. F., & Catts, H. W. (1998). The role of phonological processing in early reading ability: What we. can learn from Chinese? Scientific Studies of Reading, 2, 55-79. https://doi.org/10.1207/s1532799xssr0201_3

Huang, H. S., & Hanley, J. R. (1995). Phonological awareness and visual skills in learning to read Chinese and English. Cognition, 54, 73-98. https://doi.org/10.1016/0010-0277(94)00641-W

Huang, H. S., & Hanley, J. R. (1997). A longitudinal study of phonological awareness, visual skills, and Chinese reading acquisition among first-graders in Taiwan. International Journal of Behavioral Development, 20, 249-268. https://doi.org/10.1080/016502597385324

Kaneko, M., Uno, A., & Haruhara, N. (2004). Relationship between rapid automatized naming and Kana. reading tasks in preschool children. The Japanese Journal of Logopedics and Phoniatrics, 45(1), 30-34. https://doi.org/10.5112/jjlp.45.30

Kao, H. S. R. (2000) The visual-spatial features of Chinese characters and a psychogeometric theory of. Chinese character writing. Hong Kong: Hong Kong University Press.

Landerl, K., & Wimmer, H. (2008). Development of word reading fluency and spelling in a consistent. orthography: An 8-year follow-up. Journal of Educational Psychology, 100, 150-161. DOI: 10.1037/0022-0663.100.1.150

Lei, L., Pan, J., Liu, H., McBride-Chang, C., Li, H., ...& Shu, H. (2011). Developmental trajectories of reading development and impairment from ages 3 to 8 years in Chinese children. Journal of Child Psychology and Psychiatry, 52, 212-220.

Liao, C. H., Georgiou, G. K., & Parrila, R. K. (2008). Rapid naming speed and Chinese character. recognition. Reading and Writing, 21, 231-235. https://doi.org/10.1111/j.1469-7610.2010.02311.x

Lin, C. Y., & Uno, A. (2015). Cognitive Abilities Underlying Reading in Chinese: Typical Readers among Third-Grade Children in Taiwan. The Japanese Journal of Logopedics and Phoniatrics, 56, 37-42. https://doi.org/10.5112/jjlp.56.37

Liu, Y. & Liu, D. (2020) Morphological awareness and orthographic awareness link Chinese writing to reading comprehension. Reading and Writing, 33, 1701-1720.

Liu, P. D., McBride-Chang, C., Wong, A. M.-Y., Tardif, T., Stokes, S., Fletcher, P., & Shu, H. (2010). Early language markers of poor reading performance in Hong Kong Chinese children. Journal of Learning Disabilities, 43, 322-331.

Liu, P. D., & McBride-Chang, C. (2010) What is morphological awareness? Tapping lexical compounding awareness in Chinese third graders. Journal of Educational Psychology, 102(1), 62-73.

Lo, J. C. M., Ye, Y., Tong, X., McBride, C., Ho, C. S.-H., & Waye, M. M. Y. (2018). Delayed copying is unique related to dictation in bilingual Cantonese-English-speaking children in Hong Kong. Writing Systems Research, 10(1), 26-42.

Manis, F. R., Seidenberg, M. S., Doi, L. M., McBride-Chang, C., & Petersen, A. (1996). On the bases of two subtypes of developmental dyslexia. Cognition, 58, 157-195. https://doi.org/10.1016/0010-0277(95)00679-6

McBride, C.-A. (2016) Is Chinese special? Four aspects of Chinese literacy acquisition that might distinguish learning Chinese from learning alphabetic orthographies. Educational Psychology Review, 28, 523-549.

McBride-Chang, C., Cho, J. R., Liu, H., Wagner, R. K., Shu, H., ...Muse, A. (2005). Changing models. across cultures: Associations of phonological awareness and morphological structure awareness with vocabulary and word recognition in second graders from Beijing, Hong Kong, Korea, and the United States. Journal of Experimental Child Psychology, 92(2), 140-160. https://doi.org/10.1016/j.jecp.2005.03.009

McBride-Chang, C., Chung, K. K. H., & Tong, X. (2011). Copying skills in relation to word reading and writing in Chinese children with and without dyslexia. Journal of Experimental Child Psychology, 110, 422-433.

McBride-Chang, C., & Ho, C. S. H. (2005). Predictors of beginning reading in Chinese
and English: A 2-year longitudinal study of Chinese kindergartners. Scientific Studies of Reading, 9, 117-144. https://doi.org/10.1207/s1532799xssr0902_2

McBride-Chang, C., & Kail, R. V. (2002). Cross-cultural similarities in the predictors of reading acquisition. Child Development, 73, 1392-1407. https://doi.org/10.1111/1467-8624.00479

McBride-Chang, C., Lam, F., Lam, C., Doo, S., Wong, S. W. L., & Chow, Y. Y. Y. (2008). Word recognition and cognitive profiles of Chinese pre-school children at-risk for dyslexia through language delay or familial history of dyslexia. Journal of Child Psychology and Psychiatry, 49(2), 211-218. https://doi.org/10.1111/j.1469-7610.2007.01837.x

McBride-Chang, C., Lam, F., Lam, C., Chan, B., Fong, C. Y. C., ... & Wong, S. W. L. (2011). Early predictors of dyslexia in Chinese children: familial history of dyslexia, language delay, and cognitive profiles. Journal of Child Psychology and Psychiatry, 52(2), 204-211. https://doi.org/10.1111/j.1469-7610.2010.02299.x

Mo, J., McBride, C. & Yip, L. (2018) Identifying the unique role of orthographic working memory in a componential model of Hong Kong kindergarteners' Chinese written spelling. Reading and Writing, 31, 1083-1108

Osterrieth, P. A. (1993). The complex figure copy test. The Clinical Neuropsychologist, 7(1), 4-21.

Park, H.-R. & Uno, A. (2015). Cognitive abilities underlying reading accuracy, fluency and spelling acquisition in Korean Hangul Learners from Grades 1 to 4: A cross-sectional study. Dyslexia,21(3), 235-253. http://dx.doi.org/10.1002/dys.1500

Pan, J., McBride-Chang, C., Shu, H., Liu, H., Zhang, Y. & Li, H. (2011). What is in the naming? A 5-year longitudinal study of early rapid naming and phonological sensitivity in relation to subsequent reading skills in both native Chinese and English as a second language. Journal of Educational Psychology, 103(4), 897-908.

Rack, J. P., Snowling, M. J., & Olson, R. K. (1992). The nonword reading deficit in developmental dyslexia: A review. Reading Research Quarterly, 27, 28-53. http://psycnet.apa.org/doi/10.2307/747832

Raven, J. C., Court, J. H., & Raven, J. (1995). Coloured progressive matrices. Oxford, UK: Oxford Psychologists Press.

Shu, H., McBride-Chang, C., Wu, S., & Liu, H. Y. (2006). Understanding Chinese developmental dyslexia: Morphological awareness as a core cognitive construct. Journal of Educational Psychology, 98, 122-133. http://psycnet.apa.org/doi/10.1037/0022-0663.98.1.122

Siegel, L. S., & Ryan, E. B. (1988). Development of grammatical-sensitivity, phonological, and short-term memory skills in normally achieving and learning disabled children. Developmental Psychology, 24, 28-37. http://psycnet.apa.org/doi/10.1037/0012-1649.24.1.28

Siok, W. T., & Fletcher, P. (2001). The role of phonological awareness and visual-orthographic skills in Chinese reading acquisition. Developmental Psychology, 37(6), 886-899. http://psycnet.apa.org/doi/10.1037/0012-1649.37.6.886

Snowling, M. J. (1981). Phonemic deficits in developmental dyslexia. Psychological Research, 43, 219-234.

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

Snowling, M., & Hulme, C. (1989). A longitudinal case study of developmental phonological dyslexia. Cognitive Neuropsychology, 6(4), 379-401.

Tan, L. H., Spinks, J. A., Eden, G. F., Perfetti, C. A., & Siok, W. T. (2005). Reading depends on writing, in Chinese. Proceedings of the National Academy of Sciences of the United States of America, 102(24), 8781-8785. https://dx.doi.org/10.1073%2Fpnas.0503523102

Tong, X., McBride-Chang, C., Wong, A. M.-Y., Shu, H., Reitsma, P., & Rispens, J. (2011). Longitudinal. predictors of very early Chinese literacy acquisition. Journal of Research in Reading, 34, 315-332.

Treiman, R., Tincoff, R., Rodriguez, K., Mouzaki, A., & Francis, D. J. (1998). The foundations of literacy: learning the sounds of letters. Child Development, 69(6), 1524-1540. doi:10.2307/1132130

Uno, A., Haruhara, N., & Kaneko, M. (2002). SCTAW-The Standardized Test of Abstract Words. Tokyo: Interuna Publishers.

Wang, Y., McBride-Chang, C., & Chan, S. F. (2014) Correlate of Chinese kindergarteners' word reading and writing: The unique role of copying skills? Reading and Writing, 27(7), 1281-1302.

Wang, Y., Yin, L., & McBride, C., (2015) Unique predictors of early reading and writing: A one-year longitudinal study of Chinese kindergarteners. Early Childhood Research Quarterly, 32, 51-59.

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

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