

Investigating Cognitive Skills Advantages of Early Exposure to Chinese-English Bilingual Children

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Introduction

- Bilingual children are better than monolingual children at coordinating executive control components when performing complex tasks. (Ellen Bialystok, 2011)
- Bilingual speakers are also better than monolingual speakers at switching between two tasks, (A Prior, B MacWhinney, 2010) which reflects better cognitive control or cognitive skills when changing strategies quickly.
- Cognitive skills are mental abilities that use the brain to process information, including working memory and attentional control. (Stephen K. Reed, 2020)

Method

Participants

- 178 grade 3 children from different classes at the same school in China; average age is 9.24 years; L1 Chinese; L2 English
- 176 grade 6 children from different classes at the same school in China; average age is 11.35 years; L1 Chinese; L2 English
- The same grade are divided into two groups with different levels of exposure to L2 (i.e. early and late).
- Task completed
- Language skills: receptive vocabulary tests in English and Chinese
- Reading abilities: reading fluency tests in English and Chinese; word recognition tasks in English and Chinese
- Cognitive-linguistic skills: phonological awareness in English and Chinese; morphological awareness in English and Chinese
- Working memory: the Backward Digit Span (BDS) (Christian Füllgrabe, Ozan Cem Öztürk, 2022)
- Attention: attentional control task

Purpose

- Differences in bilingualism mean differences in language skills, reading ability and cognitive-linguistic skills, which can affect cognitive processes. (Jing Yin, Connie Qun Guan, 2022)
- The purpose of this study is to compare the cognitive performance and cognitive skills of children exposed to bilingualism for different periods of time, including working memory and attention.

TABLE 1:

Results

TABLE 1 | Intercorrelations among English and Chinese cognitive, linguistic, and reading tasks: grade 3 (N=178) below the diagonal and grade 6 (N=176) above the diagonal.

	1	2	3	4	5	6	7	8	9	10	11	12
1. WM-BDS	–	0.174*	–0.042	0.091	0.163*	0.202**	0.009	0.136	0.122	0.042	0.153*	0.198**
2. Att Control	0.172*	–	0.017	–0.080	–0.105	–0.148	–0.104	–0.078	–0.029	–0.143	–0.139	–0.221**
3. PA-EN	0.299**	0.100	–	0.125	0.231*	–0.134	0.251*	0.111	0.202**	0.164*	0.050	0.023
4. PA-CH	0.260**	0.181*	0.305**	–	0.167*	0.182*	0.084	0.375**	0.076	0.224**	0.381**	0.448**
5. MA-EN	0.019	–0.077	–0.103	0.016	–	0.153*	0.279*	–0.001	0.187**	–0.073	0.281**	0.241**
6. MA-CH	–0.061	0.073	0.162*	0.290*	–0.155*	–	–0.007	0.128*	0.108	0.241**	–0.005	0.216*
7. RF-EN	0.171*	0.038	0.310*	0.373**	–0.032	0.043	–	0.249**	0.314*	–0.018	0.197**	0.208*
8. RF-CH	0.351**	0.133	0.269**	0.428**	–0.072	–0.005	0.433**	–	0.113	0.236**	0.372**	0.471**
9. Word Recog-EN	–0.031	0.141	0.029	0.037	–0.113	0.264**	0.043	0.068	–	0.234**	0.252**	0.049
10. Word Recog-CH	–0.073	–0.159	–0.121	0.060	–0.057	0.216*	0.085	–0.107	0.103	–	0.033	0.311**
11. Rec-Voc-EN	0.338**	0.293**	0.234**	0.238	–0.077	0.142	0.425**	0.278	0.130**	0.185*	–	0.428**
12. Rec-Voc-CH	0.164*	0.266**	–0.036	0.370**	–0.008	0.025	0.106	0.368*	0.370**	0.076	0.182*	–

WM-BDS, Backward Digit Span; Att Control, Attentional Control Simon Task; PA-EN, Phonological Awareness in English; PA-CH, Phonological Awareness in Chinese; MA-EN, Morphological Awareness in English; MA-CH, Morphological Awareness in Chinese; RF-EN, test Reading Fluency in English; RF-CH, test Reading Fluency in Chinese; Word Recog-EN, Word Recognition in English; Word Recog-CH, Word Recognition in Chinese; Rec-Voc-EN, Receptive Vocabulary in English; Rec-Voc-CH, Receptive Vocabulary in Chinese. The values for grade 3 are shown below the diagonal. The values for grade 6 are shown above the diagonal. *Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

- Table 1 shows the correlation coefficients among the indicators in this study. The main results of the correlation analysis show that, on the whole, the language achievement development of grade 3 and grade 6 in primary school is consistent. The relative contributions of verbal and cognitive measures to reading may change with age.

TABLE 2:

Results

TABLE 3:

TABLE 3 | Descriptive statistics by tasks for grade 6: early vs. late exposure to English.

	Early exposure (N=96)		Late exposure (N=78)		p-value	η
	M (SD)	Cronbach's α	M (SD)	Cronbach's α		
Rever's Matrices	35.1 (5.3)	0.86	35.5 (5.1)	0.83	0.67	0.08
Language						
Rec-Voc-EN	78.0 (11)	0.78	72 (12)	0.92	0.022*	0.030
Rec-Voc-CH	75.0 (15)	0.82	74 (17)	0.83	0.181	0.008
Reading						
Word Recog-EN	0.72 (0.15)	0.85	0.660 (0.18)	0.87	0.044*	0.034
Word Recog-CH	0.81 (0.14)	0.83	0.790 (0.13)	0.88	0.316	0.006
RF-EN	33.5 (5)	0.87	27.5 (5)	0.89	0.038*	0.025
RF-CH	32.2 (5.8)	0.86	30.5 (5.1)	0.88	0.078	0.005
Cognitive-Linguistic						
PA-EN	16 (1.9)	0.90	17 (2.1)	0.91	0.753	0.001
PA-CH	47 (9.8)	0.88	46 (9.9)	0.85	0.088	0.025
MA-EN	8.9 (1.2)	0.90	8.5 (1.5)	0.89	0.031*	0.027
MA-CH	5.7 (2.6)	0.90	5.4 (2.7)	0.90	0.351	0.001
Cognitive abilities						
WM-BDS	7.8 (2.4)	0.92	6.6 (2.9)	0.92	0.008*	0.039
Att Control	8.0 (2.2)	0.87	3.0 (1.1)	0.88	0.283	0.007

Standard deviations are given in parentheses. Language was measured using Receptive Vocabulary. Reading was measured using test reading fluency and word recognition. Cognitive-linguistic skills were measured using Phonological Awareness and Morphological Awareness. These above-mentioned measures were assessed in both Chinese and English. Cognitive abilities were measured using backward Digit Span and the Attentional Control Simon task. WM-BDS, Backward Digit Span; Att Control, Attentional Control Simon Task; PA-EN, Phonological Awareness in English; PA-CH, Phonological Awareness in Chinese; MA-EN, Morphological Awareness in English; MA-CH, Morphological Awareness in Chinese; RF-EN, test Reading Fluency in English; RF-CH, test Reading Fluency in Chinese; Word Recog-EN, Word Recognition in English; Word Recog-CH, Word Recognition in Chinese; Rec-Voc-EN, Receptive Vocabulary in English; Rec-Voc-CH, Receptive Vocabulary in Chinese. *stands for significant at 0.05 level.

TABLE 2 | Descriptive statistics by tasks for grade 3: early vs. late exposure to English.

	Early exposure (N=86)		Late exposure (N=64)		p-value	η
	M (SD)	Cronbach's α	M (SD)	Cronbach's α		
Rever's Matrices	23.12 (4.1)	0.86	24.5 (4.6)	0.83	0.52	0.12
Language						
Rec-Voc-EN	35 (16)	0.78	32 (18)	0.84	0.11	0.004
Rec-Voc-CH	37 (9)	0.80	42 (13)	0.81	0.005*	0.013
Reading						
Word Recog-EN	0.59 (0.17)	0.82	0.590 (0.18)	0.82	0.46	0.001
Word Recog-CH	0.58 (0.11)	0.81	0.590 (0.12)	0.83	0.76	0.001
RF-EN	18 (12)	0.82	14 (11)	0.81	0.43	0.001
RF-CH	24 (13)	0.80	25 (13)	0.85	0.66	0.001
Cognitive-Linguistic						
PA-EN	14.3 (2)	0.79	14.1 (3)	0.82	0.66	0.001
PA-CH	24.2 (8)	0.81	25.4 (8)	0.82	0.024*	0.005
MA-EN	8.2 (1)	0.83	8.1 (1)	0.82	0.50	0.003
MA-CH	3.1 (1)	0.82	3.8 (1)	0.83	0.01*	0.001
Cognitive abilities						
WM-BDS	4 (2)	0.79	3 (1.7)	0.83	0.032*	0.033
Att Control	–6 (38)	0.80	–6 (41)	0.85	0.987	0.000

Standard deviations are given in parentheses. Language was measured using Receptive Vocabulary. Reading was measured using test reading fluency and word recognition. Cognitive-linguistic skills were measured using Phonological Awareness and Morphological Awareness. These above-mentioned measures were assessed in both Chinese and English. Cognitive abilities were measured using backward Digit Span and the Attentional Control Simon task. WM-BDS, Backward Digit Span; Att Control, Attentional Control Simon Task; PA-EN, Phonological Awareness in English; PA-CH, Phonological Awareness in Chinese; MA-EN, Morphological Awareness in English; MA-CH, Morphological Awareness in Chinese; RF-EN, test Reading Fluency in English; RF-CH, test Reading Fluency in Chinese; Word Recog-EN, Word Recognition in English; Word Recog-CH, Word Recognition in Chinese; Rec-Voc-EN, Receptive Vocabulary in English; Rec-Voc-CH, Receptive Vocabulary in Chinese. *stands for significant at 0.05 level.

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TABLE 4:

Results

TABLE 4 | Significant multivariate main effects and interaction of exposure (early/late) to English and grade on working memory and attentional control (at p<0.001 level).

Source	Dependent variable	df	F	p-value	η
Exposure	Working memory	1/291	8.425	0.004	0.029
	Attentional control	1/291	0.711	0.400	0.002
Grade (3, 6)	Working memory	1/291	155.867	<0.001	0.336
	Attentional control	1/291	9.077	0.003	0.029
Exposure × MA-CH	Working memory	2/291	11.016	<0.001	0.071
	Attentional control	2/291	0.162	0.951	0.001
Exposure × Word Recog-CH	Working memory	2/291	1.392	0.250	0.010
	Attentional control	2/291	7.157	0.006	0.075

Exposure, early vs. late exposure; MA-CH, morphological awareness in Chinese; Word Recog-CH, word recognition in Chinese.

- Tables 2 and 3 present descriptive statistics and Cronbach's alpha reliability for all measures of early and late exposure in grades 3 and 6. In both grade 3 and 6, the early English exposure group performed better on working memory overall than the late English exposure group. But there is no significant difference in attention control tasks.
- As can be seen from Table 4, working memory is significantly affected by three factors: the age at which English is exposed, the grade, and the age at which morphological awareness in Chinese is exposed. In addition, grade and Chinese word recognition have remarkable effects on attentional control.

Conclusions

- Overall, these results suggest that learning a second language is beneficial for cognitive development. Specifically, early exposure to bilingualism (Chinese-English) improves cognitive skills, especially working memory. It also shows that language ability, reading ability and cognitive-linguistic ability play an important role in the cultivation of children's cognitive skills.