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The contribution of rapid automatized naming to Chinese character recognition

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ABSTRACT

This study investigated the longitudinal relationship between rapid automatized naming (RAN) and Chinese character recognition for Taiwanese children moving from grades 1 to 3. A sample pool of 1412 kindergartners took a Digit RAN subtask and were then grouped into the slow naming group (SNG) or the matched subject group (MSG). The two groups were controlled for gender, age, socio-economic status and non-verbal intelligence. They then took the RAN task, a Phonological Awareness Test and the Graded Character Recognition Test in each of the next three years. The results of statistical analyses showed that the third-grade SNG children were more likely to be identified as reading disabled in comparison to their MSG counterparts. Regardless of the grade the SNG participants were in, RAN remained a significant predictor of character recognition in the three years of investigation. However, this predictive relationship did not apply to the MSG.

1. Introduction

Many studies have identified rapid automatized naming (RAN) as an important skill which affects current and future reading performance (e.g., Kirby, Parrila, & Pfeiffer, 2003; Wagner & Torgesen, 1987). RAN refers to the speed at which a subject names as quickly as possible a whole series of familiar stimuli such as digits, letters, colors, or objects. It is a multi-componential cognitive skill requiring the coordination of several processes including attention, perception, lexical access and motor control (Wolf, 1991).

Denckla and Rudel (1976) found that English-speaking children with reading disability (RD) were significantly slower than average readers in RAN. The fact that RAN tasks were associated with RD prompted subsequent researchers to focus on the relationship between RAN and RD in childhood (Bowers & Swanson, 1991) and adulthood (Felton, Naylor, & Wood, 1990). Empirical evidence also reveals the relationships between RAN and various reading factors. First, RAN accounts for accuracy and fluency in word reading but shows a stronger association with fluency than accuracy (Katzir et al., 2006; Savage & Frederickson, 2005). Second, RAN is more closely related to orthographic processing than phonological processing (Manis, Seidenberg, & Doi, 1999; Wolf, Bowers, & Biddle, 2000). Third, RAN is also a significant predictor of reading ability when intelligence (IQ) (Badian, 1993; Hulslander et al., 2004), socio-economic status (SES) (Felton et al., 1990; Swanson, Trainin, Necoechea, & Hammill, 2003) and phonological awareness (PA) (Kirby et al., 2003; Manis et al., 1999) are statistically controlled for.

Given the distinctive orthographic features of Chinese, it is important to know what the effect of RAN is on Chinese readers. A deeper understanding of how this relationship changes in different developmental phases allows us to generalize theoretical insights into children's reading development in Chinese. Due to there being few studies addressing these issues (e.g., Chow, McBride-Chang, & Burgess, 2005; Liao, Georgiou, & Parrila, 2008; Pan et al., 2011), we focus specifically on the changing relationship between RAN and reading Chinese for children during their first three years of schooling.

1.1. RAN and reading in Chinese

Chinese is a logographic system that does not carry readily transparent rules of grapheme–phoneme correspondence. The basic written unit in Chinese is the character. The sound representation systems Zhu-Yin-Fu-Hao (Chinese Phonetic Alphabet) and Hanyu Pinyin are

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employed to represent phonological segments and to help students to learn the new characters or words in Taiwan and China respectively. Thus, the pronunciation of ideophonetic compounds is considered to be tied with phonological processing ability that accounts for variation in Chinese reading (Huang & Hanley, 1995).

Some studies of Chinese-speaking participants have suggested that RAN is a significant predictor of Chinese reading ability (e.g., Georgiou, Parrila, & Liao, 2008; Liao et al., 2008; McBride-Chang & Zhong, 2003) and that RAN deficits are connected to developmental RD in Chinese (e.g., Ho, Chan, Lee, Tsang, & Luan, 2004; Ho, Chan, Tsang, & Lee, 2002). Ho et al. (2004, 2002) examined Chinese primary school children with developmental RD, mentioning that RAN deficits and orthographic deficits were the two most dominant types of cognitive deficits in developmental RD.

The study by Liao et al. (2008) examined the relationship between RAN and Chinese character recognition in grades 2 and 4. The participants, 63 second-graders and 54 fourth-graders, were measured for their reading ability by using the Graded Character Recognition Test and a Character Reading Test which each lasted for 1 min. They found that RAN significantly accounted for the unique variance in character recognition fluency in grade 2 and for both character recognition accuracy and fluency in grade 4. These findings were consistent with McBride-Chang and Zhong's (2003) study of 103 kindergartners in Hong Kong. They reported that, after controlling for age, IQ, visual processing skills, and the speed of processing, RAN still significantly predicted future character recognition ability. Based upon the evidence from the above studies, we might conclude that early RAN slowness will forecast later difficulties in reading Chinese.

Additionally, Tan, Spinks, Eden, Perfetti, and Siok (2005) reported that for Chinese readers, RAN accounted for greater variance in children's recognition of characters or words as their age increased. Their finding was based on experiments with 131 children in Beijing—58 beginning readers and 73 intermediate readers. This tendency seems not to be consistently observed in the case of English readers (Neuhaus, Foorman, Francis, & Carlson, 2001; Wagner et al., 1997). Interestingly, Wagner et al. (1997) noticed that the influence of RAN tasks (digit and letter) on word-level reading accuracy gradually decreased as the participants' age increased.

The difference between Chinese and English in the RAN-reading relationship, as Liao et al. (2008) emphasized, is probably due to the distinctive orthographic properties of the two languages. Young readers of the two languages apply different strategies to reading the scripts throughout their developmental phases. However, the conclusions of Liao et al. (2008) and Tan et al. (2005) may be difficult to maintain since both studies employed a cross-sectional method in which the results of synchronic observations might have been contaminated by sampling problems. The observed differences among groups might merely reflect the characteristics of the groups and bear little relationship with the developmental phase. To assess the notion that Liao et al. and Tan et al. proposed, a longitudinal research design that traces the same participants over a long period of time appears to be a more feasible option.

1.2. Alphanumeric vs. non-alphanumeric RAN

Previous studies have also mentioned that in the processing of an alphabetic script, alphanumeric RAN that uses letters or digits accounts for greater reading variance than non-alphanumeric RAN that uses objects or colors (e.g., Bowers & Swanson, 1991; Bowey, McGuigan, & Ruschena, 2005; Georgiou, Parrila, & Kirby, 2006). This tendency was confirmed by Liao et al. (2008) in their study of Chinese readers in grade 4 but not those in grade 2. Such a tendency may reflect a subtle difference in the cognitive processing required for these two types of subtasks. As Humphreys, Riddoch, and Quinlan (1988) pointed out, when individuals are engaged in a non-alphanumeric RAN subtask, they inevitably need to access semantic information at the outset. In contrast, when they are engaged in an alphanumeric RAN subtask, their cognitive operations are more directly associated with orthographic and phonological processing than non-alphanumeric subtasks (see also Compton, 2003; Georgiou et al., 2008). This could be interpreted to imply the relative ease for Chinese readers to process an RAN subtask involving digits or Zhu-Yin-Fu-Hao symbols over one involving colors or objects. However, it remains to be seen whether the tendency and processing variance highlighted here exist for readers at different ages.

1.3. The current study

The present study involved children who were assessed annually from kindergarten through the third grade. The main purpose of this study was to examine the longitudinal relationship between RAN and Chinese character recognition. Despite the previous reports that RAN correlates with reading ability, there is uncertainty whether children with early RAN slowness are more likely to be identified as disabled readers of Chinese later on. The study employed techniques similar to those used by Liao et al. (2008) and Tan et al. (2005), but capitalized on a longitudinal design and a larger sample pool. Based upon our review of related literature, we proposed three hypotheses.

Hypothesis 1. After three years of development, kindergartners who initially scored in the bottom 5% for a Digit RAN subtask were more likely to be identified as RD in comparison to their matched peers who scored in the average or above average range.

Hypothesis 2. The concurrent correlation between RAN and Chinese character recognition would become stronger as the participants' age increased, even after controlling for non-verbal IQ, SES, and PA.

Hypothesis 3. The participants' naming of alphanumeric stimuli consisting of digits and Zhu-Yin-Fu-Hao symbols would account for greater variance in character recognition than non-alphanumeric stimuli consisting of objects and colors after controlling for non-verbal IQ, SES, and PA.

2. Method

2.1. Participants

The original sample pool for this study consisted of 1412 Taiwanese kindergartners, 785 boys and 627 girls, whose ages ranged from 74 months to 82 months at the time of testing, Mean = 78.83, SD = 2.8. Children from 23 kindergartens in Taichung City, Tainan City, and Taitung County in Taiwan participated. They were fluent speakers of Mandarin Chinese with non-verbal IQ of 85 or higher, as measured by the Raven's Colored Progressive Matrices (Raven, Raven, & Court, 1998). The children were administered a Digit RAN subtask to differentiate their ability in rapid naming. Seventy-one children who scored in the bottom 5% for the subtask were designated as the slow naming group (SNG). Of them, 5 participants were excluded due to emotional or kinesthetic control or our failure to obtain consent from parents. Therefore, there were 66 participants in the SNG.

We also selected 66 participants for the matched subject group (MSG), who scored between 40% and 65% for the Digit RAN subtask. These participants were selected from the same class as each student in the SNG and were matched on gender, age, SES, and non-verbal IQ. As Table 1 shows, there was no significant difference between these two groups of kindergartners in terms of SES and non-verbal IQ.

2.2. Materials

The materials administered to each participant consisted of the Rapid Automatized Naming Task, the Graded Character Recognition Test, the Raven's Colored Progressive Matrices, and the Chinese