

Abstract

Although previous studies from western societies have indicated that print awareness of alphabetic language is associated with arithmetic performance, studies of visual-orthographic skills in Chinese and its relation to arithmetic competence are scarce and findings were inconclusive. This 2-year longitudinal study aimed at investigating whether visual-orthographic skills concurrently and longitudinally predict grade 1 Chinese students' arithmetic performance. Two measures of visual-orthographic skills, lexical decision task and delayed character copying task, along with written arithmetic calculation and non-verbal reasoning ability were assessed among 314 grade 1 Cantonese-speaking children (mean age = 6.94 years) in Hong Kong. Children were tested again two years later. Simple correlations showed that the two measures of visual-orthographic skills significantly correlated with arithmetic competence at both Time 1 (T1) and Time 2 (T2), suggesting that children with higher visual-orthographic skills performed better in arithmetic calculation. Multiple regression analyses showed that while visual-orthographic skills did not predict T1 arithmetic performance, it explained a significant 2.4% of the variance in T2 arithmetic performance after controlling for all other variables. Furthermore, only delayed character copying task was a unique predictor of longitudinal arithmetic competence. The study set out to extend literature on the association of visual-orthographic awareness and learning to calculate into Chinese writing system and the results of the present study provided a partial support to the

hypothesis. The differences between the 'static' nature of lexical decision task and the 'dynamic' nature of delayed character copying task were discussed. The results of this study highlighted the possible role of visual-orthographic skills in affecting arithmetic competence and shed light on what educators could do to promote visual-orthographic skills and help children with mathematical learning difficulties.

Reading and arithmetic competence are foundational to later academic achievement (Duncan et al., 2007). It is widely observed in typically-developing children that reading and arithmetic competence are associated from early age (Davis et al., 2014; Träff, 2013) and remain predictive of each other over time (Duncan et al., 2007). Prior literature has identified distinct and shared cognitive processes of the two competencies (Huo et al., 2021) and visual-spatial processing is found to contribute to the development of both reading (Ho & Bryant, 1997; Huang & Hanley, 1995) and arithmetic (Gunderson et al., 2012; Zhang et al., 2014) in different lines of research.

Chinese children generally outperform western peers in mathematic tasks (Stevenson et al., 1990). It is suggested that learning to read Chinese may facilitate arithmetic development (Lui et al., 2021). Unlike alphabetic orthographies like English, Chinese characters are rich in visual-spatial features and relations among components. Previous studies revealed reciprocal relationship between Chinese reading development and visual-spatial skills, suggesting that reading visuo-orthographically complex characters promotes visual-spatial skills development (McBride-Chang et al., 2005; McBride-Chang et al., 2011). Moreover, both reading and solving arithmetic problems requires understanding of printed symbols (Zhang & Lin, 2018). It comes as no surprise that apart from pure visual skills, visuo-orthographical skills would be associated with arithmetic competence. Until now, there is a lack of research investigating visual-orthographic skills in Chinese and its relation to arithmetic competence.