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## Validity of the growth model of the ‘computerized visual perception assessment tool for Chinese characters structures’



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### ABSTRACT

Morphological awareness is the foundation for the important developmental skills involved with vocabulary, as well as understanding the meaning of words, orthographic knowledge, reading, and writing. Visual perception of space and radicals in two-dimensional positions of Chinese characters' morphology is very important in identifying Chinese characters. The important predictive variables of special and visual perception in Chinese characters identification were investigated in the growth model in this research. The assessment tool is the "Computerized Visual Perception Assessment Tool for Chinese Characters Structures" developed by this study. There are two constructs, basic stroke and character structure. In the basic stroke, there are three subtests of one, two, and more than three strokes. In the character structure, there are three subtests of single-component character, horizontal-compound character, and vertical-compound character. This study used purposive sampling. In the first year, 551 children 4–6 years old participated in the study and were monitored for one year. In the second year, 388 children remained in the study and the successful follow-up rate was 70.4%. This study used a two-wave cross-lagged panel design to validate the growth model of the basic stroke and the character structure. There was significant correlation of the basic stroke and the character structure at different time points. The abilities in the basic stroke and in the character structure steadily developed over time for preschool children. Children's knowledge of the basic stroke effectively predicted their knowledge of the basic stroke and the character structure.

### What does this paper add? What are the contributions of this paper?

1. Computerized visual perception assessment for Chinese character structures, consisting of two subtests, basic stroke and character structure, was developed in this study.
2. A two-wave cross-lagged panel design was used to locate important variable(s) to the prediction of how a child learns Chinese

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character structures.

3. Preschool's ability in basic stroke and character structure could effectively predict a child's future performance of basic stroke and character structure.
4. The learning of the basic stroke in Chinese characters improves a child's basic visual perceptual ability.
5. The tool developed by this study, "Computerized Visual Perception Assessment Tool for Chinese Characters Structures," reports good validity in a growth model.

## 1. Introduction

### 1.1. Morphological structures of Chinese characters

The morphological structure of Chinese characters includes strokes, radicals, character component and structures (Chen, Chang, Chang, Chiou, & Sung, 2011). Orthographic knowledge includes the relationship between morphologic, phonetic, and semantic components (Chall, 2011; Chen et al., 2011). Semantic radicals represent the knowledge of a word that make the meaning of Chinese characters apparent. For example, “金” (metal) is the radical of “銅” (copper) as the radical part “金” represents metallic materials. A phonetic radical in the character component expresses phonetic knowledge. For example “嗎”, “媽”, and “馬” share the identical pronunciation but come with different tones (Li, Shu, McBride-Chang, Liu, & Peng, 2012). Spatial arrangement of radical and character components formulate the rules for composing a word. The radical is located on the left, and the character component is located on the right; the direction is not interchangeable.

Chinese characters can be divided into single-component characters and compound characters. The basic stroke is the fundamental element of Chinese characters. Chinese character complexity can be described by the number of strokes and parts in each character. (Chen et al., 2011; Shu, Chen, Anderson, Wu, & Xuan, 2003). In comparison, the alphabet is the core of English reading and spelling (Leong, Hau, Cheng, & Tan, 2005). Orthographic processing and alphabetical order are closely related (Martin, Claydon, Morton, Binns, & Pratt, 2003).

Spatial perception and radicals in two-dimensional positions of Chinese characters' morphology is very important for identifying Chinese characters (Shu et al., 2003). As their name implies, single-component characters have only one part. Glyphs can be identified according to the surrounding area formed by Chinese character contour. Most Chinese characters have a compound form, and are divided into several parts. The most common seen is a top-bottom vertical structure (47.04% of the characters; for example, 冒). This is followed with the left-right horizontal structure (33.87% of the character; for example, 好). Further, some characters have a top-left enclosure (5.26% of the characters; for example, 庭). Other glyphs account for less than 15% of the characters: the left-right surround (3.21% of the characters; for example, 夾); the bottom-left enclosure (2.08% of the characters; for example, 週); the top three-sided enclosure (2.32% of the characters; for example, 同); a top-right enclosure (2.76% of the characters, for example, 包); the complete enclosure (1.64% of the characters; for example, 回); and an no enclosure (1.18% of the characters; for example, 人); and a left or bottom three-sided enclosure (0.64% of the characters; for example, 區, 函) (Chen et al., 2011). Most compound characters are in left-right and top-bottom structures (80.91%). Thus, the most commonly seen compound characters are of either horizontal or vertical structures. This statistical fact is used as the framework of compound characters in this study.

Morphological awareness is one of exclusively important components for preschoolers to recognize Chinese character (McBride-Chang, Shu, Zhou, Wat, & Wagner, 2003). Literacy skills of first grade students depend on their reading ability acquired in kindergarten (Lonigan, Burgess, & Anthony, 2000; McCoach, O'Connell, Reis, & Levitt, 2006). Visual perception and character recognition are important elements of reading ability. The ability to discriminate the spatial structure for Chinese character is the basic skill of morphological awareness. The basic strokes, just as morpheme, represent the smallest unit of Chinese characters. The basic stroke constructs the radicals which compose Chinese characters. The structure skills are about the recognition of radicals, spatial positions, and basic strokes. It was inferred that structures skills during the preschool stage are an important predictive variable of future Chinese visual perception.

### 1.2. Predictive study of Chinese characters structure

Reading is one of the most important skills to be acquired at school. In learning Chinese and English, morphological awareness is the foundation of the important developmental skills of vocabulary, the meaning of words, orthographic knowledge, and reading (Li et al., 2012; Nagy, Berninger, & Abbott, 2006), as well as of writing (Rosenblum, Parush, & Weiss, 2003). Visual perception for morphological awareness enhances the speed and fluency of word recognition.

The children with poor early visual perception for Chinese character structures experience difficulties in literacy assignments (Keung & Ho, 2009; Pacton et al., 2013) and activities at school. This slows down their learning and affects their ability to participate in daily activities (Bundy, Lane, & Murray, 2002).

The glyphs of Chinese characters can be used to recognize dyslexia (Ho, Chan, Lee, Tsang, & Luan, 2004). The importance of Chinese characters' recognizing ability can be found in the two studies concerning the training of morphological awareness, which enhances the phonological decoding speed and forms phoneme mapping in the brain (Foorman, 2003; Richards et al., 2006).

Using path analyses, Shu, McBride-Chang, Wu, & Liu (2006) identified the importance of morphological awareness in reading among fifth to sixth grade students. In this study, morphological awareness was the best predictive variable of literacy-related skills (Shu, McBride-Chang, Wu, & Liu, 2006). It was an essential element of word recognition in children. Wenling, Anderson, Nagy, and Houcan (2002) used structural equation models to present the importance of morphological awareness over phonological awareness

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