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Exploring factors underlying children's acquisition and retrieval of sound–symbol association skills

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ABSTRACT

Letter knowledge is considered an important cognitive foundation for learning to read. The underlying mechanisms of the association between letter knowledge and reading skills are, however, not fully understood. Acquiring letter knowledge depends on the ability to learn and retrieve sound–symbol pairings. In the current study, this process was explored by setting preschool children's ($N = 242$, mean age = 5.57 years) performance in the acquisition and retrieval of a paired associate learning (PAL) task in relation to their letter knowledge as well as to their performance in tasks assessing precursors of reading skills (i.e., phonological awareness, rapid automatized naming, phonological short-term memory, backward recall, and response inhibition). Multiple regression analyses revealed that performance in the acquisition of the PAL task was significantly associated with phonological awareness and backward recall, whereas performance in the retrieval of the PAL task was significantly associated with rapid automatized naming, phonological awareness, and backward recall. Moreover, PAL proved to be mediating the relation between reading precursors and letter knowledge. Together, these findings indicate that the acquisition of letter knowledge may depend on a visual–verbal associative learning mechanism and that different factors

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contribute to the acquisition and retrieval of such visual–verbal associations.

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Introduction

Learning to read is assumed to depend on phonological representations and a unique crossmodal associative learning process of mapping orthographic and phonological units. The process of mapping is critical for learning letter–sound correspondences at the level of single letters, letter groups, and whole words when acquiring a word recognition system (Hulme and Snowling, 2013). Basically, paired associate learning (PAL) tasks, which require (a) pairing of a stimulus and response item in memory and (b) retrieval of these pairings from memory, are thought to tap this associative learning mechanism. Evidence indeed suggests that visual–verbal PAL (i.e., pairing a visually presented symbol with a verbal output) shares a robust and specific relationship with reading abilities (Hulme, Goetz, Gooch, Adams, & Snowling, 2007; Litt, de Jong, van Bergen, & Nation, 2013; Litt & Nation, 2014). Differences in PAL abilities have been demonstrated between children with dyslexia and those without dyslexia (Messbauer and de Jong, 2003; Wimmer, Mayringer, & Landerl, 1998) as well as in studies predicting reading skills with PAL (e.g., Georgiou, Liu, & Xu, 2017; Hulme et al., 2007; Lervåg, Bråten, & Hulme, 2009; Poulsen & Elbro, 2018).

Although significant work has been carried out to clarify the relationships between PAL and reading, only few studies examined the factors underlying sound–symbol association skills (e.g., de Jong, 2007; Windfuhr & Snowling, 2001). More specifically, to our knowledge, no study exists examining possible differences in factors underlying the acquisition and retrieval of new sound–symbol pairs. The current study, therefore, investigated the relationships between the acquisition and retrieval of sound–symbol pairs and other cognitive skills associated with the acquisition of reading skills in a sample of pre-kindergarten children.

PAL can be seen as a basic learning mechanism that requires the storage and retrieval of arbitrary associations between stimulus (i.e., input) items and response (i.e., output) items in memory. These pairings can be unimodal (e.g., visual–visual, verbal–verbal) or crossmodal (e.g., visual–verbal, verbal–visual). In the context of reading, crossmodal PAL, defined as any association requiring a connection between a visual stimulus and a verbal stimulus, is in the focus of interest (Lervåg et al., 2009; Litt et al., 2013; Warmington & Hulme, 2012; Windfuhr & Snowling, 2001). The association and retrieval of letter names and sounds or learning of sight vocabulary—that is, an association of printed words with their pronunciations—are excellent examples of crossmodal PAL. This may be especially true for irregular sight words in deep orthographies such as English (Hulme et al., 2007; Windfuhr & Snowling, 2001). Finally, reading can also be seen as a form of crossmodal visual–verbal PAL, particularly in the early stages of development (Litt et al., 2013).

The empirical implementation of the visual–verbal PAL paradigm has a similar format. The visual stimuli, which can be abstract symbols (e.g., a dot; Horbach, Scharke, Cröll, Heim, & Günther, 2015), photographs (e.g., of children; Mayringer & Wimmer, 2000), drawings (e.g., cartoon animals; Poulsen & Elbro, 2018), and unfamiliar letters (e.g., Greek, Hebrew, and Arabic; Lervåg et al., 2009) or even letters of extinct languages (e.g., Akkadian; Litt et al., 2013), are presented together with the verbal stimuli, which are usually names, nonword names, or syllables. Thus, differences in the complexity of the stimulus material are found, which is mainly due to the adaptation of the tasks to the respective age range of the participants. Irrespective of the exact stimuli, performance on any PAL paradigm depends on successful learning of three distinct components, namely the visual stimulus, the verbal stimulus, and the association between these two items. Individual performance differences, thus, may stem from processes operating at any of these three levels (Litt et al., 2013). Moreover, individuals may differ with regard to their ability to retrieve learned associations from memory. Accordingly, the question arises as to which individual abilities are responsible for individual differences in visual–verbal PAL tasks.

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