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Verbal task demands are key in explaining the relationship between paired-associate learning and reading ability

Francina J. Clayton [a], Claire Sears [b], Alice Davis [b], Charles Hulme [c,*]

[a] Department of Psychology, University of York, Heslington, York YO10 5DD, UK
[b] Division of Psychology and Language Sciences, University College London, London WC1E 6BT, UK
[c] Department of Education, University of Oxford, Oxford OX2 6PY, UK

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ABSTRACT

Paired-associate learning (PAL) tasks measure the ability to form a novel association between a stimulus and a response. Performance on such tasks is strongly associated with reading ability, and there is increasing evidence that verbal task demands may be critical in explaining this relationship. The current study investigated the relationships between different forms of PAL and reading ability. A total of 97 children aged 8–10 years completed a battery of reading assessments and six different PAL tasks (phoneme–phoneme, visual–phoneme, nonverbal–nonverbal, visual–nonverbal, nonword–nonword, and visual–nonword) involving both familiar phonemes and unfamiliar nonwords. A latent variable path model showed that PAL ability is captured by two correlated latent variables: auditory–articulatory and visual–articulatory. The auditory–articulatory latent variable was the stronger predictor of reading ability, providing support for a verbal account of the PAL–reading relationship.

Introduction

The ability to create and consolidate associations between letters and corresponding speech sounds is an essential component of learning to read (Melby-Lervåg, Lyster, & Hulme, 2012; Muter, Hulme,

* Corresponding author.
E-mail address: charles.hulme@education.ox.ac.uk (C. Hulme).

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Snowling, & Stevenson, 2004). Individual differences in letter–sound knowledge are a powerful predictor of reading success (Lervåg, Bråten, & Hulme, 2009; Muter et al., 2004).

Paired-associate learning (PAL) tasks measure the ability to form novel associations between stimuli and responses. Such associations may be unimodal (between either visual or auditory stimuli) or cross-modal (between a visual stimulus and an auditory stimulus). Learning paired associates depends on learning both the individual stimuli and the association between them (Hülse, Egeth, & Deese, 1980). Many studies have shown that performance on PAL tasks predicts children's word reading ability, and evidence suggests that PAL taps a mechanism, distinct from phonological awareness, that is also important for learning to read (Lervåg et al., 2009; Warmington & Hulme, 2012; Windfuhr & Snowling, 2001). Indeed, it has been suggested that the cognitive processes underlying performance on PAL tasks reflect the very nature of learning to read—the generation of novel associations between letters (and letter strings) and phonological speech output (Ehri, 1992; Hulme & Snowling, 2013a; Snowling, 2000).

In previous studies, two different views have been taken about the nature of the relationship between PAL and reading. One view is that this relationship reflects a role for cross-modal learning as a fundamental process underlying reading development (e.g., Hulme, Goetz, Gooch, Adams, & Snowling, 2007). A second view is that the PAL–reading relationship depends specifically on verbal, or phonological, learning mechanisms (Litt, de Jong, van Bergen, & Nation, 2013).

There is some evidence that performance on tasks involving cross-modal PAL is a stronger predictor of reading as compared with other unimodal PAL tasks. A study by Hulme et al. (2007) investigated the relationship between reading and three PAL conditions: two unimodal (visual–visual and verbal–verbal) and one cross-modal (visual–verbal). Of the three conditions, visual–verbal PAL was most strongly correlated with reading ability in typically developing children, although verbal–verbal PAL was also correlated, albeit less strongly, with reading. Importantly, performance on visual–verbal PAL was a unique predictor of word reading even after controlling for performance on verbal–verbal PAL and phoneme awareness. Therefore, the authors suggested that the PAL–reading relationship was specific to learning associations between visual (orthographic) and verbal (phonological) representations. This cross-modal hypothesis is consistent with the important role of letter–sound knowledge in predicting early reading ability because acquiring letter knowledge also depends on the formation of cross-modal visual–verbal associations (Hulme & Snowling, 2013b). In addition, the finding that visual–verbal PAL is a unique predictor of reading after controlling for phoneme awareness is in line with previous research (e.g., Windfuhr & Snowling, 2001) and suggests that PAL ability depends on skills that are, at least in part, separable from children's phonological skills or the quality of stored phonological representations.

In addition, there is good evidence that, relative to typically developing controls, children with dyslexia struggle to learn visual–verbal associations (Mayringer & Wimmer, 2000; Vellutino, Scanlon, & Spearing, 1995; Wimmer, Mayringer, & Landerl, 1998). For example, Messbauer and de Jong (2003) reported that children with dyslexia perform worse on measures of visual–verbal PAL compared with a chronological-age-matched control group. Children in this study completed three PAL tasks; two cross-modal (visual–word and visual–nonword) and one unimodal (visual–visual). Children with dyslexia performed worse on both visual–verbal PAL tasks (involving words or nonwords) but did not differ from chronological-age- and reading-age-matched control groups on the visual–visual PAL task. Impaired performance on both visual–verbal PAL tasks might suggest that a cross-modal learning mechanism is important in explaining the PAL–reading relationship. However, performance on such cross-modal PAL tasks also involves verbal learning, whereas the visual–visual task involves only nonverbal stimuli and responses. In addition, Messbauer and de Jong reported that when differences in phonological awareness were taken into account, group differences on visual–verbal PAL tasks disappeared. Therefore, these findings question the notion that cross-modal associative learning drives the PAL–reading relationship. Rather, differences in verbal or phonological processing may be key.

Although the cross-modal account clearly has some support, the alternative verbal account arguably has stronger support. The verbal learning account argues that it is individual differences in learning verbal information that differentiates poor readers from good readers. Litt et al. (2013) reported a study in which children learned pairs of stimuli across four experimental conditions (verbal–verbal, visual–visual, visual–verbal, and verbal–visual) in order to dissociate modality and task demands.