Journal of Experimental Child Psychology 132 (2015) 155–188

Contents lists available at ScienceDirect

Journal of Experimental Child Psychology

journal homepage: www.elsevier.com/locate/jecp

# Growth in literacy, cognition, and working memory in English language learners

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ARTICLE INFO

*Article history:*
Received 12 February 2014
Revised 11 December 2014
Available online 28 February 2015

*Keywords:*
Working memory
English language learner (ELL)
Cognitive processing
Reading
Language acquisition
Bilingual

ABSTRACT

This cohort sequential study explored the components of working memory that underlie English reading and language acquisition in elementary school children whose first language is Spanish. To this end, children ($N$ = 410) in Grades 1, 2, and 3 at Wave 1 were administered a battery of cognitive (short-term memory [STM], working memory [WM], rapid naming, phonological processing, and random letter and number generation), vocabulary, and reading measures in both Spanish and English. These same measures were administered 1 and 2 years later. The results showed that (a) a three-factor structure (phonological STM, visual–spatial WM, and verbal WM) captured the data within both language systems, (b) growth in both the executive and STM storage components was uniquely related to growth in second language (L2) reading and language acquisition, and (c) the contribution of growth in the executive component of WM to growth in L2 processing was independent of growth in storage, phonological knowledge, inhibition, and rapid naming speed. The results suggested that growth in the phonological storage system does not supersede growth of the executive component of WM as a major contributor to growth in children's L2 reading and language.



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http://dx.doi.org/10.1016/j.jecp.2015.01.001
0022-0965/

## Introduction

In the United States, reading achievement is lower for English language learners (ELLs) who speak Spanish as their first language than for other minorities and Caucasian children (e.g., August & Hakuta, 1997; Lesaux, Crosson, Kieffer, & Pierce, 2010; McCardle, Keller-Allen, & Shuy, 2008). Several studies suggest that the gap in reading performance between ELL Spanish speakers and monolingual children increases across age (Kieffer, 2011; Lesaux, Rupp, & Siegel, 2007; Mancilla-Martinez & Lesaux, 2010; Swanson, in press). Thus, because literacy (narrowly defined here as word identification and comprehension) is lower for Latino children than for many other minority groups, and children with Spanish as their first language are more likely to have reading difficulties than are other minority and Caucasian children (e.g., August & Hakuta, 1997; Chen, Geva, & Schwartz, 2012; Swanson, Orosco, & Lussier, 2012).

The purpose of this study was to explore cognitive processes that may underlie some of the difficulties in second language (L2) reading and vocabulary in children whose first language is Spanish. One process that that may play a role in understanding some of the individual differences in L2 learning is working memory (WM). Working memory has been referred to as a processing resource of limited capacity involved in the preservation of information while simultaneously processing the same or other information (e.g., Baddeley, 2012; Engle, Tuholski, Laughlin, & Conway, 1999). Several studies suggest that the development of WM involves the increasing ability to retain information (e.g., Alloway, Gathercole, Kirkwood, & Elliot, 2009; Gathercole, Pickering, Ambridge, & Wearing, 2004; Swanson, 2011) and that such development may be related to English language learners' performance on measures of reading and language acquisition (e.g., Gorman, 2012; Swanson, Sáez, & Gerber, 2006).

One framework to capture diverse memory processes as they apply to L2 reading and vocabulary is Baddeley's multicomponent WM model (Baddeley & Logie, 1999). This multiple-component model characterizes WM as comprising a central executive controlling system that interacts with a set of two subsidiary storage systems: the speech-based phonological loop and the visual–spatial sketchpad. The phonological loop is responsible for the temporary storage of verbal information; items are held within a phonological store of limited duration, and the items are maintained within the store through the process of subvocal articulation. The phonological loop is commonly associated with short-term memory (STM) because it involves two major components discussed in the STM literature: a speech-based phonological input store and a rehearsal process (see Baddeley & Logie, 1999, for a review). The visual–spatial sketchpad is responsible for the storage of visual–spatial information over brief periods and plays a key role in the generation and manipulation of mental images. The central executive is involved in the control and regulation of the WM system. According to Baddeley (Baddeley, 2012; Baddeley & Logie, 1999), the central executive coordinates the two systems, focusing and switching attention and activating representations within long-term memory (LTM). The central executive is thought to play an important role in "controlled attention," which coincides with Norman & Shallice's, 1986 supervisory attentional system (SAS) model. This model has been revised to include an episodic buffer (Baddeley, 2000), but support for the tripartite model has been found across various age groups of children (Gathercole et al., 2004).

### *Differentiating storage from executive processing*

This study addressed two questions related to the relationship between growth in WM and growth in L2 reading and language. The first question addressed whether processes related to the executive component of WM are distinct from those related to the storage or STM component. This question is raised for two reasons. The first is that although learning a second language places demands on WM, the majority of studies implicate phonological STM (e.g., see Baddeley, Gathercole, & Papagno, 1998; Gathercole, Willis, Emslie, & Baddeley, 1992; Linck, Osthus, Koeth, & Bunting, 2013) and not the executive system. For example, children's new word learning ability in their second language and L2 vocabulary is predicted by phonological memory in their first language (e.g., Engle de Abreau & Gathercole, 2012; Lipka & Siegel, 2007; Stanovich & Siegel, 1994; Swanson, Sáez, Gerber, & Leafstedt, 2004; Thorn & Gathercole, 1999; Thorn, Gathercole, & Frankish, 2002). Thus, children with relatively poor phonological memory are less successful in L2 acquisition and in learning the sound structure of new words (e.g., see Genesee & Geva, 2006, for a review).