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# Attention allocation: Relationships to general working memory or specific language processing



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### ABSTRACT

Attention allocation, updating working memory, and language processing are interdependent cognitive tasks related to the focused direction of limited resources, refreshing and substituting information in the current focus of attention, and receiving/sending verbal communication, respectively. The current study systematically examined the relationship among executive attention, working memory executive skills, and language abilities while adjusting for individual differences in short-term memory. School-age children completed a selective attention task requiring them to recall whether a presented shape was in the same place as a previous target shape shown in an array imposing a low or high working memory load. Results revealed a selective attention cost when working above but not within memory span capacity. Measures of general working memory were positively related to overall task performance, whereas language abilities were related to response time. In particular, higher language skills were associated with faster responses under low load conditions. These findings suggest that attentional control and storage demands have an additive impact on working memory resources but provide only limited evidence for a domain-general mechanism in language learning.

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## Introduction

Attention allocation, updating working memory, and language processing are interdependent cognitive tasks related to the focused direction of limited resources, refreshing and substituting information in the current focus of attention, and receiving/sending verbal communication, respectively. These systems are probably impossible to study in isolation, which makes interpretation of findings related to any one of them challenging. For example, we know that children with an unexpected and disproportionate impairment in language development known as specific language impairment (SLI) show deficits relative to age-matched peers on measures of attention (Finneran, Francis, & Leonard, 2009) and working memory (Archibald & Gathercole, 2007). Despite efforts to employ non-linguistic tasks in these studies, the interdependency of the cognitive systems supporting working memory, attention, and language processing makes it difficult to rule out entirely explanations related to the language deficit in SLI. Another concern arising from these studies relates to the potential discrepancy in the cognitive load imposed by the tasks on children with and without impairments. Even in cases where children with impairments perform accurately, the cognitive load of the task may be higher, requiring the recruitment of additional or alternate resources. The current study provided a systematic examination of the relationship among working memory skills, language abilities, and cognitive functioning by examining whether performance on a selective attention task imposing varying but individually adjusted memory demands is dependent on working memory and/or language abilities in children with and without impairments.

Attention is viewed as a limited capacity system (e.g., Kahneman, 1973; Lavie, 2005; Lavie, Hirst, de Fockert, & Viding, 2004) that consists of multiple components, including the ability to focus, sustain, and switch mental focus (Parasuraman & Davies, 1984; Posner, 1978; Shiffrin, 1988). Essentially, in functional terms, attention refers to the ability to selectively process information, a critical aspect of our cognitive capacities (Fougnie, 2008). Attentional functions performed by distinct networks include alerting to achieve a general state of responsiveness to sensory stimulation, orienting to a subset of sensory information for privileged processing, and executive attention acting on post-sensory representations when competition exists for access to a central, limited-capacity system (Fan, McCandliss, Sommer, Raz, & Posner, 2002; Posner & Petersen, 1990). Executive attention is considered a domain-general resource shared broadly in post-perceptual cognitive tasks such as those under study in the current work.

Another critical aspect of our cognitive capacities is working memory, the ability to retain task-relevant information in a highly activated and accessible state over time (Hambrick, Kane, & Engle, 2005; Kane & Engle, 2002). One key component of working memory is a controlled attentional resource responsible for the coordination of storage and processing within working memory (Bayliss, Jarrold, Gunn, & Baddeley, 2003; Engle, Tuholski, Laughlin, & Conway, 1999; Kane et al., 2004). There is clearly a role for the executive attentional resource described above in the notion of a controlled attentional resource or “central executive” (Baddeley & Hitch, 1974) in working memory. Indeed, many studies have demonstrated the close relationship between attention and working memory (Bleckley, Durso, Crutchfield, Engle, & Khanna, 2003; Martinussen, Hayden, Hogg-Johnson, & Tannock, 2005; Vogel, McCollough, & Machizawa, 2005).

Nevertheless, the constructs of executive attention and the central executive of working memory are not entirely isomorphic. The central executive of working memory is a broader concept incorporating responsibility for the monitoring of ongoing cognitive processes and actions, the selective activation of relevant representations and procedures, and the suppression of irrelevant, distracting ones (Oberauer, Süß, Wilhelm, & Wittman, 2003). Beyond the theoretical distinctions, however, it is challenging to empirically demonstrate the unique contributions of executive attention and central executive/working memory processes. In one study of healthy adults, the best model of the data included both attention and working memory as separate predictors of intelligence (Schweizer & Moosbrugger, 2004). In the current study, we further examined the relationship between attention and working memory by having participants complete a selective attention task under different working memory loads while individually equating the demands of another component of working memory, short-term storage.

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