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Impact of auditory selective attention on verbal short-term memory and vocabulary development

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ABSTRACT

This study investigated the role of auditory selective attention capacities as a possible mediator of the well-established association between verbal short-term memory (STM) and vocabulary development. A total of 47 6- and 7-year-olds were administered verbal immediate serial recall and auditory attention tasks. Both task types probed processing of item and serial order information because recent studies have shown this distinction to be critical when exploring relations between STM and lexical development. Multiple regression and variance partitioning analyses highlighted two variables as determinants of vocabulary development: (a) a serial order processing variable shared by STM order recall and a selective attention task for sequence information and (b) an attentional variable shared by selective attention measures targeting item or sequence information. The current study highlights the need for integrative STM models, accounting for conjoined influences of attentional capacities and serial order processing capacities on STM performance and the establishment of the lexical language network.

Introduction

Over the past 20 years, a considerable literature has accumulated showing close relations between performance on verbal short-term memory (STM) measures and estimates of lexical development.

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However, the reason for this association remains uncertain, and a number of different interpretations have been proposed. The aim of the current study is to explore the respective role of serial order storage and auditory attention capacities for accounting for the association between performance on verbal STM measures and vocabulary development.

The main difficulty when interpreting the association between STM measures and vocabulary development is related to the difficulty of clearly understanding what verbal STM tasks actually measure. Typically, a verbal STM task requires immediate repetition of sequences of familiar or unfamiliar verbal information, the sequences containing either multiple items (e.g., word list immediate serial recall) or single items of variable length (e.g., multisyllabic nonword repetition). The most straightforward interpretation is to consider that verbal STM tasks reflect the capacity of a specialized verbal short-term storage system such as the phonological loop model proposed by Baddeley and Hitch (1974). In that view, the association between performance on STM tasks and vocabulary development reveals the importance of temporary phonological storage capacity for forming new long-term phonological lexical representations (e.g., Baddeley, Gathercole, & Papagno, 1998; Gathercole & Baddeley, 1989). In other words, verbal STM tasks are considered to measure verbal short-term storage capacity that is causally involved in lexical development. Longitudinal studies, showing that performance in nonword repetition tasks at 4 years of age predicts vocabulary knowledge at 5 years of age, are supportive of this assumption (Gathercole, Willis, Emslie, & Baddeley, 1992).

However, verbal STM tasks do not only reflect the capacity of a specialized STM system. A substantial body of research now shows that many verbal STM tasks are dependent on the quality and level of segmentation of lexical and sublexical phonological representations in the language system. For example, immediate serial recall tasks using word stimuli lead to higher performance levels than do tasks using nonwords, suggesting that lexical knowledge contributes to short-term recall, either indirectly via redintegration processes of the decayed STM trace during retrieval (e.g., Hulme, Maughan, & Brown, 1991; Schweickert, 1993) or directly via stabilizing feedback activation between language and STM systems at the moment of encoding (e.g., Baddeley et al., 1998; Martin, Lesch, & Bartha, 1999). Similarly, at the sublexical level, subtle knowledge about statistical properties of sound co-occurrences for the native language phonology leads to a recall advantage for nonwords containing frequent phonotactic patterns relative to nonwords with less frequent phonotactic patterns (Gathercole, Frankish, Pickering, & Peaker, 1999; Thorn & Frankish, 2005). The impact of lexical and sublexical phonological knowledge on STM performance seems to remain constant across development (Majerus & Van der Linden, 2003; Majerus, Van der Linden, Mulder, Meulemans, & Peters, 2004; Peters et al., 2007). Finally, functional neuroimaging studies also show that language-processing areas are actively recruited during verbal STM tasks (Collette et al., 2001; Fiebach, Friederici, Smith, & Swinney, 2007; Majerus, Poncelet, Van der Linden, Albouy, Salmon, Sterpenich, Vandewalle, Collette, & Maquet, 2006). This implies that traditional STM tasks reveal at least as much about language processing as they do about STM processing. Hence, the relation between performances on STM and vocabulary measures could simply imply that both measures reflect the level of development of the language system. This possibility is also raised by a subset of the results of the longitudinal study by Gathercole and colleagues (1992), who observed that vocabulary knowledge at 5 years of age predicts nonword repetition performance at 6 years of age.

There may, however, be a possibility to separate the intervention of STM and language processes in STM tasks by distinguishing between the different types of information to be maintained in these tasks. A number of studies have shown that language knowledge primarily affects processing and recall of item information, but less so recall of serial order information (e.g., Nairne & Kelley, 2004; Poirier & Saint-Aubin, 1996; Saint-Aubin & Poirier, 2005). Most recent STM models also consider that item information is partially stored via temporary activation of the language network, whereas serial order information is processed by a specialized STM system, although the exact implementation of this system varies between models (Brown, Preece, & Hulme, 2000; Burgess & Hitch, 1999; Burgess & Hitch, 2006; Gupta, 2003). Majerus, Poncelet, Greffe, and Van der Linden (2006) implemented this distinction by designing STM tasks either to maximize processing and retention of serial order information while minimizing item processing requirement (e.g., immediate serial recall of word lists with the words being sampled from a closed set of highly predictable and familiar items) or to maximize item processing requirements while minimizing serial order processing requirements (e.g., delayed