



What links verbal short-term memory performance and vocabulary level? Evidence of changing relationships among individuals with learning disability[☆]

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Abstract

Two studies are presented that adopt a novel approach to determining whether verbal short-term memory performance is causally related to vocabulary acquisition in childhood. This involves examining whether verbal short-term memory measures are more closely related to the absolute level of individuals' vocabulary, or the rate at which vocabulary has been attained. In a first study, two groups of individuals with learning disability, who differed in age but were matched for vocabulary knowledge at around the 8-year-old equivalent level, showed comparable verbal short-term memory performance. However, a second study showed that in less developed individuals functioning around the 5-year-old level of vocabulary development, matching for vocabulary knowledge did not equate verbal short-term memory performance across groups differing in chronological age. This pattern is consistent with the view that variance in verbal short-term memory performance is causally related to individual differences in vocabulary acquisition, but only early on in development.

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1. Introduction

Verbal short-term memory is typically assessed by presenting an individual with a sequence of verbal items, such as spoken digits, which they have to then repeat in

correct serial order. There is a limit to the maximum number of items that can be successfully remembered in this way—an individual's verbal short-term memory span—which is about seven items in adults (Miller, 1956). However, this limit does depend on the nature of the to-be-remembered stimuli. Verbal short-term memory spans are smaller for words which sound alike or are phonologically similar (e.g., cat, bat, and hat) than words which are phonologically dissimilar (Baddeley, 1966; Conrad & Hull, 1964). This is taken as evidence that information is stored in a phonological code in verbal short-term memory (Baddeley, 1986), with phonologically similar items being harder to discriminate successfully at recall. In addition, spans are shorter for words of a long spoken duration (e.g., helicopter and policeman) than for words of short spoken duration

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(e.g., pig and shoe) (Baddeley, Thomson, & Buchanan, 1975). This effect of word length is consistent with the view that phonological codes in verbal short-term memory are subject to time-based forgetting that is offset by a subvocal rehearsal process, the efficiency of which is constrained by the speed with which an individual can rehearse the to-be-remembered items (Baddeley et al., 1975).

Phonological storage and subvocal rehearsal form the basis of the verbal short-term memory component of Baddeley and Hitch's working memory model—the phonological loop (Baddeley, 1986; Baddeley & Hitch, 1974). According to this model, the phonological loop is a dedicated system that is separate from visuo-spatial short-term memory. Support for the distinctiveness of verbal and visuo-spatial short-term memory comes partly from evidence that these systems can be damaged in isolation. A number of neuropsychological cases have been reported in which individuals appear to have selective damage to the phonological loop, with spared visuo-spatial short-term memory (Hanley, Young, & Pearson, 1991; Shallice & Vallar, 1990; Shallice & Warrington, 1970; Vallar & Baddeley, 1984). In addition it has been argued that certain developmental disorders, in particular specific language impairment and Down syndrome, might be associated with specific phonological loop impairments (Ellis Weismer et al., 2000; Gathercole & Baddeley, 1990a; Jarrold & Baddeley, 1997; Jarrold, Baddeley, & Hewes, 1999; Jarrold, Baddeley, & Phillips, 2002; Montgomery, 1995).

In the context of learning disability, evidence of verbal short-term memory deficits may be of particular importance as it is argued that the phonological loop plays an important role in the acquisition of certain aspects of language, and of vocabulary in particular (Baddeley, Gathercole, & Papagno, 1998). This account suggests that the phonological form of a novel vocabulary item has to be held in verbal short-term memory while more stable long-term representations of that item's meaning are established. If so, then a deficit in phonological loop functioning might explain at least some of the difficulties in language functioning that are associated with conditions such as specific language impairment and Down syndrome.

Consistent with this account is evidence that a child's verbal short-term memory performance relates to their vocabulary knowledge. A large number of studies have shown that vocabulary levels correlate with verbal short-term memory span among typically developing children, even when differences in general intelligence are accounted for (see Baddeley et al., 1998). These studies have, in many cases, assessed verbal short-term memory using traditional measures such as digit span tests. However, a number have also used the Children's Test of Nonword Repetition (CNRep, Gathercole & Baddeley, 1996). This is a task in which participants hear single

nonwords and then have to repeat each item as accurately as possible. Gathercole and colleagues argue that this requires the short-term maintenance of phonological information, and so provides an appropriate measure of phonological loop capacity. In addition, Baddeley et al. (1998) suggested that the duration in which single item repetition takes place is not long enough for rehearsal to be necessary in this task, and, consequently, that it indexes the phonological storage component of the loop. It is unclear, as yet, whether storage in verbal short-term memory is limited by the quality of phonological representations, the capacity for phonological storage, or the rate of loss of phonological information (see Gathercole & Baddeley, 1990a). Nevertheless, Baddeley et al.'s (1998) claim is that verbal short-term memory tasks such as nonword repetition tap individuals' ability to accurately hold in mind novel phonological information, and that this ability is also crucial when learning the novel phonological form of a new vocabulary item.

However, as with any correlation, it is of course possible that the direction of causality runs opposite to that proposed by Baddeley, Gathercole and colleagues. In other words, it is conceivable that an individual's vocabulary knowledge plays an important role in constraining their verbal short-term memory performance. In fact this is a perfectly plausible suggestion. Research has convincingly shown that individuals' verbal short-term memory spans are higher for known lexical items than for unfamiliar nonword stimuli (e.g., Gathercole, Pickering, Hall, & Peaker, 2001; Hulme, Maughan, & Brown, 1991; Roodenrys, Hulme, & Brown, 1993; see also Brener, 1940). Similarly, nonword stimuli differ in their ease of memory and repetition depending on the extent to which they might be described as 'wordlike' (Gathercole, 1995; Gathercole, Willis, Emslie, & Baddeley, 1991; Grant et al., 1997; Metsala, 1999; Montgomery, 1995; Roodenrys & Hinton, 2002) or have lexical items embedded within them (Dollaghan, Biber, & Campbell, 1993, 1995). These effects of 'lexicality' and 'wordlikeness' are thought to reflect a process of 'redintegration' during the recall stage of a task (cf. Brown & Hulme, 1995). At recall, partially degraded memory traces are reconstructed or filled-in on the basis of an individual's long-term knowledge of the language and a 'best guess' about the identity of that stimulus. Support for the view that redintegration is a top-down process, that operates during recall rather than encoding, comes from work by Gathercole et al. (2001). They found that lexicality effects were substantially reduced in recognition tasks, in which participants needed to remember item order rather than item identity, relative to standard recall tests (see also Howard & Franklin, 1990; Knott, Patterson, & Hodges, 2000; Thorn, Gathercole, & Frankish, 2002).

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