

## Children's Serial Recall Errors: Implications for Theories of Short-Term Memory Development

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Three experiments examined developmental changes in serial recall of lists of 6 letters, with errors classified as movements, omissions, intrusions, or repetitions. In Experiments 1 and 2, developmental differences between groups of children aged from 7 to 11 years and adults were found in the pattern of serial recall errors. The errors of older participants were more likely to be movements than were those of younger participants, who made more intrusions and omissions. The number of repetition errors did not change with age, and this finding is interpreted in terms of a developmentally invariant postoutput response inhibition process. This interpretation was supported by the findings of Experiment 3, which measured levels of response inhibition in 7-, 9-, and 11-year-olds by comparing recall of lists with and without repeated items. Response inhibition remained developmentally invariant, although older children showed greater response facilitation (improved correct recall of adjacent repeated items). Group differences in the patterns of other errors are accounted for in terms of developmental changes in levels of output forgetting and changes in the efficiency of temporal encoding processes. © 2000 Academic Press

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The serial recall task is the most widely used measure of adult verbal short-term memory (STM). In this task, participants are presented with a series of items, often letters, which they must remember in the correct order. Recently,

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much research on adult STM has focused on examining the detailed patterns of errors made over different serial positions in such tasks. This examination of error patterns under various task conditions has proved useful in adjudicating between different models of adult verbal STM (e.g., Brown, Preece, & Hulme, 2000; Burgess & Hitch, 1999; Henson, 1998b). Our aim in the present paper is to use a similar method to examine the development of STM.

Errors made on serial recall tasks are commonly placed in one of three categories (see Henson, 1996, for further subdivisions). Two of these categories can be thought of as item errors: An *intrusion error* occurs when an item from outside the original presentation set is given as a response, and an *omission error* occurs when no response is given for a particular serial position. An *order or movement error* occurs when a list item is recalled in an incorrect serial position. Task manipulations may affect particular error types differentially. For example, phonological similarity tends to affect movements and intrusions rather than omissions (see Henson, 1998b, for other examples).

From a developmental perspective, differential effects of this kind suggest that developmental changes in serial recall performance may not be accompanied by equivalent changes in all error types (Maylor, Vousden, & Brown, 1999). Furthermore, as we discuss below, some models of STM development make predictions regarding the particular changes in error patterns expected to be associated with the development of serial recall. However, the majority of STM studies with children have not examined such error patterns in detail. The aim of the current paper is to explore the predictions that current theoretical approaches to STM development make in relation to error patterns, and to provide a detailed empirical examination of such patterns.

### *Rehearsal-Based Accounts of STM Development*

Many studies of verbal STM in children have involved tasks that require serial recall (e.g., Hulme, Silvester, Smith, & Muir, 1986; Pickering, Gathercole, & Peaker, 1998; Roodenrys, Hulme, & Brown, 1993). The general aim of many such studies has been to examine whether changes in rehearsal processes are the principle cause of the development of verbal STM (e.g., Henry, 1991; Hitch, Halliday, Dodd, & Littler, 1989; Hitch, Halliday, Schaafstal, & Heffernan, 1991; Hulme & Tordoff, 1989; for reviews see Cowan & Kail, 1996; Gathercole & Hitch, 1993; Henry & Miller, 1993). However, detailed predictions regarding developmental changes in specific patterns of errors in serial recall tasks have typically not been generated from rehearsal-based accounts. As they stand, such accounts simply predict improvements in overall levels of performance, without specifying the pattern of error changes expected to accompany STM development. Without a well-specified account of the rehearsal process, and a description of how it functions in conjunction with serial recall mechanisms, such predictions are unlikely to be forthcoming (Brown & Hulme, 1995).

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