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# Memory development and event-related brain potentials in children

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**Abstract**

This review examines the evidence for the maturation of memory function during childhood using event-related brain potentials (ERP), and behavioral measures. It has been shown that brain structures implicated in different forms of memory mature during the first and into the second decade of life. Whereas the maturation rates of implicit and explicit memory have not been directly assessed in the literature, studies of the maturation of the corresponding brain regions imply that there should be a progression in the maturation of the different forms of memory. This review also motivates the use of brain imaging techniques for investigation of memory systems during the developing years. Although, only a handful of such studies with children are currently available, they demonstrate that such techniques can provide information that may be unavailable otherwise. For example, when children fail to generate the ERP old/new effect, an index of episodic retrieval, it has been suggested that they may lack the necessary pre-existing representations in their long-term lexical or semantic memories. Similarly, age-related differences in ERP scalp topography during source memory paradigms suggest that children, who do not appear to show frontal scalp activity, lack inputs from frontal regions that are necessary for successful retrieval of source information. Future research with children will reveal more details about the nature of mnemonic processing during the developmental years. 

*Keywords:* Repetition priming; Old/new effect; Novelty P3; Recognition; Source memory

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Children's memory has recently received much attention in both the popular media and the scientific literature. Assessing the validity of children's eye witness testimony has been a significant motivating factor in this interest, since increasing numbers of children have been questioned about past events in their lives as social awareness of child abuse has expanded. It has been shown that autobiographical memory is not present in infancy but is established in early childhood, usually between ages 3 and 8 (for review see Nelson, 1989). Young children are also more susceptible to suggestibility than older children and adults (Ceci and Bruck, 1993), and they are more likely to confabulate and to mix locations, people and events (Ceci et al., 1994). In order to understand fully why children are less reliable in their autobiographical stories, and at what age their memory becomes qualitatively similar to that of adults, we need to understand the biological basis and the psychophysiological aspects of children's memory. We need to identify the abilities and the limits of brain memory systems during childhood, and the time course of maturation for these systems. Unfortunately, research linking neurophysiological maturation and memory development lags behind that of the behavioral domain in which the ontogeny of memory is being carefully examined (e.g. Homberg et al., 1993; Nelson, 1995), and behind other areas such as normal aging (e.g. Friedman and Fabiani, 1995; Friedman et al., 1996; Swick and Knight, 1997) and neurological diseases (e.g. Schacter and Church, 1995; Shimamura and Squire, 1988; Verfaellie et al., 1996). In particular, investigation of memory processes using event-related potentials (ERPs) has progressed rapidly in recent years (for reviews see Friedman and Fabiani, 1995; Johnson, 1995; Rugg, 1995), but only a small number of these studies deals with questions regarding the nature of children's memory.

The goal of this paper is to motivate the use of imaging techniques, and in particular the ERP method, in studying the memory processes of kindergarten to adolescent children. For a review on the developmental aspects of memory before the age of four see Nelson (1995, 1997). One important feature of brain imaging techniques, that may be particularly useful when working with young children, is that they can provide information about the nature of stimulus processing in the absence of overt behavioral responses. Among current imaging techniques, the ERP method is ideally suited for use with children because it poses no risk, such as injection of a contrast agent required by PET, and allows the child to be in a relatively comfortable environment as compared with using functional magnetic resonance imaging (fMRI). In addition, unlike some behavioral methods (such as reaction time measures) and other imaging techniques (e.g. PET, MRI), ERPs can be used across the entire lifespan, and therefore, allow direct comparison across age groups. Thus, this review will concentrate on research using the ERP technique, but much of the reasoning would apply equally well to other suitable imaging methods.

As there are many different ways to approach human memory, I will begin by briefly providing some definitions and information regarding the maturation rates of the neural systems that are implicated in the types of memory that will be