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# Advances in early memory development research: Insights about the dark side of the moon

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## Abstract

Over the past three decades impressive progress has been made in documenting the development of encoding, storage, and retrieval processes in preverbal infants and children. This literature includes an extensive and diverse database as well as theoretical conjecture about the underlying processes that drive early memory development. A selective review of some of this literature is provided to illustrate the extent and scope of this research, what is currently known about how memory develops over time, and some of the questions that remain to be answered. Importantly, research on early memory development has provided insights into a number of longstanding issues that have been prominent in the memory literature more generally (e.g., the memory systems question, infantile amnesia). It has also yielded practical information relevant to memory functioning in real world settings (e.g., for forensic and clinical psychology). We conclude that the basic processes needed to encode, store, and retrieve information are present very early in life and that although significant developmental advances take place across early childhood, many of the processes that govern memory in preverbal children are common with those of verbal children and adults. These issues are discussed and future directions for research are suggested.

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We have come a very long way from Piaget's observation that the mental life of the infant was "unhappily, a mysterious abyss for the psychologist" (Piaget, 1927, p. 7) with the chance of revealing its nature as remote as "the dark side of the moon" (Bower, 1977, p. 5). Indeed, the past thirty years have witnessed enormous advances in our understanding of the mental life of infants and toddlers including for example, the viability of the sensory and perceptual systems from birth (or before), the development of discrimination abilities within and across modalities, perceptual and conceptual category formation, problem-solving, recognition and recall memory, language comprehension, and reasoning about the physical and social worlds (for reviews see Baillargeon, 2001; Bauer, Burch, & Kleinknecht, 2002; Chen & Siegler, 2000; Courage & Howe, 2002; Gopnik & Meltzoff, 1997; Haith & Benson, 1998; Howe, 2000; Kellman & Arterbury, 1998; Lacerda, von Hofsten, & Heimann, 2001; Rovee-Collier, Hayne, & Colombo, 2001). This evidence has been garnered with a remarkable array of procedures and paradigms and an assortment of ingenious tasks that have harnessed the enormous curiosity of infants and toddlers whose response repertoire is severely limited by linguistic, perceptual, cognitive, and motor immaturities (e.g., see Hayne, this issue).

Given that the scientific study of early child development goes back at least to Darwin's observations (e.g., Darwin, 1877), this evidence has been a long time coming. There are several reasons for this, but perhaps the most basic was the assumption that infants' cognitive processes were qualitatively different from those of older children and adults because: (1) infants are nonverbal and must therefore process information (or not) without language, (2) the underlying nervous system is structurally and functionally very immature in the first two years and cannot sustain information processing activities, and (3) Piaget had persuaded a generation of researchers that the sensorimotor infant's understanding of people, objects, and events is limited to his or her immediate actions on and perceptions of them, but entails no mental representation. This assumption about the qualitative difference between the nonverbal infant and toddler and the verbal child and adult was affirmed by the repeated failure of early tests of infants' mental development (e.g., the Bayley Scales) to predict IQ in later life (for a review see Colombo, 1993). Interestingly, vestiges of these early assumptions about infant cognition can still be found in current developmental theory and debate (e.g., arguments about the role of language in memory, memory and brain development).

In this article, we provide a historical backdrop for the other articles in this special issue and briefly summarize some of the literature on early memory that illustrates our current knowledge of the factors that effect its development. We will then illustrate how progress to date in early memory research has provided insights into a number of classical issues in the memory development literature. Some of these are of theoretical significance, for example: (1) whether there are multiple memory systems or a single memory system, (2) the longstanding puzzle of infantile amnesia, and (3) whether basic memory processes and mechanisms are continuous or discontinuous from the preverbal infant to the verbal child. Early memory research has also provided answers (and provoked further questions) to a number of difficult practical matters such as (4) how to provide reliable cognitive indices for infants at risk for

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