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When autobiographical memory begins

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Abstract

The authors review competing theories concerning the emergence and early development of autobiographical memory. It is argued that the differences between these accounts, although important, may be more apparent than real. The crux of these disagreements lies not in *what* processes are important, but rather, the *role* these different processes play in the emergence of autobiographical memory and the *temporal primacy* of these controlling variables. These differences are explored theoretically and then extant as well as new data are brought to bear on these issues. What emerges is a new, more inclusive, multifactorial framework that integrates the controlling variables from diverse perspectives providing a more complete account of the beginnings of autobiographical memory.

Keywords: Autobiographical memory; Infantile amnesia; Childhood amnesia; Cognitive self; Early memory; Memory development

Research over the past decade has yielded a lively debate over the origin and subsequent development of autobiographical memory. Howe and Courage (1993, 1997) have argued that the necessary and founding achievement for the onset of autobiographical memory is the establishment of the cognitive self, an event that occurs late in the second year of life. This cornerstone event sets the lower limit on the age at which memories can be encoded, stored, and retrieved as personal—as something that happened to "me,"—and coincides roughly with the point at which a number of recent, well-controlled studies have dated the onset of adults' earliest memories

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for certain significant life events (e.g., Eacott & Crawley, 1998; Usher & Neisser, 1993). Like the onset of autobiographical memory itself, Howe and Courage contend that the accumulation of autobiographical memories follows the same course of development, involving the same basic mechanisms and processes, as other aspects of memory.

Alternative views of the onset and development of autobiographical memory set a rather different time course for this achievement. For example, Nelson, Fivush and their colleagues (e.g., Fivush, 1994, 1997; Fivush, Haden, & Reese, 1996; Fivush & Reese, 1992; Nelson, 1993, 1996) arguing from a sociolinguistic perspective contend that autobiographical memory follows the ability of the child to establish a "personal life story" in memory, an achievement that occurs through conversations with adults and significant others in which personal events and experiences are shared. As this autobiographical memory requires a certain level of linguistic and narrative competence, it does not come on line until the preschool years and by definition precludes the infant and toddler periods (see also Pillemer & White, 1989). Also espousing a later age of onset, Perner and Ruffman (1995) have tied the emergence of autobiographical memory to more general advances in metacognition, specifically to children's emerging theory of mind. They argue that event memory in very young children is initially based on "noetic" awareness or "knowing" something happened rather than on "autonoetic" awareness or "remembering" something happened (see Tulving, 1984) and that the transition from one to the other at around the age of 4 years marks the beginning of autobiographical memory. Consistent with the sociolinguistic perspective, they believe that children's conversations with others (mothers in particular) serve as an important source of data for the development of their theory of the mind, in turn promoting the establishment of children's autobiographical memory.

The age gap in the onset of autobiographical memory that exists between the proponents of the cognitive self perspective and those of the sociolinguistic and metacognitive perspectives is significant for both practical and theoretical reasons. From a pragmatic point of view, establishing the earliest age at which adults can recall personally experienced events has profound forensic implications concerning the veracity of recollections about abusive or traumatic incidents that allegedly occurred in early childhood (see Howe, 2000). From a theoretical point of view, it gets to the crux of a number of central issues in the debate over the nature and functioning of early memory (e.g., the role of consciousness in infant memory, the relationship between implicit and explicit processes), the resolution of which promises to have considerable scientific merit in its own rite. We will argue here that this debate over the importance of the cognitive self versus sociolinguistic factors in the development of autobiographical memory may be more apparent than real. That is, both the cognitive self and sociolinguistic factors are important to the development of autobiographical memory. However, what differs is the role each play and the temporal primacy of these controlling variables. Specifically, we continue to maintain that it is the emergence of the cognitive self late in the second year of life that launches autobiographical memory and that the coincident developments in both language and social cognition that occur in the same time frame

do not directly affect its *onset*. Rather, it is subsequent to this that advances in language and social cognition (and later, in metacognition) assume a particular importance as they come to provide an expressive outlet for those recollections (and reflections on those recollections) as autobiographical memory continues to evolve and mature into the childhood years. In that capacity, conversational exchanges not only provide a narrative structure for reporting events, but also serve to preserve (e.g., through rehearsal, reinstatement) or potentially alter (e.g., through reconstruction) memory records of personally experienced events. However, they are not a prerequisite to their foundation.

Before we elaborate this argument in detail and provide recent experimental evidence to support it, we summarize the early development of two key factors that are linked to autobiographical memory, namely, the cognitive self and event memory. As these have been reviewed at length elsewhere (e.g., Howe, 2000, in press; Howe & Courage, 1993, 1997), the reader is referred to those sources for additional detail. We then outline the processes that we believe guide the increase in the accessibility of autobiographical memories following the onset of the cognitive self.

Early development of the cognitive self

Although speculation about the nature and function of the self has a long tradition, one that continues to include debate about the appropriate definition of the self, its developmental course is the focus of active research (e.g., Butterworth, 1995; Cicchetti & Beeghly, 1990; Kopp & Brownell, 1991; Parker, Mitchell, & Boccia, 1994; Neisser, 1993; Povinelli, Landau, & Perilloux, 1996; Rochat, 1995,1999,2001; Snodgrass & Thompson, 1997). Despite the ongoing definitional debate, theorists from diverse perspectives (e.g., Bowlby, 1969; Darwin, 1877; Freud, 1959; James, 1890/1961; Mead, 1934; Piaget, 1954) agree on at least one important issue, namely, that there are at least two fundamental (though interrelated) facets of the self. Specifically, the "I," a subjective or implicit sense of the self as a thinker, knower, and causal agent, and the "me," an objective or explicit sense of the self with the unique and recognizable features and characteristics that constitute one's self-concept (but for a alternative view see Neisser, 1993). The mechanisms and processes underlying the growing awareness of the self in both of these aspects are the subject of ongoing investigations in both theoretical and empirical domains. As this literature is extensive, we restrict our overview to the first two postnatal years.

Until relatively recently, empirical investigation of the self in infancy was focussed almost exclusively on the objective or explicit self, (i.e., the "me"). Particular attention was paid to the development of visual self-recognition assessed by observing infants' reactions to their images in mirrors, photos, and videos (e.g., Amsterdam, 1972; Bertenthal & Fischer, 1978; Bullock & Lutkenhaus, 1990; Butterworth, 1992; Johnson, 1983; Lewis & Brooks-Gunn, 1979; Lewis, Brooks-Gunn, & Jaskir, 1985; Lewis, Sullivan, Stanger, & Weiss, 1989; Pipp, Fischer, & Jennings, 1987; Priel & DeSchonen, 1986). Collectively, these studies reveal that at least from 3 months of age infants are both attentive and positive toward their mirror image and that within

several months can discriminate their facial (and other body) features from that of another infant (Bahrick, Moss, & Fadil, 1996; Legerstee, Anderson, & Schaffer, 1998). By about 8 months they show awareness of the contingency cues provided by the tandem movement of the image with themselves and can use these for play and imitation. Full self-recognition of a mirror image as their own occurs unambiguously at about 18 months of age when infants first respond to a spot of rouge that has been covertly applied to their noses by touching their own noses. With the onset of this mark-directed behavior, infants begin to show embarrassment (shy smiling, gaze aversion, and self touching) when confronted with their images and subsequently, at about 22–24 months of age, will provide a correct verbal label for the image. Collectively, these behaviors provide a consistent picture of an infant who recognizes the mirror (photo or video) image as "me."

However, visual self-recognition is only one facet of the self-concept, one that is relatively easy to operationalize for research with infants. The self-concept (and self-awareness) implies more than recognition of one's physical features, is a fundamental aspect of social cognitive development that has roots in the early weeks of life, and continues to evolve throughout childhood and adolescence (for a review see Damon & Hart, 1988). In fact, Povinelli and his colleagues (Povinelli et al., 1996; Povinelli, Landry, Theall, Clarke, & Castile, 1999; Povinelli & Simon, 1998) have argued that mirror self-recognition may be only the first step toward the recognition of the objective self as "temporally extended" and continuing to exist over time. In a series of experiments they have shown that 2-year-old children who were able to recognize themselves on line, failed to do so after a brief delay and the provision of noncontingent video or photo feedback of themselves. Though 3- to 4-year-olds showed delayed self-recognition, it was not until between 4 and 5 years that children fully understood the relationship between the present self vis-a-vis both the recent and more distant pasts. Unfortunately, the interpretation of these outcomes is not straightforward. This is because young children's poor performance may reflect problems they have understanding the video-delay task and not their failure to understand the self extended in time (for a thorough methodological critique of this work see Suddendorf, 1999).

Most theorists do agree, however, that the achievement of mirror self-recognition marks an important developmental milestone and that a critical step is reached when children are able to represent themselves as an object of knowledge and imagination (Asendorpf & Baudonniere, 1993; Butterworth, 1992; Kagan, 1981, 1998; Lewis, 1994; Meltzoff, 1990; Neisser, 1993). In fact, mirror self-recognition may differentiate humans and a few nonhuman primates (chimpanzees, orangutans) from the rest of the animal kingdom (but see Mitchell, 1993), marking a phylogenetic boundary between primary and higher-order consciousness (see Butterworth, 1992). More importantly, mark-directed behavior reflects something bigger than self-recognition per se and signals a more pervasive transition in cognitive development late in the second year of life (for a discussion see Courage & Howe, 2002). Indeed, it is linked to achievements in a number of domains including object permanence (Bertenthal & Fischer, 1978), altruism (Johnson, 1983), empathy and self-evaluation (Kagan, 1981; Lewis et al., 1989; Stipek, Gralinski, & Kopp, 1990), synchronic imitation

(Asendorpf & Baudonniere, 1993), the language "explosion" (Bates, Bretherton, & Snyder, 1988), and pretend play (Lewis, 1994).

Although the importance of mirror self-recognition as a marker of the objective self is generally accepted it has not gone unchallenged. At issue is the meaning of mirror self-recognition, or more specifically, what pre- or co-requisite cognitive-developmental achievements (e.g., understanding the reflective properties of mirrors) in addition to self-awareness might mediate (or mask) successful task performance. In effect, the objective sense of self might be well under way by the time the infant can successfully perform the mirror task at 18 months, perhaps rooted in the early perception of, and interaction with, the social and physical environment (for discussions see Butterworth, 1995; Loveland, 1993; Mitchell, 1993; Robinson, Connell, McKenzie, & Day, 1990; Rochat, 1995, 2001). However, proponents of the idea that mirror self-recognition signals the onset of the objective sense of self also acknowledge the reality of an earlier developing, subjective or implicit sense of self-awareness—the "I." Importantly however, they contend that this is a very different self from the one that emerges in the middle of the second year of life (for a discussion see Lewis, 1994, 1995; Rochat, 2001). The subjective self originates in neonatal perceptual, motor and social processes, includes self-regulation and self-other differentiation, and affects and directs much of our behavior. However, as it is not a conscious, mental state it does not require the idea of "me." Moreover, although this subjective self provides a foundation for the objective self, it is not replaced by it in ontogeny, rather, the two continue to co-exist. The failure to differentiate these two aspects of the self underlies some of the argument over the onset and measurement of the objective self. Once these matters of definition are resolved, Lewis (1994) contends that the infant's self-referential touching before the mirror image is the measure that most clearly separates the two aspects of the self, and as such is the best single index of the construct of "me."

In sum, contemporary theories of the development of the self are consistent in the position that important foundations of the self system (most likely the self as subject, or "I") are evident in early infancy, perhaps from birth. However, there are two distinct perspectives on its subsequent developmental course. In one view, perception (e.g., visual, auditory, kinesthetic), learning, and social exchanges provide infants with information whereby they can differentiate their own characteristics from the physical and social environment (e.g., see Bahrick et al., 1996; E.J. Gibson, 1995; Neisser, 1993; Rochat, 2001). This includes the information that they need to learn about mirror properties, about their own body features (including the face), and about contingency cues whereby they can map their self-features onto the mirror image and recognize their identity. In this view, the development of the self is a continuous, incremental process and mirror self-recognition is nothing more than a step along the pathway—"me" evolves from "I." In contrast, there are those who see mirror self-recognition as something more, that is, a sudden, qualitative shift or discontinuity in the development of the self system from "I" to "me" (e.g., Kagan, 1998; Lewis, 1994; Meltzoff, 1990). The proponents of this view argue that self-recognition of "me" is more than incremental knowledge and heralds a level of conscious awareness and self-reflection that is unique to humans and only a few of

the higher nonhuman primates. They also see significance in the fact that self-recognition is part of a larger package of cognitive changes that emerge coincidentally (e.g., language, symbolic play, planning, object permanence) and which collectively permit the infant to represent various sources of information simultaneously, to formulate "testable" hypotheses and rules about the way the world operates, and to evaluate and modify these until they "get it right" (see Courage & Howe, 2002; Gopnik & Meltzoff, 1997). Importantly, the achievement of this "critical mass" of awareness of, and knowledge about, the self that comes on line at about 18 months of age serves to provide a new organizer and regulator of experience (see also Kopp & Brownell, 1991) and as we have argued elsewhere (Howe & Courage, 1997), it provides the foundation for new cognitive achievements including autobiographical memory.

Early developments in event memory

Although the definition of what constitutes "event memory" is admittedly arbitrary, we have elected here to summarize the literature that provides unequivocal evidence that infants and toddlers are able to recall a specific event (or components of an event) that occurred in the recent or more distant past. We focus on event memory as it is a developmental precursor to autobiographical memory. A particular difficulty with this research has been the establishment of a set of necessary and sufficient conditions for deciding what exactly constitutes *recall* of an event (see Bauer, 1997 for a recent discussion). As infants and toddlers lack the productive language to tell us what they recollect in words, researchers have had to look for evidence in their nonverbal behavior. In that regard, compelling arguments have been made that deferred and elicited imitation of action sequences can be considered as nonverbal analogues of cued verbal recall (see Bauer, 1996, 1997; Mandler, 1990; Meltzoff, 1990, 1995). Performance on these imitation tasks entails retrieving a cognitive structure that has been established on the basis of past experience in the absence of perceptual support for that experience, as do tests of adults' verbal recall (see Mandler, 1986). Importantly, however, a fundamental characteristic of adults' verbal recall that remains ambiguous in the infant literature is that of conscious awareness. We will return to this point later but first provide a brief overview of some of the literature on infants nonverbal recall of events.

In a now classic procedure, Meltzoff (e.g., 1988a,1988b,1988c,1990,1995) provided groups of 9- to 24-month-old infants with the opportunity to observe an adult model demonstrate a series of novel activities with a variety of unfamiliar objects. The infants were not permitted to practice the responses prior to at least a 24 h delay at which time the previously seen objects were presented. The results showed that by 9 months infants clearly have long-term memory for such object-action events and that with increasing age infants can retain a greater number of these events over progressively longer retention intervals (see Meltzoff, 1995). As noted, because these infants imitated multiple novel activities, witnessed (but not practiced) only briefly on one prior occasion, there is general agreement that such deferred imitation reveals a

capacity for nonverbal episodic-like recall rather than simple conditioning or recognition memory. Interestingly, Meltzoff and Moore (1994) have proposed that deferred imitation may occur even earlier in the first year of life. Using a rather different procedure they showed that 6-week-olds imitated an adult's facial gestures following a 24 h delay, though they were cautious in attributing this remarkable achievement to recall of the earlier witnessed event. In a variation of deferred imitation Bauer and colleagues (for reviews see Bauer, 1995; Bauer, Wenner, Dropik, & Wewerka, 2000) used *elicited* imitation, a procedure in which infants are encouraged to produce sequences of temporally ordered actions immediately following a modeling demonstration as well as after a delay. Overall, their program of research showed that 11- to 24-month-olds represent order information in their recall of 2- to 8-component event sequences. Further, they found that over the age range tested there was a steady increase in the length of the sequences that could be recalled accurately but that recall could also be facilitated and prolonged (to 24 h in the youngest infants to 8 months in the oldest) if the components of the events contained enabling or causal order relations, were familiar, and were accompanied by verbal cues at the retention test.

Hayne and colleagues (Barr, Dowden, & Hayne, 1996; Collie & Hayne, 1999; Hayne, McDonald, & Barr, 1997; Herbert & Hayne, 2000a, 2000b) extended the research on developmental changes in deferred imitation in a series of studies with 6- to 30-month-olds and found that even the youngest infants showed evidence of deferred imitation on a series of as many as 8 unique actions with various toy props following a 24 h delay. Again, significant developmental improvements were evident over the age range studied. Younger infants (6-month-olds) required twice as much exposure to the target actions in order to exhibit deferred imitation, they (6- and 12-month-olds) were less accurate in their imitation (i.e., produced fewer components), and they (12-month-olds) generalized the modeled actions less readily to a new object at retention than older (18- and 21-month-old) infants. Moreover, not until about 30 months of age were infants able to easily generalize an observed action to a new target following a 1-day delay (Herbert & Hayne, 2000a). Finally, the duration of the interval over which observed actions could be retained for imitation of 3-step sequences of modeled actions increased from 14 days for 18-month-olds up to 3 months for 24-month-olds (Herbert & Hayne, 2000b). Hayne and her colleagues attributed these developmental advances in deferred imitation over the first 2 years of life to an increase in "representational flexibility," an inherent characteristic of declarative memory processing that depends on maturing interactions between the hippocampus and association cortex as well as on experiences at encoding and test (e.g., see Eichenbaum, 1997; Hayne, Boniface, & Barr, 2000).

Rovee-Collier, Hayne, and Colombo (2001) have argued that deferred and elicited imitation are not the only tasks in which very young infants have shown memory for a single prior episode. Results of research with the mobile conjugate reinforcement paradigm have shown that 3-month-old infants are also able to retain information about an event that occurred just once. Infants learned an operant foot-kick in order to move a mobile displaying a series of yellow blocks painted with red numbers. Four days after the completion of training, infants were given passive exposure to

a wind chime suspended from the mobile stand that was briefly set in motion by an experimenter. One day later, when again shown the suspended wind chime, infants kicked vigorously, trying to move it as they did the blocks. Importantly, only infants who experienced the moving wind chime increased their kicking rate, control infants who saw a still wind chime during passive exposure did not. Rovee-Collier and her colleagues argued that as the wind chime was seen briefly only once and as infants did not activate it during that exposure, that their foot-kicking behavior at test indicated retrieval of their memory of the prior passive exposure episode in which "that thing moved."

Finally, using a variety of other procedures (e.g., behavioral re-enactment) researchers have shown that young children's memory for both naturally occurring and contrived events that occurred during their infant and toddler years are retained for considerable periods of time. In fact, under certain conditions, these memories can persist for months or years, although with the passage of time recollection of these events becomes increasingly fragmentary. For example, McDonough and Mandler (1994) found some evidence of recall of single object-specific actions in groups of 2-year-olds who had participated in an experiment when they were 11-months-old. Similarly, Sheffield and Hudson (1994) reported that 18-month-olds who experienced a series of toy-play events recalled them 6 months later. However, a longitudinal study of infants' memories of a toy-play event experienced at home when they were 10- and 14-months-old and in a laboratory setting when they were 32- and 60- months-old, revealed progressively less recollection of the event over time (Myers, Perris, & Speaker, 1994). Similarly, Boyer, Barron, and Farrar (1994) failed to find evidence of recollection of a 9-action event sequence learned by 20-month-olds and tested after a 12- to 22-month delay. As well, in an investigation of children's memories for injuries requiring emergency room treatment, Howe, Courage, and Peterson (1994) reported that children who were younger than 2-years-old expressed recollection of their accidents nonverbally after a 5-day retention interval but very little recall 6 months later.

In spite of the seeming fragility of infants' and toddlers' recall of events in the long term, marked improvements in the durability of their recollections do occur over the second year of life. Interestingly, although younger toddlers appear to take longer to encode certain stimuli than older toddlers, Bauer (1997) has argued that once the information has been acquired neither age per se nor neurological developments seem to be the primary determinants of whether or for how long an event will be recalled. This is not to denigrate the importance of maturational factors in early memory development but simply that, given the time frame being considered, these factors are not paramount (but see Hayne et al., 2000). Instead, the duration of recall seems to depend on a number of variables that affect both storage and retrieval processes and include (a) the organization of the event representation (e.g., whether the temporal relations among the event elements are enabling or arbitrary; the familiarity of the event sequence; whether and how often the event is repeated and the timing of that repetition), (b) the availability of cues or reminders of past events (e.g., through passive exposure, direct re-enactment, videotapes, still photos, or verbal narration) (see Hudson & Sheffield, 1999), and (c) improvements in cognitive and representational

processes that enhance and facilitate strategy use. Concerning these latter changes, DeLoache and her colleagues (DeLoache, Cassidy, & Brown, 1984; DeLoache & Todd, 1988) have found that 20- to 24-month-olds were better than 18- to 22-month-olds at using landmark cues, strategies such as rehearsal and monitoring, and spatial categorization to aid the retrieval of hidden toys (see also Howe, Courage, & Bryant-Brown, 1993).

As convincing as this evidence is that infants' and toddlers' recall improves for many types of events, researchers have only indirectly dealt with one traditionally important criteria of recall, that of "consciousness." That is, those who agree with the assumption that recall is by definition a conscious product (Mandler, 1986) and who acknowledge that infants show very good recall of events (albeit nonverbally), need to make the further leap of faith that such recall must be the result of a conscious or deliberate effort. Although a detailed consideration of the definition of consciousness and its role in memory development is beyond the scope of this paper, the distinction between mnemonic behavior based on conscious (explicit) recollection and that based on unconscious (implicit) influence is fundamental and gets to the heart of the debate over the nature of early memory. For example, there has been considerable speculation in the cognitive neuroscience literature that the memory systems necessary for declarative (i.e., conscious) memory do not come on line until the latter half of the first year of life (e.g., C. A. Nelson, 1995, 1997). This conjecture has been based on controversial comparisons between the memory difficulties experienced by adults with amnesia and surgically lesioned animals and intact, developing infants (for a critique see Rovee-Collier et al., 2001). Recent empirical evidence showing deferred imitation in 6-month-olds (Collie & Hayne, 1999), retention of single events by 3-month-olds (see Rovee-Collier et al., 2001), and imitation of facial gestures by 6-week-olds (see Meltzoff & Moore, 1994) as well as a number of theoretical reviews of memory phenomena in the infant and adult literatures (e.g., Gerhardstein, Adler, & Rovee-Collier, 2000; Howe & Courage, 1997; Roediger, Rajaram, & Srinvas, 1990; Rovee-Collier, 1997; Shapiro & Olson, 1994; Willingham & Preuss, 1995) have provoked an active reevaluation of this hypothesis. As part of this debate more fundamental questions have arisen including (a) whether multiple memory systems exist at all, and if so, whether they develop along serial or parallel trajectories, (b) whether our standard tests and measures are sensitive enough to distinguish declarative from nondeclarative memories (e.g., Buchner & Wippich, 2000), and (c) as the level of awareness of infants' recollections cannot be ascertained, whether consciousness has falsely become the sine qua non of an explicit or declarative memory system (Rovee-Collier, 1997; Rovee-Collier et al., 2001).

Early memory for events that happened to "me"

These theoretical issues notwithstanding, it is clear that from early in the first year of life infants can recall many aspects of previously experienced events. However, an important question for the thesis of this article concerns when these early event memories become autobiographical, that is, when do memories for events become

memories of events that happened to "me." As already briefly articulated, we argue that only when the cognitive sense of self has emerged late in the second year of life will the child be able to *organize* his or her memory for events as memory for events that were personally experienced. Thus, the emergence of the cognitive self sets the lower limit on the age at which autobiographical memories can become formed. Importantly however, this event does not guarantee that autobiographical memories will be available (or accessible), as a host of individual differences (e.g., mnemonic, affective, cognitive, neurobiological) will mediate this achievement over the preschool years (for a review see Howe, 2000).

Regardless of whether the self develops continuously from birth or emerges suddenly in the second year of life, the fact remains that at about the age of 2 years the cognitive self, a new organizer of information and experiences, becomes available and facilitates the grouping and personalization of memories for events into what eventually becomes autobiographical memory. That childhood memories become more numerous after the onset of the self can be anticipated given that (a) the features associated with the self continue to expand providing a larger base from which encoding processes can draw, and (b) improvements in the general functioning of the basic processes that drive memory (encoding, storage, and retrieval) that occur across development (attention, strategy use, knowledge, and metamemory) facilitate memory functioning in general. With what we know about early developments in memory and about the emergence of the self in infancy, it remains only to ask what it is that makes them conjoin to produce the emergent property, autobiographical memory.

To begin, we need to understand not only how basic processes can mediate improvements in autobiographical retention but also how (and which) basic processes are affected by the self in memory. A number of researchers who have addressed this issue have concluded that the self, like any other knowledge structure (e.g., see Bjorklund, 1987), can be used to interpret and organize incoming information (see Greenwald & Banaji, 1989; Klein & Kihlstrom, 1986). In a recent meta-analysis of studies of the self-reference effect in memory, Symons and Johnson (1997) concluded that the self is important not only because of its elaborative and organizational properties but also because it links encoding and test conditions, a phenomenon that facilitates access to memories (see Tulving, 1984). It is also significant that the self plays a prominent role in autobiographical recall, particularly at points in time where there are major transitions in the self. The view that the self behaves like any other organizational framework in memory is consistent with the idea that autobiographical memory is functionally no different than any other "type" of memory.

Howe and Courage (1997) have combined these ideas with the trace-integrity framework, a model that provides a viable account of the development of long-term retention generally. In this model, storage and retrieval are processes lying on a single continuum of trace integration where traces consist of collections of primitive elements (e.g., features). The key to initial acquisition is integrating features into a single, cohesive structure in memory. Across any retention interval, traces tend to disintegrate and their stability (both in terms of storage and retrieval) is compro-

mised. When this occurs, the original memory trace begins to lose its cohesion and distinctiveness fading into the background noise of other memory traces. This conceptualization of how storage and retrieval processes operate in children's memory has been widely accepted and is generally consistent with other recent views of these processes (e.g., see Schneider & Bjorklund, 1998). The trace-integrity framework is important here because it (a) provides a general context (one that is common to all of long-term memory) in which to situate autobiographical memory and (b) explains the accumulation of autobiographical memories across childhood using a simple, basic-process mechanism, namely, storage maintenance (Howe, 2000). By using the same mechanisms to explain autobiographical memory as those used to explain other memories and their development, we enhance our understanding of memory processes at both a very specific, as well as a global, level.

To see how this synthesis is achieved, consider first how such a system might encode an event both before and after the emergence of the cognitive self. When sampling features from an ongoing event (or nominal stimulus), it is well known that interpretive or internal contextual features are also included. It is also well known that only a subset of features that characterize an event (internal and external) are actually encoded and stored and that that subset is determined in a probabilistic fashion being contingent on a number of factors (e.g., a feature's salience, the encoder's expectation, attentional factors). As in stimulus sampling theory then (e.g., see Hilgard & Bower, 1975; Neimark & Estes, 1967), the stored trace of encoded features (the functional stimulus) is extracted and consists of a subset of features from the event itself (the nominal situation) as well as interpretive elements.

Like other categories and concepts, it is not until the self becomes a viable cognitive entity with recognizable features that the encoding of such features into the functional memory trace becomes possible. Importantly, even when the self becomes viable and its features become *potentially* samplable, like other features in the nominal situation, there is no guarantee that they will be sampled. Indeed, like the features that comprise any memory trace, whether features about the self are sampled is determined probabilistically and is contingent on the same factors that control sampling probabilities for other features (e.g., salience, attention, the extent to which or centrality of participation by the self in the event). These encoding fluctuations (also see Flexer & Tulving, 1978) may be used to explain the variability in the numbers of early autobiographical memories across individuals. As features get added to the self the likelihood that at least some self features will be sampled and encoded in the functional trace for an event increases.[1] Thus, although there is no

[1] Interestingly, one potential mechanism whereby features get added to the self-concept is through the conversational exchanges about personally experienced events, a phenomenon held to be critically important to the development of autobiographical memory by sociolinguistic theorists. In that view, it is through such narrative reports and conversational exchanges with others that the child gets (and is given) a sense of who he or she is and of their place in the ecology of their society. In this way, then, sociolinguistic factors may indirectly contribute to autobiographical memory serving to elaborate features about the self as seen through the eyes of the communicator.

chance of encoding self features prior to the emergence of a recognizable cognitive self, this does not mean that events cannot be remembered as events, per se. In fact, this is the likely status of the variety of events that infants do recall in the first year or so of life. In addition, it is important to note that even when a viable cognitive self emerges, events can remain depersonalized if features of the self are not sampled and encoded in the stored trace (or "decay" during the retention interval). In sum, having a viable cognitive self does set the lower limit as to when autobiographical memories can be established although it does not guarantee that such memories will be established at that age. As the number of features associated with the self increases, the corresponding likelihood of at least some of these features being sampled increases, with the result that memory for an event now becomes memory for an event that happened to me, a memory that, by definition, is now autobiographical. This, coupled with the growth in storage capacity (Howe, 2000), can account for the accumulation of autobiographical memories across childhood.

There is a body of empirical support for these claims. First, autobiographical memories do increase in both number and longevity in memory as childhood progresses (e.g., Wetzler & Sweeney, 1986). Second, a number of studies have shown that the best retained memories over the lifespan are those pertaining to the self, especially the self in times of transition (e.g., Conway, 1996). In particular, as the self goes through changes, events associated with those change points are well remembered (e.g., Csikszentmihalkyi & Beatie, 1979). Although such findings highlight the importance of changes in the self in autobiographical memories, such transitions also represent unique occurrences in one's life, an idea that squares well with other findings showing that the uniqueness of an event is one of the best overall predictors of recall generally (e.g., Howe, Courage, Vernescu, & Hunt, 2000) and autobiographical recall specifically (Betz & Skowronski, 1997; Brewer, 1988; Linton, 1979). Thus, it is clear that events about the self, particularly those that are personally consequential, transition defining, or otherwise distinctive, are best remembered autobiographically.

Further developments in autobiographical memory: Language and metacognition

As noted earlier, alternative hypotheses about the onset of autobiographical memory set a later beginning and a developmental course rooted in language and social cognition. One of these perspectives has focussed on the role of social interaction in the emergence of the autobiographical memory system, in particular, the sharing of experiences with others linguistically (Fivush et al., 1996; Fivush & Reese, 1992; Hudson, 1990; Nelson, 1993). As young children learn to talk about the past with adults, they begin to organize these events autobiographically (especially in terms of time lines) in memory. Thus, the primary *function* of autobiographical memory is to develop a life history in time and to do that by telling others what one is like through narrating the events of the past. In this way children learn both the form of reporting about past events and the social functions that talking about the past performs.

It is important to note here that the functional aspects of memory should not be identified with its representational structure. As Damasio (1999) has pointed out "language—that is, words and sentences—is a translation of something else, a conversion from nonlinguistic images which stand for entities, events, relationships, and inferences. If language operates for the self and for consciousness in the same way it operates for everything else, that is, by symbolizing in words and sentences what exists first in nonverbal form, then there must be a nonverbal self and a nonverbal knowing for which the words 'I' and 'me' or the phrase 'I know' are the appropriate translations in any language" (p. 108).

At an empirical level research has indicated that at about 2.5 years most children begin to talk about specific events but that these early conversations are heavily "scaffolded" by adults (e.g., Hudson, 1990). By about 3 years, children assume more responsibility for talking about past events and begin to use the story or narrative form in these conversational interactions. However, although some of these advances begin to occur as early as 3–4 years of age, Nelson (1993) has maintained that "true" autobiographical memory is quite late to develop and may only be complete near the end of the preschool years. According to this sociolinguistic view, then, autobiographical memory is predicated on the development of rather sophisticated language-based representational skills, ones that do not emerge until children are about 5- or 6-years-old. Once these skills are established, memories can be retained and organized around a life history, one that extends in time. Povinelli and his colleagues (Povinelli et al., 1996, 1999; Povinelli & Simon, 1998) also contend that a sense of continuity must be linked with our knowledge of our personal history. As it is this "life history" element that ostensibly makes a memory autobiographical, very young children's reports of personally experienced events are precluded (see earlier discussion of young children's self extended in time), a judgement that does not square well with many findings in the empirical literature on young children's memory for events.

Because this sociolinguistic perspective places considerable importance on children's conversations about the past, particularly with their parents (and especially mothers), it is important to see what empirical support exists for the role of these conversations in children's autobiographical memory. Research conducted within this framework reveals that individual differences in the way that parents talk to their children about the past leads to individual differences in children's reporting of their own past experiences. In particular, two different parent conversational styles of talking with children have been identified. "High-elaborative" parents provide a large amount of detailed information about past events. They elaborate and expand on the child's partial recall, ask further questions to enhance event detail, and correct the child's memory if necessary. In contrast, "low-elaborative" parents tend to repeat their questions over and over in an attempt to get a specific answer from the child, switch topics more frequently, and do not seek elaborative detail from the child's report. Importantly, the high-elaborative style is associated with children's provision of more elaborative narratives, both concurrently and longitudinally (Haden, Haine, & Fivush, 1997; Reese, Haden, & Fivush, 1993). Although adult conversational style does appear to facilitate the richness and narrative organization of children's

memory talk and in so doing plays an important role in children's developing ability to *report* autobiographical memories, it does not necessarily determine the *content* or *accuracy* of children's memory reports (see Fivush, 1994; Goodman, Quas, Batterman-Faunce, Riddlesberger, & Kuhn, 1994). In fact, reconstruction of events through conversations with others can lead to systematic distortions of memory details, ones that are congruent with the recaller's, as well as the listener's, current beliefs and expectations (e.g., Ross & Wilson, 2000). Thus, consistent with the well-replicated finding in the memory literature more generally, the strategy of verbal rehearsal (elaborative or otherwise) can serve not only to reinforce and reinstate memories, but can also lead to a number of errors in recall.

From the sociolinguistic perspective then, parents are actively involved in teaching their children how to remember and also the techniques of sharing memories with others through narrative reports. On the broader scale in which culture is our teacher, recent research shows that like the individual differences in children's conversational styles and the memory reports that correlate with parent talk, children in other cultures exposed to different conversational styles differ in memory reporting. For example, some research shows that American mothers talk to their 3-year-olds about past events three times as often as Korean mothers do. Further, American children talk about past events more than Korean children do and American adults report earlier autobiographical memories than Korean adults do (Han, Leitchman, & Wang, 1998; Mullen, 1994; Muller & Yi, 1995). Similar relationships were found between age of earliest memory, culture, and conversational interactions in a comparison of Maori, Pakeha, and Asian adults living in New Zealand (MacDonald, Uesiliana, & Hayne, 2000). Interestingly, culture appears to affect not only the linguistic expression of event memories but also the perspective from which events that are encoded. In a recent study with Asian and American adults, Cohen and Gunz (2002) found that the contents of their memories of events were colored by their phenomenological experiences as members of these two cultures, with Asians being more likely than Americans to experience the self in memory from the perspective of the generalized other (e.g., to have more third person memories).

As mentioned briefly earlier, another view of the development of autobiographical memory in which language plays a more ancillary role is one in which children's own self-awareness or autonoetic consciousness is the critical necessary ingredient. For example, Perner and Ruffman (1995) argue that autobiographical memory follows achievements in metacognition in which children begin to have recollective experiences of remembering (as opposed to simply knowing about) past events, experiences that are unlikely to occur before the age of 3–5 years. They contend that young children's need for scaffolding and prompting in order to elicit recollections means that their memories are dominated by the contents of adults' questions and suggests a noetic rather than an autonoetic form of remembering. Like the sociolinguistic model, mother's elaborated talk about past episodes is thought to play a significant role in the evolution of autonoetic consciousness as well as in children's theory of the mind (see Perner & Ruffman, 1995). Although conscious awareness of oneself and one's experiences may be a component of episodic memory more generally, and may play a role in the accumulation of autobiographical memories throughout childhood, it

does not appear to be necessary for the initial onset of autobiographical memory. That is, although the *experience* of remembering often accompanies autobiographical recall (e.g., see Conway, 1996), the existence of personalized memories is not contingent on such experiencing.

What these language-based theories of the development of autobiographical memory contribute to the debate is that the language environment of the child be it familial or cultural serves to teach children that *reporting* memories is important, that such reports have a particular *narrative structure*, and a particular *social and cognitive function*. Further, language can serve to strengthen (or alter) the content of events to be preserved over time. The importance of this role for language and language interactions in autobiographical memories is not a matter of debate. What is controversial is the role of language in the initial onset of autobiographical memory. We have argued here and elsewhere (Howe, 2000; Howe & Courage, 1997) that its role is negligible with the critical event being the onset of the cognitive self. Once this latter event has occurred, the foundation for autobiographical memory has been laid and only then can the variety of other (experiential) factors (including language) and individual differences come into play to shape and mold our autobiographies and to permit us to reflect upon them. As we show next, this is also what the data show.

Recent empirical evidence

Only recently has there been any empirical research which has examined the role of the onset of the cognitive self and early language conjointly. In the first such study, Harley and Reese (1999) repeatedly examined 58 mother–child dyads when the children were 19-, 25-, and 32-months-old. The toddlers were tested on a number of dimensions including language, self-recognition, deferred imitation, and, in conjunction with their mothers, memory conversation styles. For this latter measure, children's verbal memory and maternal reminiscing style (low or high elaboration) concerning real, one-time events in the past were evaluated at each interview. In order to evaluate the roles of self-recognition and maternal reminiscing styles in the development of children's talk about the past independent of children's language and nonverbal memory abilities, analyses were conducted on data in which variability in a language measure and a nonverbal memory measure (deferred imitation) were removed. The results showed that both self-recognition and maternal reminiscing style contributed independently to verbal memory with self-recognition emerging as a stronger predictor. In fact, memory appeared to be developing faster in early than late self-recognizers. The authors concluded that their data provided the first direct empirical support for the argument that it is the advent of self-recognition that spells the end of infantile amnesia. Interestingly, a follow-up study revealed that what was remembered over the long haul was related to maternal reminiscing styles. However, there are any number of reasons why this result is not surprising—some related to measurement (e.g., use of verbal recall measures), some related to rehearsal (e.g., more rehearsal of shared information), and some related to changes in self and

memory at the level of storage (e.g., alterations in knowledge and organization of information, distinctiveness of events). Consistent with findings reviewed elsewhere in this article, these latter findings indicate that conversational exchanges play a significant role in the maintenance of autobiographical memories over time, although such maintenance does not insure accuracy.

In a previously unreported series of cross-sectional and longitudinal studies from our lab, we are examining a number of measures of children's early self-recognition, language, and event memory. The goal is to track coincident changes in these variables over time and to determine their developmental sequence vis-a-vis the onset of autobiographical memory. In the first wave of this research, 90 infants participated in a cross-sectional study, 10 from each of the age groups 15, 16, 17, 18, 19, 20, 21, 22, and 23 months. These infants participated in standard mirror self-recognition and photo self-recognition tests once and in an event memory recall test following a 3-, 6-, or 12-month delay. Measures of language acquisition were taken on both occasions. An additional 12 infants were followed longitudinally over this same age range and participated in the test activities every two weeks. A brief description of key procedural details follows.

(1) *Self-recognition measures*. These included (a) the classic "rouge task" in which a spot of face paint was surreptitiously applied to the infant's nose and his/her reaction to the mirror image is noted. If the child did not show mark-directed behavior we prompted with the questions "Who has a mark on their nose?" and "Who has a funny nose?"; (b) a photo identification task in which the infant had to identify his/her photo (taken about 20 min earlier) from an array of three, 4×4 in. photos of same age, same sex infants; and (c) a video identification task in which the child had to identify him or herself from a video of their participation in the rouge task made 3-, 6-, or 12 months earlier.

(2) *Language development measures*. After the first and second visits to the lab, parents were given the age appropriate version of the *MacArthur Communicative Development Inventories* to fill out at home and return by mail.

(3) *Event memory measures*. In order to assess the infant's recall of the testing experience following a 3-, 6-, or 12-month delay we created an "event" that might be distinctive and memorable. Accordingly, on the initial visit to the lab we led the child to an adjacent room where a replica of the popular television character Tinky-Winky was "sleeping" in the bottom drawer of a file cabinet. The drawer was opened and the child was allowed to remove the toy and play with it for several minutes before "putting it back to bed." After the appropriate delay interval, the child returned to the lab and was given the opportunity to find Tinky-Winky. A second measure of memory for the initial event was taken when the child returned to the lab where the Rouge Task had been conducted several months previously and again seated in front of the mirror. They were given a free recall trial in which spontaneous self-recognition behavior was coded (1 = no response, 2 = any mark-directed or verbal behavior relating to the previous red spot). Following this (if necessary), the child's recall was cued with the question "Do you remember who had a funny nose?" The correct answer had to include verbal or gestural reference to the self. Infants and parents in the longitudinal group experienced the same procedure except that it was

repeated every two weeks in their homes. Exceptions were that Tinky-Winky was hidden in a carry-bag and the delayed mirror and video tests were excluded.

Although the results of this study are preliminary, we summarize some of the findings as they relate to the onset and sequencing of self-recognition, language development, and event memory. First, the results of mirror self-recognition in the cross-sectional sample were consistent with the classic findings in showing wide variability in the age of onset (15–23 months in our sample) with the median age of 19 months. Although the verbal prompt was not effective, we serendipidously discovered that a nonverbal prompt (we silently passed the child a tissue) was effective in eliciting mark-directed behavior in some "ambiguous" children (i.e., those who stared fixedly at the mirror or looked shy but did not touch their noses). This suggests that infants may have self-recognition somewhat earlier that indicated by the standard red-mark test (see also Asendorpf, Warkentin, & Baudonniere, 1996). Consistent with this, infants in the longitudinal group showed self-recognition at a median age of 17 months, an effect most likely due to practice with the task. In contrast, photo self-recognition was not seen in any child in the cross-sectional sample until 17 months and even then was infrequent and unreliable until 22 months. Further, no nonrecognizer was able to identify themselves from a photo. Again, recognition occurred earlier in the longitudinal group, where reliable photo self-identification was seen by about 20 months. Although our photo test was stringent, their difficulty with the task is consistent with anecdotal parent reports that children could correctly name family members in home photos, but when asked to identify themselves would say "baby." This later onset of photo self-recognition supports the view that infants acquire a sense of the "present self" before they understand the "proper self" as extended in time (Povinelli et al., 1996). Recall that in that view, the "proper self" is not present until children are about 4-years-old and is also necessary for the emergence of "true" autobiographical memory. Interestingly however, when the child was shown the videotape of their previous visit and asked to identify themselves and to state who had a funny nose, well over half of the children were successful, an impressive feat given that their appearance had changed over the interval. It would seem then, that children do have a sense of self that extends at least across the intervals tested here (12 months), and that autobiographical memory, as indexed by the more conservative "proper self" measure, has a much earlier onset than the age of 4 years.

The measures of language were scored for total vocabulary and the use of self-referent pronouns (e.g., me, my, mine, I). Not surprisingly, infants' productive vocabulary was linearly related to age ($r = .42$, $p < .01$) and ranged from a mean of 21 words at 15 months to 240 words at 23 months in our samples. There was also variability in the age at which infants began to use personal pronouns (from 15 to 21 months) although most did so by 20 months and subsequent to successful mirror self-recognition. However, a 2 (self-recognition and no self-recognition) $\times$ 2 (pronouns and no pronouns) analysis of covariance (ANCOVA) in which age served as the covariate ($F(1, 49) = 4.28$, $p < .05$) revealed no significant differences in productive vocabulary as a function of recognition status or personal pronoun use. However, across all ages, self-recognizers used significantly more personal pronouns than nonrecognizers ($\chi^2 = 12.6$, $p < .001$). These findings, along with those on

self-recognition, indicate that for most infants the use of personal pronouns follows the achievement of self-recognition. This conclusion was strengthened by the results of a scalogram analysis conducted to test whether the sequence of behaviors demonstrated a Guttman-type scale (see Green, 1956). When this was done using the order of what we found to be successful performance on these self tasks (i.e., mirror self-recognition, then personal pronoun use, then photo identification), the performance of 86% of the cross-sectional group and 80% of the longitudinal group fit the scale and provided a coefficient of reproducibility of .87 (where .50 indicates scalibility).

The primary event memory measure consisted of finding Tinky-Winky who had been hidden on the previous visit. At the follow up, the child was asked "Do you remember our Tinky-Winky? Can you find him?" If necessary, prompts were given (e.g., "He's asleep. Do you remember putting him to bed with his blanket and pillow?"). Recall for the cross-sectional subjects was scored as: (0) no response, (1) child leaves the initial room, (2) child finds the correct room, (3) child searches any file cabinet drawer, and (4) child searched the correct drawer. Recall on the retention test session (3, 6, or 12 months) was analyzed using an ANCOVA where vocabulary was the covariate and age, gender, delay interval (3, 6, or 12 months), photo recognition status (yes or no), pronoun use status (yes or no) and self-recognition status (yes or no) were between-subjects variables. The covariate was not significant and the only variable that contributed to memory performance was self-recognition status, with self-recognizers performing reliably better on the memory task than non-self-recognizers (recall = 2.28 vs 0.78). In the longitudinal sample, no infant recalled the location of the toy prior to achieving mirror self-recognition and none used personal pronouns before achieving mirror self-recognition.

In a second test of event memory at the follow-up, children returned to the room where the rouge test had been performed initially and were prompted to recall the previous rouge task and to identify themselves in the mirror. Though most children indicated self-recognition in situ either by showing a shy look, stating their name or "me," few indicated verbal recall of the event autobiographically, that is, by correctly indicating that they had had a "funny nose" on the prior occasion. Importantly, however, some children *did* indicate nonverbal autobiographical recall by touching their own noses as they had done initially. Although these findings are preliminary and the procedure needs to be refined, to our knowledge we are among the first to report a task with the potential to afford a nonverbal measure of autobiographical recall of the event (see also Simcock & Hayne, 2002).

Conclusion

The results just reviewed, along with those of Harley and Reese (1999), indicate that the emergence of the cognitive self is developmentally prior to achievements in language development in general and to self-referent language in particular, and we contend, to the onset of autobiographical memory. Although we have no direct evidence that our event memory measures were autobiographical (except for the provocative finding that some children who were self-recognizers on the rouge task also

touched their un-rouged noses when seated before the mirror several months later), we do know that it was only that group of children who showed self-recognition that were the ones who also showed long-term recall of the toy hiding event. Further research is clearly needed to map out these temporal relationships and to consider them in the context of the cognitive and linguistic developments (e.g., knowledge acquisition and reorganization, increased durability of stored information, greater facility with language to report memories) that will refine, extend, and support autobiographical memory subsequently. One thing that is clear is that the basic requisites are present by about 2 years of age. That such memories do exist is without doubt—we have shown that they are present during early childhood and many have shown that such memories can (but may not) survive into later childhood and adulthood (e.g., see Eacott & Crawley, 1998; Usher & Neisser, 1993). Although the onset of the cognitive self sets the lower limit for the formation of autobiographical memories, it does not guarantee that such memories will be formed at that age. Indeed, personalized memories may not be formed until sometime later depending on a host of individual, situation-specific, and memory-specific factors. Although the launching of autobiographical memory itself is not contingent on advances in narrative skills or extending oneself in time, the subsequent ability to retain more autobiographical information with age in childhood does depend on global improvements in children's memory and retention abilities, including changes in their sociolinguistic and metacognitive skills.

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