Turning memory development inside out

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Received 4 August 2004
Available online 12 October 2004

Abstract

These papers provide a useful progress report on how the mature and successful field of memory development is transcending traditional boundaries of populations, content, context, and design. Examining children’s memory for distant as well as recent occurrences, for social interactions as well as individual experiences, for meaningful as well as arbitrary information, and for emotion-laden as well as neutral experiences is creating a broader and more vigorous field. Even greater progress can be made by measuring at a fine grain level the processing activities that experiences elicit, how such immediate processing activities shape later memory, and how changes in processing with age and experience produce memory development.

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This special issue is a progress report on a mature field, one with a long tradition of excellent research. In large part because of that strong tradition, the area of memory development has been more stable in recent years than many other areas of developmental psychology. This phenomenon is apparent in textbook coverage, including that in my own book, “Children’s Thinking.” Over the two decades from the earliest edition (Siegler, 1986) to the most recent (Siegler & Alibali, 2004), most of the basic organizing constructs regarding memory development have remained the

Note: Preparation of this chapter was supported in part by Grant HD19011 from the National Institutes of Child Health and Human Development and Grant R305H020060 from the U.S. Department of Education.

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0273-2297/$ - see front matter © 2004 Published by Elsevier Inc.
doi:10.1016/j.dr.2004.08.007
same: encoding, storage, and retrieval; episodic and semantic memory; implicit and explicit memory; procedural and declarative memory; basic processes, strategies, metamemory, and content knowledge; and so on. New sub-areas have arisen, such as the study of eyewitness testimony, but the basic structure has remained intact. This stability contrasts with the situation in some other areas of development such as conceptual development, where the basic structure has been transformed by the theory–theory approach, and motor development, where the basic structure has been transformed by dynamic systems theory.

A stable structure is not at all synonymous with a lack of progress, however. As the articles in this special issue illustrate, the field of memory development is continuing to make significant progress. It is achieving this progress by transcending traditional boundaries of populations, content, context, and design.

For many years, the canonical memory development experiment involved one-shot laboratory examinations of isolated 4- to 10-year-olds engaging in minimally meaningful mnemonic behaviors: repeating lists of unrelated words, numbers, or letters; organizing sets of objects into categories and then recalling which objects were present; associating arbitrary words or pseudo-words with each other; and so on. This canonical design was identified by Brown and DeLoache (1978), and as is evident in several articles in this issue, its popularity has continued to the present day.

However, the canonical design is becoming less dominant than it was. Rather than most studies examining children’s memory within a single session, many now examine memory over substantial periods of time: weeks, months, even a year, or more. Each of the four articles in this issue reflects this change, as do the research programs of all of the individual investigators. The change seems highly desirable, because in the everyday environment, the vast majority of uses to which memory is put span substantial time periods; in fact, there are precious few situations in which people need to remember something for half an hour but no longer. Put another way, the focus on longer time periods has enhanced the ecological validity of memory development research.

A second change from the canonical memory development study is the focus on social interaction. Rather than conceptualizing memory as a process engaged in by the individual child, all of the studies in the special issue directly, or indirectly recognize that memory is a social interactive process as well as an individual one. This point was pursued most directly by Ornstein, Haden, and Hedrick, who focused on the ways in which mother–child interactions influenced children’s short- and long-term recall of meaningful events. However, the trend is evident in the other papers as well. Both Brainerd and Reyna (this issue) and Pipe, Lamb, Orbach, and Esplin (this issue) examined how the particular questions asked by other people, the timing of the questions, the attitude toward the child taken by the other person, and the exact protocol followed by the interviewer, influenced children’s recall of events. Imitation, the subject of Bauer’s research, is an inherently social process, and understanding of psychological characteristics, such as whether behaviors are intentional or inadvertent, influences even toddlers’ likelihood of imitating other people’s actions.

A third type of expansion beyond the canonical memory development experiment involves the content that children are asked to remember. Rather than asking chil-
children to remember arbitrary lists or to form arbitrary associations, the articles in this special issue emphasize memory for meaningful material. Bauer asks children to remember how to build small, functional toys; Ornstein et al. ask children to remember enjoyable special events such as archaeological digs and pirate adventures; and Pipe et al. and Brainerd and Reyna describe studies in which children are asked to remember complex social interactions, including traumatic ones.

Related to both the second and third points is the surmounting of barriers between the study of memory and the study of emotion. This is probably most evident in the studies of eyewitness testimony reviewed by Pipe et al., but it also is present at times in the work reviewed by Ornstein et al. and by Brainerd and Reyna. In addition to the issue of whether memory for emotion-laden experiences such as trauma differs from memory of more neutral experiences, many of these studies also examine the role of the child's emotion regarding the interviewer and the people whose behavior is being remembered. This transcending of the artificial barrier between the study of memory and the study of emotion is again a welcome development.

Two other types of expansion, reflected in some but not all of the articles, are also noteworthy. One expansion is in the age groups that are studied. In the past, the large majority of memory development studies focused either on 4- to 10-year-olds or (increasingly in recent years) on infants. Bauer's imitation paradigms have made possible the investigation of memory development in the in-between period (end of the first year to end of the third), about which much less is known. A second type of expansion, also best represented by Bauer's research, is toward examining the neural substrate of memory. As she notes, research on the neural basis of memory development has lagged behind research on the neural basis of adult memory. Although it appears that neuroscientific methods such as fMRI are safe for use with children, sufficient concerns remain that very few neuroimaging studies on typical children have been conducted. The less spatially precise, but also less invasive, ERP method used by Bauer and her colleagues can yield valuable data about the neural basis of memory development without raising the concerns that accompany use of other imaging methods.

These expansions of the field of memory development reflect both extrinsic and intrinsic motivations. Granting agencies, under increasing pressure to demonstrate the value of the research they fund, have increasingly favored studies whose practical benefits could be realized in the here and now rather than in the hereafter. Victims rights groups, the legal profession, and a variety of social policy constituencies all have contributed to the demand for research that could help them obtain the most accurate possible eyewitness testimony from children and also help them evaluate the validity of the testimony that children provide. The advent of theories of cognitive development that emphasize social interaction, in particular sociocultural theories, has stimulated interest in memory for social interactions, and for meaningful cultural practices, such as the camping trips studied by Ornstein et al. Technological developments, not only cutting edge technologies such as neural imaging scanners but also more mundane ones such as camcorders and VCRs, have made possible far more rigorous analyses of memory for complex situations than was possible heretofore. Without these technologies, it is difficult to see how any of the research programs described in this special issue could have been pursued.
The internal logic of the field, together with the intrinsic desire of individual researchers to do what no one has done before, also has played a large role in these changing research emphases. The existence of so many high quality, single session, behavioral studies of lone 4- to 10-year-olds learning emotionally neutral material stimulated a search for genuinely new paths, rather than more of the same. Looking backward, the sequence of research emphases makes a great deal of sense. Imagine the field of memory development as a Piagetian child. Just as infants in the sensorimotor stage focus on the interface between themselves and the environment, so did the field initially focus on the child/environment interface in the form of behavior in particular situations. And just as toddlers and preschoolers progress beyond that interface to probe both inward (to understand their own minds) and outward (to understand other people and the broader world), so is the field of memory development increasingly probing both inward (to understand how the developing brain remembers) and outward (to understand how the sociocultural context influences remembering).

The Piagetian child analogy also works at another level. Preoperational achievements are impressive relative to sensorimotor ones, but they are less impressive in absolute terms. The same may be said of the accomplishments to date of the field of memory development (and of pretty much all areas of developmental psychology). Our degree of satisfaction with the current state of the field must depend on whether we are focusing on relatives or absolutes. Relative to where the field was a decade or two ago, the progress is impressive. In absolute terms, however, the field seems to me at least to be far from where it needs to be. In particular, although the range of phenomena and populations that are being explored has been considerably extended, understanding of the key underlying issue—how change occurs—has not shown comparable progress.

A large part of the reason, of course, is that understanding the process of change is genuinely difficult. It is also fair to note that the area of memory development is far from alone in this limitation. Moreover, at least two of the papers in this special issue, those of Ornstein et al. and Bauer, explicitly recognize the limitation. As Ornstein et al. put it, the area needs to focus not only on memory development but also on the development of memory.

One step that seems important for progressing toward a better understanding of the development of memory is a deeper assimilation of the lesson that external conditions can influence development only to the extent that they influence children’s mental and physical activity at the time of the original event. Logically, all of memory is memory of our own mental activity. Events in the external environment cannot be remembered; all that can be remembered is our processing of them.

This is not an idle philosophical distinction; instead, it points in a direction that I believe is fruitful for understanding cognitive change. Specifying the external conditions to which children are exposed and age-related differences in their recognition or recall, is just the beginning of the task of understanding the development of memory. The task also requires specifying the child’s processing of those external events, because it is that processing that eventually will or will not be remembered. In a sense,
then, what needs to be done is to turn the field inside out—to focus on internal processing of experiences, rather than on stimuli, and responses.

This is not a new point. Craik and Tulving’s (1975) research on depth of processing and encoding specificity and Bransford and Johnson’s (1973) demonstrations of the crucial role of understanding the context of events are two of many examples of the perspective. It is also fair to note that the main constructs that organize the present articles and much of the field—encoding, consolidation, storage, recall, and so on—do refer to internal processing. However, in practice, the measures of these constructs are quite indirect and only convey limited information about children’s processing activity. For example, although initial encoding of experiences is recognized as important in all of these articles, it would be difficult to specify from any of them what, exactly, children encoded from their experiences in the experiments. The problem is not that anyone is against detailed specification of processing activity; there is broad consensus that it is a good thing. Instead, the problem is that it is easy to fool ourselves into thinking we have gone further toward specifying processing than we have. There is a constant temptation to think that specifying the experimental manipulation also specifies the processing done in response to the manipulation, and also to think that giving a construct a process name, such as encoding or consolidation, and providing an operational definition of the construct, means that we have specified the processing.

The point is worth considering in the contexts of two articles in this special issue that focused on change to an unusual, and commendable, degree: the articles by Bauer and by Ornstein et al. Bauer lays out an interesting and well-supported account of the neural bases of explicit memory in adults and goes on to propose an interesting and plausible, though more speculative, account of the neural bases of development of explicit memory. The developmental account emphasizes structural changes in number, density, and connectivity of cells and synapses in medial temporal areas, primary association areas, and prefrontal cortex.

Although interesting, the developmental account ignores children’s mnemonic activity as a source of change; the structural changes are described as if they are simply realizations of a maturational blueprint. This is a significant limitation, even in a model that emphasizes anatomical aspects of development. As the work of Greenough, Black, and Wallace (1987) and of Johnson and Morton (1991), among others, has shown, anatomical development does not occur in a vacuum. Patterns of connectivity and synaptic density are shaped in large part by the processing activity in which the child engages. To cite one well-known example, in the brains of deaf children, areas that would ordinarily process auditory stimuli come to process visual stimuli, due to the lack of auditory stimulation. Conversely, in the brains of blind children, areas that would ordinarily process visual stimuli come to process auditory stimuli (Neville, 1995). At a more molecular anatomical level, unsuccessful attempts to process information result in formation of new synaptic connections within 15 min of the unsuccessful processing (Chang & Greenough, 1984). Note that it is not exposure to the situation per se that produces the new synaptic connections; instead, the key factor is the unsuccessful processing activity in particular areas of the brain. Neural development does not just happen; it reflects in large part the organism’s past processing activity.
The same point applies in the very different context of Ornstein et al.’s research on the effects of mother–child conversations on children’s memory. On the basis of both correlational and experimental evidence, Ornstein, Haden, and their collaborators concluded that maternal questions and comments influence children’s long-term memory for rich, real world experiences, such as archaeological digs. However, examination of their data, for example the 3-week follow-up data in Haden, Ornstein, Eckerman, and Didow (2001), reveals that in the absence of children’s verbal participation, mothers’ comments had modest effects. To support the importance of maternal elaborations, Ornstein, Haden, and Hedrick (this issue) reported that after taking into account children’s language skills and elaborative talk during the activity, maternal elaborations uniquely accounted for 5% of the variance in children’s recall of the events. However, this was 5% out of a total of 49% of variance accounted for when the children’s language skills and elaborative talk were also considered. At minimum, this finding suggests that the children’s processing activity, as reflected both in their speech and in their nonverbal mental activities, must be considered to explain their subsequent remembering.

I singled out these two examples not because they are unusual or egregious, but precisely because they demonstrate that the problem arises even in first-rate memory development research. The examples also suggest that establishing how memory develops will require a deeper assimilation of Simon’s (1962) insight that children are self-modifying systems than has commonly occurred thus far. To understand the development of memory and how external circumstances affect it, we will need to carefully examine how their ongoing mental and physical activity shapes their subsequent activity. Put another way, we need to turn the field inside out by directly measuring the processing activity that experiences elicit, how that processing activity shapes what they remember, and how changes in processing activity with age and experience shape the development of memory.

References


